WHO Regional Publications, Eastern Mediterranean Series 6

Health laboratory facilities in emergency and disaster situations

Second edition

World Health Organization
Regional Office for the Eastern Mediterranean

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Contents

Foreword

Complex emergencies and disasters of various types and natures may strike any country or region in the world causing destruction, suffering, high loss of life and property, and are often followed by epidemics causing more loss of life.

The first edition of *Health laboratory facilities in emergency and disaster situations* was unique, filling a gap with important information and laboratory tools needed to respond to emergencies and disasters. It has been comprehensively updated and expanded with detailed modules designed to meet modern needs.

The material and information presented in this second edition is relatively simple, affordable and appropriate, and applicable to emergencies and disasters in general, especially in difficult environments encountered in many countries with limited resources.

I am sure that this book will be of great benefit to the laboratory personnel who work in disasters and emergencies as well as to international agencies, national authorities and other bodies involved in emergency and disaster relief. I highly recommend it for worldwide consideration and use.

Prof. Dr. med. Hans Reinauer

Former president of the Society for Promotion of Quality Assurance in Medical Laboratories (INSTAND e.V.)

Former president of the World Association of Societies of Pathology and Laboratory Medicine (WASPaLM)

Preface to the second edition (2017)

Many countries are vulnerable to disasters and emergencies, and a number of countries in the Eastern Mediterranean Region have suffered from such situations in recent years. The Eastern Mediterranean Regional Office of the World Health Organization has identified a need for guidelines on health laboratory services and problems associated with disasters and emergencies that fall within the scope of these services. In 2016, the WHO World Health Assembly created a new Health Emergencies Programme (WHE). This second edition will contribute towards improving early response.

As was the case for the first edition, this second edition is intended to provide information on the provision of basic laboratory services in emergencies. It is aimed at all health professionals, including managers, physicians, nurses, laboratory technicians and other paramedical staff.

The material and information presented are also intended to assist international agencies, national authorities and other bodies involved in emergency and disaster relief in drawing up contingency plans for the provision of emergency laboratory services. These national contingency plans should enable those involved to respond rapidly and specifically to the needs of the situation.

Chapters on testing water supplies; energy supply; laboratory equipment; supply of blood for transfusion in emergencies; collection, storage and transport of specimens; and laboratory kits and modules are updated and significantly expanded. The authors hope the revised and expanded modules with new flow charts outlined in Chapter 6 will aid the reader in the selection of modules and additionally will help motivate those involved in preparing for a disaster with "ready to go" laboratory modules and kits. Chapter 6 had to stand on its own, hence there is necessary repetition (such as detailed specifications of equipment) in some modules; this is especially important for those who would prepare modules and assemble kits.

It should be emphasized, however, that this publication describes laboratory services and modules that are intended for emergencies and therefore may not necessarily represent what would be recommended for health laboratory services functioning under normal conditions. Nevertheless, under any conditions, principles of quality assurance must always be applied and laboratory safety respected.

This book is not designed to be a detailed technical textbook or a stand-alone training manual. Throughout the text it has been assumed that the laboratory staff involved are technically competent and well trained in good laboratory practice and quality assurance. For this reason, with a few exceptions, no laboratory testing technical procedures details are given.

Preface to the first edition

Many countries are vulnerable to disasters and emergency situations and a number of countries in the Eastern Mediterranean Region have suffered from such situations in recent years. The Eastern Mediterranean Regional Office of the World Health Organization has identified the need for guidelines on health laboratory services and problems associated with disasters and emergency situations that fall within the scope of these services.

This publication is intended to provide information on the provision of basic laboratory services in emergency situations. It is aimed at all health professionals, including physicians, nurses, laboratory technicians and other paramedical staff.

The guidelines are also intended to assist international agencies, national authorities and other bodies involved in emergency and disaster relief in drawing up contingency plans for the provision of emergency laboratory services. These plans should enable those involved to respond rapidly and specifically to the needs of the situation. It should be emphasized, however, that the guidelines describe laboratory services that are intended for emergency situations and therefore may not necessarily represent what would be recommended for health laboratory services functioning under normal circumstances. Nevertheless, under any conditions, principles of quality assurance must always be applied and laboratory safety respected.

Throughout the text it has been assumed that the laboratory staff involved are technically competent and well trained in good laboratory practice and quality assurance. For this reason, with a few exceptions, no technical details are given.

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[1] Also authors of the first edition of WHO Regional Publications, Eastern Mediterranean Series No 6: Health laboratory facilities in emergency and disaster situations, 1994.

Introduction

There are various definitions for "emergency" and "disaster". For the purposes of this publication the following definitions of "emergency" and "disaster" are used.

Emergency

A situation impacting the lives and well-being of a large number of people or a significant percentage of a population and requiring substantial multi-sectoral assistance. For a WHO response, there must be clear public health consequences.[2]

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.[3]

Emergencies and disasters demand prompt and adequate responses, and the provision and monitoring of relief will be required until normal services can be resumed. To meet these demands, contingency plans and preparedness are of fundamental importance. In order to be able to respond quickly and adequately to an emergency or a disaster, every country should formulate a national contingency plan and establish mechanisms for emergency preparedness and response in the health sector. The national plan should encompass coordinated multisectoral emergency activities. All aspects, including the plan for emergency health services, should fit into the established administrative structure. The provision of disaster relief may require the support of health laboratory services. Therefore a national programme of emergency health services should include provision for an emergency health laboratory service.

When formulating a national plan for timely and appropriate response to emergencies and disasters a presumptive assessment of needs should be made. The assessment of needs depends upon many factors, some of which relate to the type of disaster (for example, earthquake, destructive wind, flooding, extreme climate, epidemic, war, famine) and others which relate to local conditions (for example, national economic situation; geographic conditions; state of transport

[2] Emergency response framework. 2nd ed. Geneva: World Health Organization; 2017 (http://apps.who.int/iris/bitstream/-9789241512299/1/258604/10665eng.pdf?ua=1).

[3] Operational framework for building climate resilient health systems. Geneva: World Health Organization; 2015 (http://apps.who.int/iris/bitstream/9789241565073/1/189951/10665_eng.pdf?ua=1&ua=1

and communication; availability of health facilities in the country as a whole and specifically in the affected area; number of people affected; availability of water, food, sanitation facilities, shelter and electricity). Those responsible for a national programme of emergency health services should have readily available a list of external health relief agencies to be contacted, should external support be needed (see Annex 1 for a list of agencies providing health relief).

Information on the prevalence of priority diseases needs to be constantly evaluated and updated through a national surveillance system so that when emergencies occur, the baseline information is readily available. In emergencies and disasters, basic medical care is essential to limit morbidity and mortality due to infectious diseases and other health conditions. It is recommended that disease information and current trends of disease known to be endemic to the region of the disaster be reviewed.

Morbidity and mortality may result from an increase in the prevalence of existing endemic diseases, such as measles or infantile gastroenteritis, or from epidemic diseases such as cholera, typhus or malaria. Disease surveillance is an essential component of disaster assessment and for monitoring the effectiveness of relief interventions. Some diseases, such as measles, have a typical clinical presentation of patients which permits diagnosis without laboratory investigations. However, many infectious diseases require laboratory facilities to make or confirm diagnosis or to enable valid epidemiological data to be collected.

Emergency laboratory facilities operating in response to disaster face many constraints, including remoteness of location, lack of reagents, limited equipment and power supplies, and insufficient numbers of trained staff. Among other frequently encountered constraints is a lack of: effective supervision, access, support (supply, training, quality control, etc.) and communication between reference laboratories and field laboratories/testing sites directly serving the affected areas. Additionally, in some situations (for example, an earthquake) the national reference laboratories themselves are in a state of emergency. Experience gained from disasters and famine relief areas over the past two decades has provided important information on the optimal use of laboratory services with limited resources.

The primary objectives of laboratory services in emergencies and disasters are the prevention or control of infectious diseases, by identification of the causative agent(s) of outbreaks, and the management of conditions that occur secondary to the prime cause of the outbreak/disaster such as anaemia and trauma. Advances in technology have allowed for much more portable, capable and compact clinical testing systems designed to perform well in a range of conditions including emergencies and disasters. It is critical that laboratories in developing countries have the right tools to properly support the advances in clinical medical practice over the past two decades. Chapter 6

of this book contains descriptions of modules which have been designed to meet basic testing needs using methodologies appropriate for situations which could be faced by the great majority of countries, especially those with limited resources. The reason these modules are effective is they are designed to be fully supported by a country's laboratory network. The whole concept is that the modules, with a few exceptions, are not stand-alone; they must be supported and built to meet the needs of any given emergency or disaster. In some circumstances/contexts, it may not be possible to send a module in total, but capability will then be limited accordingly.

The response to emergencies and disasters can be addressed on two levels: the early emergency response phase (immediate relief) with short-range goals; and the recovery, rehabilitation and reconstruction phase with long-range goals. The early emergency response phase can also be further categorized as acute phase or post-acute. This publication mainly addresses the early response phase which in due course can contribute substantially to the recovery phase with its long-range goals. As a matter of fact, one cannot exactly tell at which point the immediate relief (immediate aftermath) phase changes to the recovery phase. That is why planning for the recovery phase should commence immediately in parallel with the early response. Another important factor for beginning with plans for the recovery phase in parallel with the early response phase is that efforts to raise funds and secure other necessary resources are more successful in the early phase. It is also important to bear in mind that physical reconstruction often happens more quickly than capacity-building. Capacity-building should be among the top priorities in any type of planning.

1. Diseases and medical conditions commonly associated with disasters

Health problems are associated with different types of disaster. Box 1.1 lists various types of disaster. A list of the diseases and medical problems that may be associated with these disasters is shown in Table 1.1. Not all of these problems will occur in every disaster. Some are dependent upon geography; for example, a flood or tidal wave in a tropical area may create the conditions for an outbreak of malaria, but this is unlikely to happen in temperate climates. Other problems, such as outbreaks of dysentery and gastroenteritis, may occur anywhere.

The conditions listed in Table 1.1 are frequently interrelated but may also occur independently. The risk factors for potential outbreaks of disease should be assessed early on by a team of experienced health professionals. Risk factors for infectious diseases must be taken into consideration when contingency plans for disasters are drawn up by national authorities. Table 1.2 shows: specimen to be examined, field laboratory tests and referral laboratory tests for certain communicable diseases encountered in disasters. Modes of transmission of diseases are outlined in Table 1.3. Modes of transmission include inhalation, injection, induced trauma and vectors.

Box 1.1 Types of disaster

Natural
- epidemics
- earthquakes
- tsunamis
- volcanic eruptions
- landslides
- bush fires
- climatic changes including floods, severe storms, hurricanes, tornados and droughts

Man-made and technological causes
- war and armed conflict
- environmental pollution
- terrorism (bioterrorism and explosions)
- major transport accidents (accidents involving air, maritime and rail transport)
- transport incident
- industrial explosion, fire, spill or radiation

Natural or man-made disasters may result in the following:
- population displacement and formation of camps for displaced people or refugees
- famine
- droughts
- fires

Table 1.1 Diseases and medical conditions encountered in disasters

Disease/medical condition	Population displacement	Epidemic	Earthquake/ volcanic eruption	Flood/ tidal wave	Drought	War	Environmental pollution
Aids/HIV	1	0	0	0	0	1	0
Anaemia	2	0	0	0	1	0	1
Anthrax	1	1	0	1	0	0	1
Cholera	2	2	0	2	1	1	1
Dehydration	1	0	1	0	1	1	0
Dengue[a]	1	1	0	1	0	0	0
Diphtheria	1	1	0	0	0	0	0
Dysentery/ gastroenteritis	2	2	0	2	1	1	1
Enteric fevers	2	2	0	1	1	1	1
Haemorrhagic fever[a]	1	1	0	1	0	1	0
Hepatitis A	1	1	2	2	1	1	1*
Intoxication	0	1	0	0	0	0	2
Leptospirosis	1	1	0	1	0	1	2
Leishmaniasis	1	1	0	0	1		
Malaria	2	2	0	1	1	1	0
Malnutrition	2	0	0	0	1	1	0
Measles	2	1	1	1	2	1	0
Meningitis	1	2	0	0	0	1	0
Plague[a]	2	1	0	0	0	1	0
Poliomyelitis	1	1	0	1	0	0	1
Protozoan dysentery	1	1	0	1	1	1	1
Relapsing fever[a]	2	2	0	0	0	1	0
Streptococcal disease	0	1	2	0	0	0	0
Tetanus	1	0	2	1	0	2	0
Trauma	1	0	2	2	0	2	0
Tuberculosis	1	1	0	0	0	0	0
Typhus[a]	1	1	0	0	1	1	0
Viral encephalitis	1	0	0	1	0	0	0
Whooping cough	1	0					

0 = rare problem
1 = potential problem (depends on area)
2 = likely problem (depends on area)
[a] Particularly in endemic areas

Table 1.2 Diagnosis of certain communicable diseases in disasters[a]

Disease	Specimen examined	Field laboratory	Referral laboratory
AIDS/HIV	Serum/plasma/ whole blood	EIAs including RDTs A reactive rapid HIV test result must be confirmed with a follow-up confirmatory test before a final diagnosis of infection can be made. Confirmation of all reactive rapid HIV test results with HIV antigen testing, even if an EIA screening test is negative	- HIV antigen testing - HIV EIAs including combination antigen–antibody immunoassay - NAT - CD4 count for antiretroviral therapy
Anthrax	Aspirate, sputum, cerebrospinal fluid, blood	Microscopy	Culture
Bacterial dysentery/ gastroenteritis	Faeces	Serological agglutination Microscopy	Culture
Cholera	Faeces	RDT	Culture
Dengue	Serum	RDT, EIA	Serology, PCR
Enteric fevers	Blood, faeces, urine	Culture/coagglutination	Culture
Hepatitis	Blood, serum	HBsAg; anti-HCV EIAs including RDT	Immunoassay (EIA/CLIA); NAT
Intestinal helminths and protozoa	Faeces	Microscopy	N/A
Leishmaniasis	Serum, aspirate	RDT, DAT, spleen/bone marrow aspirate microscopy	EIA Spleen aspirate
Leptospirosis	Blood	Microscopy, RDT	Culture, serology
Malaria	Blood	Microscopy, RDT, EIA	N/A
Measles	Serum	EIA	EIA
Meningitis	Cerebrospinal fluid	Gram stain, Indian ink, Ziehl–Neelson stain, protein/ glucose level, serology, RDT	Culture
Plague	Aspirate, sputum, blood	Microscopy, RDT	Culture
Protozoan dysentery	Faeces	Microscopy	N/A
Relapsing fever (*Borrelia recurrentis*)	Blood	Microscopy or referral wet mount (brightfield or darkfield)	Animal inoculation

Table 1.2 Diagnosis of certain communicable diseases in disasters (*concluded*)

Disease	Specimen examined	Field laboratory	Referral laboratory
Syphilis	Serum, cerebrospinal fluid	RDT	EIA (donor blood), VDRL/RPR
Trypanosomiasis	Whole blood, serum or plasma, lymph gland fluid, cerebrospinal fluid	Microscopy Latex/IgM, CATT/*Trypanosoma brucei gambiense*	N/A
Tuberculosis	Sputum	Microscopy, fluorescence microscopy (sputum smear microscopy has poor sensitivity)	Cepheid Xpert MTB/RIF assay that runs on the GeneXpert System, culture and sensitivity
Typhoid fever	Serum	IgM antibody, Widal test, RDT	Culture
Viral diarrhoeas	Faeces	Latex agglutination; immunochromatographic dipstick assays	EIA and RT-PCR
Viral encephalitis	Serum, and cerebrospinal fluid	IgM and IgG serology	Virus isolation, PCR, serology and antigen detection
Viral haemorrhagic fever	Serum	ReEBOV Antigen Rapid Test Kit[c] During Ebola outbreak field laboratories performed ELISA, RT-PCR	Virus isolation, PCR, antibody-capture ELISA and antigen-capture detection tests, serum neutralization test, and electron microscopy[b]

[a] The testing recommendations and algorithms need to be continuously updated.

[b] It is strongly recommended to work inside a certified Class I or certified Class II biosafety cabinet (BSC) when handling or manipulating patient specimens (a Class I BSC will protect the worker, and a Class II BSC will protect the worker and the sample from contamination).

[c] ReEBOV Antigen Rapid Test Kit is a rapid diagnostic test. It is not intended to be used for general Ebola virus infection screening, such as airport screening or contact tracing. Using ReEBOV, a field laboratory with trained personnel capable of such testing can diagnose suspected Ebola cases in 15–25 minutes.

CATT: card agglutination test
DAT: direct serum agglutination test
EIA: enzyme immunoassay
ELISA: enzyme-linked immunosorbent assay
IgG: immunoglobulin G
IgM: immunoglobulin M
MTB/RIF: an assay for rapid and simultaneous detection of *M. tuberculosis* and rifampicin resistance-conferring mutations directly from sputum
N/A: not applicable
NAT: nucleic acid amplification technology
PCR: polymerase chain reaction
RDT: rapid diagnostic test
RPR: rapid plasma reagin (test)
RT-PCR: reverse transcriptase polymerase chain reaction
VDRL: venereal disease research laboratory (test for syphilis)

Table 1.3 Modes of transmission of diseases encountered in disasters

Disease	Mode of transmission						
	Food contamination	Water/ sanitation	Aerosol droplet	Vector/ animal	Sexual contact	Blood/ needles	Other
AIDS/HIV					X	X	MTCT[a]
Anthrax	X	X	X				Spores
Bacterial dysentery/ gastroenteritis	X	X					
Cholera	X	X					
Dengue				X			
Ebola							Direct contact[b]
Enteric fevers	X	X					
Hepatitis B virus					X	X	
Hepatitis C virus					?	X	
Hepatitis A virus	X	X					
Hepatitis E virus		X					
Intestinal helminths and protozoa	X	X					
Leishmaniasis				X			
Leptospirosis	X	X					
Malaria				X		Transfusion	
Measles			X				
Meningitis			X				
Plague			X	X			
Pneumonia			X				
Protozoan dysentery		X					
Relapsing fever (*Borrelia recurrentis*)				X			
Syphilis					X	Transfusion	
Trypanosomiasis, American/ Chagas disease (*Trypanosoma cruzi*)				X		Transfusion	Vector-borne transmission, MTCT[a], ingestion of contaminated food or drink

Table 1.3 Modes of transmission of diseases encountered in disasters (*concluded*)

Disease	Mode of transmission						
	Food contamination	Water/ sanitation	Aerosol droplet	Vector/ animal	Sexual contact	Blood/ needles	Other
Trypanosomiasis, African (*Trypanosoma brucei gambiense*)				Tsetse flies			
Tuberculosis			X				
Typhus				X			
Viral encephalitis				X			
Viral haemorrhagic fever[c]	X	X	X	X		X	Animal reservoir

[a] Mother-to-child transmission
[b] The mode of transmission is by direct contact with the blood, secretions, organs or other body fluids of infected persons; direct contact with the body of the deceased person; or handling of infected dead and alive chimpanzees, gorillas and forest antelopes.
[c] The mode of transmission is usually a vector, but other modes occur depending on the particular virus involved.

Many medical laboratory diagnostic tests are suitable for and can be conducted by an emergency laboratory. Most tests are those that are used in conventional laboratories, but some tests have to be modified for use in the field. Diagnostic laboratory tests can be classified as either direct or indirect. Direct tests are intended to identify the agent causing the disease. Indirect tests examine the host's reaction to the infection or medical condition. Both types of diagnostic tests are appropriate for emergency laboratories. Since infectious diseases are the primary concern in most disasters, direct tests are usually more important.

Disasters often lead to situations in which those affected become displaced persons or refugees. Displaced persons or refugees are often at great distances from or completely without access to satisfactory laboratory facilities. However, very simple laboratory services at site level could be set up by the responding teams. For epidemic management and control of many diseases such as Ebola and other haemorrhagic and relapsing fevers, meningitis, cholera shigellosis, high malarial endemicity, hepatitis, etc., reference laboratory services are needed to confirm or differentiate diagnosis and perform additional advanced testing. WHO and other international organizations and institutions could help to identify suitable reference laboratories and facilitate their availability to assist with such services.

Prioritizing urgent intervention may vary according to the disaster or emergency, whether it is acute or post-acute. At the acute critical moment of disaster or emergency,

while emergency relief activities are in an ongoing process of building up capacity, a decision must be made regarding what to deploy on an urgent priority basis in terms of testing/laboratory support. The Haiti (2010) and Pakistan (2005) earthquakes are examples when deployment of blood transfusion services was required from the start. In Zimbabwe's cholera experience a different type of intervention was required.

In the case of certain infectious disease outbreaks such as an Ebola outbreak, a rapidly deployable field diagnostic laboratory would be very useful, especially in geographic areas where access to reliable and well-equipped diagnostic laboratory services is limited. An example of such a laboratory system is the European Mobile Field Laboratory (EMLab) for pathogens up to Risk Group 4, which is based on the Bundeswehr Medical Mobile Laboratory (BML) developed in 2008 by the Bundeswehr Institute of Microbiology, Munich, Germany. In 2012, The International Development and Cooperation Office of the European Commission's Directorate-General for International Cooperation and Development (EuropeAid) formed the collaborative project entitled "Establishment of Mobile Laboratories up to Risk Group 4 in Combination with CBRN Capacity Building in Sub-Saharan Africa" (EMLab Project). The project, which is funded by the European Union and implemented and coordinated by the Bernhard-Nocht-Institute for Tropical Medicine in Hamburg, Germany, was initiated to respond to infectious disease outbreaks and strengthen the collaboration between European and African scientists. The Project's Consortium assembles partners including European and African institutes and laboratories with experience in diagnostics and research on infectious disease pathogens. The Consortium also includes associated partners as well as organizations relevant to the project such as WHO, the Global Outbreak Alert & Response Network, and the European Centre for Disease Prevention and Control.

The Bundeswehr Medical Mobile Laboratory system is a modular, rapidly deployable laboratory system that provides diagnostic support in resource-limited remote areas. These laboratory units are provided with all the necessary equipment and protocols to enable safe, efficient and comfortable work. The units are able to work in a self-contained manner in the field; they are supplied with a wide-range of laboratory equipment and a variety of diagnostic technologies including quantitative polymerase chain reaction (qPCR), enzyme-linked immunosorbent assay (ELISA), immunofluorescence assays (IFA), immunochromatographic tests and microscopy (conventional light microscopy and immunofluorescence microscopy). The deployable laboratory units provide molecular diagnostics and serology for infectious diseases caused by the high and highest Risk Group 3 and 4 pathogens as well as pathogens of differential diagnostic concern. The units' equipment/appliances include real-time polymerase chain reaction (PCR) cyclers, conventional PCR cyclers, an ELISA plate reader, a microscope, centrifuges,

coolers, biosafety equipment and other small equipment. The units also have a medical kit for the treatment of minor health problems of field staff.

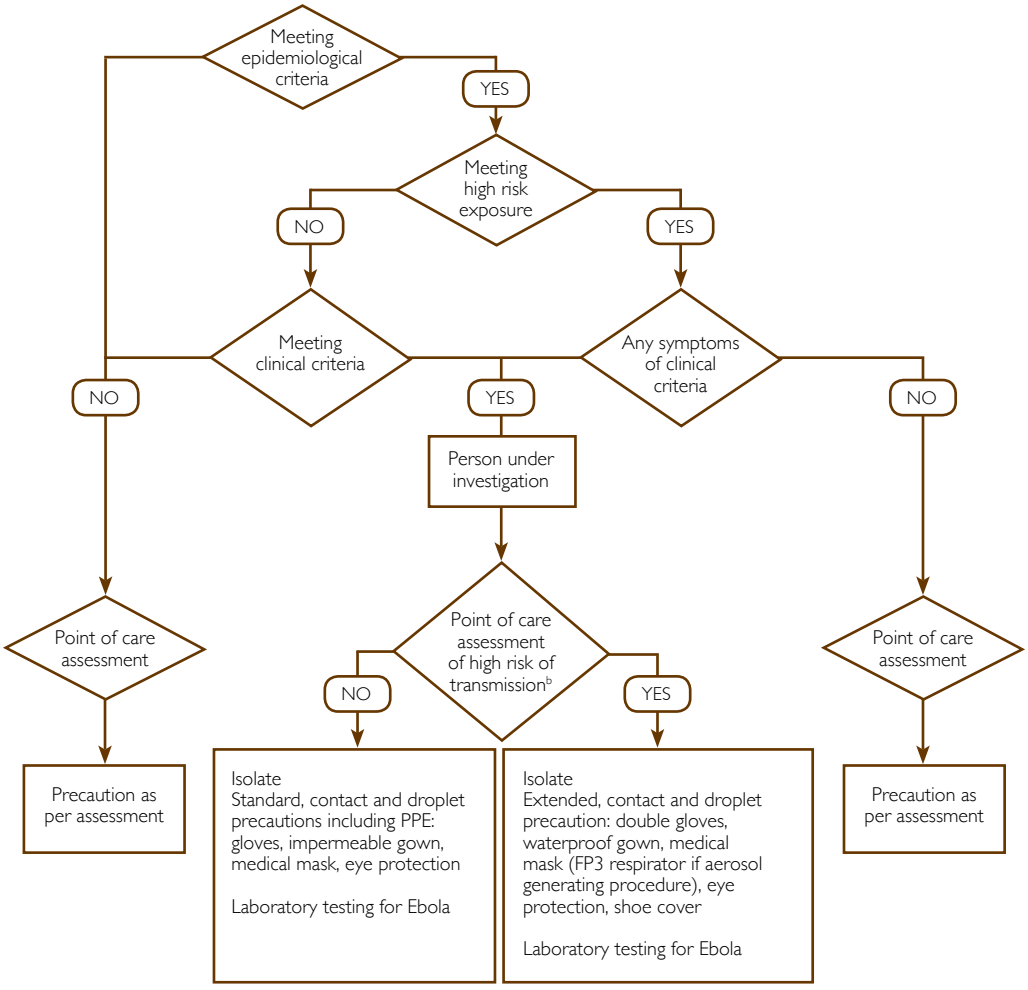
By May 2015, more than 50 assays for 33 different pathogens and toxins had been developed that can be used under field conditions with the Bundeswehr Medical Mobile Laboratory system.[4] Diagnostic reagents and assays for PCR testing were adapted to the technology used in the mobile laboratory units avoiding the need for sophisticated cold chains. Commercially available test kits or rapid tests could also be used by the mobile laboratory units if suitable. One example of a pathogen for which high-quality rapid tests are available is the dengue virus.

A number of these laboratories have been used by WHO as part of its response to infectious disease outbreaks, including the WHO response to the Ebola outbreak of 2014 in West Africa by European Mobile Laboratory Project teams. The role of the European Centre for Disease Prevention and Control teams during the Ebola outbreak was to provide technical support and leadership for the response activities in the fields of case detection, contact tracing and monitoring, collection and analysis of descriptive epidemiology, quality assurance and training of national staff engaged in the Ebola response. The teams worked as part of WHO's Global Outbreak Alert and Response Network, which works to ensure strategies are in place to respond to infectious disease outbreaks, and coordinates technical and human resources to bring together international expertise to tackle such outbreaks.

Valuable information on laboratory diagnosis of Ebola virus disease (EVD) can be found on the WHO Interim Guideline: Laboratory Diagnosis of Ebola virus disease website[5] and the US Centers for Disease Control and Prevention websites,[6] as well as the website of the European Centre for Disease Prevention and Control.[7]

Figure 1.1 shows the algorithm for laboratory diagnosis of EVD.

[4] http://www.eurosurveillance.org/images/dynamic/EE/V20N44/art21291.pdf
[5] http://apps.who.int/iris/bitstream/10665/134009/1/WHO_EVD_GUIDANCE_LAB_14.1_eng.pdf
[6] http://www.cdc.gov/vhf/ebola/diagnosis/, and: http://www.cdc.gov/vhf/ebola/healthcare-us/laboratories/safe-specimen-management.html
[7] http://ecdc.europa.eu/en/healthtopics/ebola_marburg_fevers/Pages/index.aspx



[b] Likehood of exposure to bodily fluids and/or secretions (for example, haemorrhage, vomiting, diarrhoea)

Fig. 1.1 Algorithm for laboratory diagnosis of Ebola virus disease[a]

[a] Reproduced with kind permission of the European Centre for Disease Prevention and Control (ECDC) (http://ecdc.europa.eu/en/healthtopics/ebola_marburg_fevers/algorithm-evd-diagnosis/Documents/EVD-lab-diagnosis-algorithm.pdf, accessed 4 August 2016).

2. Situation analysis

2.1 Planning and assessment of needs

2.1.1 General

Polluted water and poor sanitation, crowding, inadequate shelter and social disorganization are risk factors common to disasters and therefore likely to cause outbreaks of communicable diseases, which will require screening, diagnostic and other laboratory services. Anticipation of these factors should enable the early provision of essential laboratory services.

Preliminary assessment of the overall health situation and needs should be made by an experienced health team, using check lists and other means of collecting data. When medical services are required, an experienced laboratory professional should be part of the operational team to determine laboratory needs.

During the early stages of a disaster, laboratory services may be more orientated towards the identification of the major health problems rather than of the diagnosis of individual patients. (However, initial confirmation of causes of outbreaks involves diagnosis of a number of individuals; then individuals with similar symptoms and signs are treated without confirmation. As an outbreak proceeds, testing must be resumed on a number of individuals, to monitor the causative agent, sensitivity to drugs, etc.) The information collected combined with the available data on prevalent causes of morbidity and mortality (such as measles, diarrhoea and dysentery, respiratory infections and malaria), as well as the clinical picture and the likely causes, would narrow the investigations and can provide a basis for sound planning and expenditure reduction. Laboratory results, together with collected data on disease prevalence, enable surveillance to determine changes in disease patterns and to give early warning of epidemics. During epidemic investigations, laboratory services can provide a confirmation of a suspected disease.

For a population dispersed over a large area or several locations, it may be more appropriate to collect and transport samples to a central field laboratory rather than set up a laboratory in each location. Alternatively, when a more rapid response is indicated, consideration should be given to small mobile laboratories or testing sites, voluntary counselling and testing (VCT) centres, etc., restricted to one or more tests that focus on a specific need, for example cholera, malaria or anaemia.

The field laboratory or testing site will not always be able to undertake all the necessary investigations such as testing for viral infections, the culture of bacteria,

drug susceptibility testing or more complex clinical chemistry tests. Therefore, it is important that the laboratory functions as part of a laboratory network including district, regional and national laboratories, as illustrated in Figure 2.1.

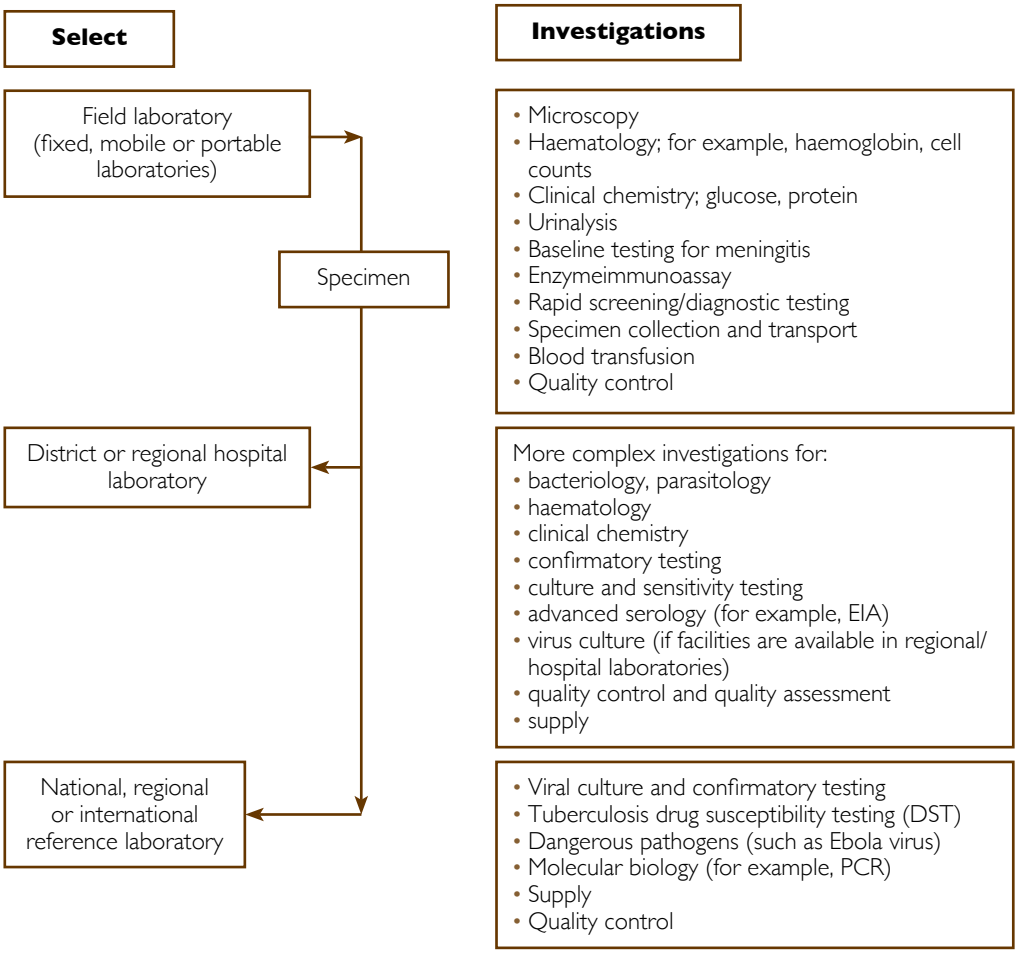


Fig. 2.1 Laboratory referral/support hierarchy

The supply of materials, equipment, or personnel to district and regional laboratories may be an important component of disaster response. National and international reference laboratories should be involved in supporting field laboratories (a list of international reference laboratories is given in Annex 2).

2.1.2 Biosafety

The emergency medical team should evaluate the risk the handling of patients' biological samples poses to the health and safety of laboratory staff.

The safety of the laboratory staff, the patients and all those visiting health facilities must be taken into consideration when deciding what equipment (including biosafety equipment), supplies and materials are selected, as well as the best place to locate (temporarily) the laboratory during the emergency phase.

Biological samples should always be handled and decontaminated in a manner that ensures the safety of those collecting samples and the laboratory staff, as well as the health and safety of patients, the general clinical staff and the community patients, the general clinical staff and the community. Biosafety and laboratory biosecurity are discussed in Chapter 5 but for a more detailed discussion, the reader is advised to refer to the WHO (See literature and recommended References).

2.2 Assessment of existing services

2.2.1 General

When setting up an emergency response capability, it is important to assess the local capacity to handle the event. Where they exist, the facilities of the central and local laboratory services should be examined. Capabilities should be recorded. Strengths and weakness of the local health laboratory services should be noted.

2.2.2 Contacting the existing laboratory services and suppliers

The laboratory supervisor/team should visit local suppliers of laboratory equipment, chemicals and reagents (For an example of an assessment checklist for laboratory suppliers, see Annex 3.) A telephone call is not sufficient. A personal visit enables detailed evaluation of:

- the availability and quality of equipment and supplies
- the storage of reagents and supplies; storerooms for stock levels; cold chain; back-up generator in case of power cuts
- local prices of laboratory equipment and consumables
- import permits for laboratory supplies if applicable.

The laboratory team should register the following:

- names, addresses and telephone numbers (work and private) of contact persons and storeroom key holders; printed copies of contacts should be distributed to laboratory staff and kept up to date
- opening hours of supply services and offices

- availability and call-up signs of high-frequency radio, for base offices of United Nations organizations, Red Cross/Red Crescent, Médecins Sans Frontières and other organizations
- fax and telex numbers of services, including the above organizations.

The team may recommend to procurement units that a clause be added in the purchase contract with suppliers regarding the "time frame and available quantity of supplies" for timely provision. Second-hand equipment donations are not appropriate for emergencies and disasters.

2.2.3 Reference laboratories

The reference laboratories should be visited to establish what levels of laboratory testing are available in the country. Check for issues such as the types of tests that each laboratory is able to perform, the kind of support they can provide to those field laboratories directly serving the affected areas, conditions for referral of specimens, quality control reports, and participation in international quality assessment schemes, thus deciding what needs to be referred to the regional/national reference laboratories or to international reference centres.

2.2.4 Blood transfusion services

The local blood transfusion service should be assessed to check the following:

- adequacy of blood stocks
- storage conditions of blood and supplies
- contingency plans for provision of extra blood supplies to/from other centres
- the availability and use of appropriate cold chain systems for the transportation of donor blood
- transport time between the collection centre and the field sites
- whether donor blood is being scanned routinely for human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C (HCV), *Treponema pallidum* and when indicated *Treponema cruzi*
- blood donor recruitment policy, in particular if the collection centre uses paid donors, and if donors are informed of their HIV status with counselling
- staffing levels
- facilities
- quality control scheme and reporting system.

2.2.5 Logistics of sample referral and transport of blood

The following should be checked:

- state of geographical conditions for transportation (road, rail, river, sea and air)
- timetables of transportation systems (buses, trains, ships, ferries and aircraft)
- transport mechanisms of other agencies (for example, United Nations or Red Cross/Red Crescent) that could be used
- storage during transportation (that is, cold chain monitoring).

2.3 Selection of laboratory staff

Staff for emergency laboratories must be adequately trained to perform the required laboratory testing. Criteria for selection of laboratory personnel to be deployed to the site of an emergency or a disaster should include the following.

Essential

- Skills and experience to perform the testing required by the emergency response programme.
- Specific training in safe laboratory practice.
- Ability to identify and solve problems encountered in field and emergency laboratories.
- Knowledge of quality control schemes.
- Implementation of standard operations procedures.
- Ability to work and make decisions without direct supervision.
- Dedication to teamwork and ability to work harmoniously with colleagues from varied cultures and professional backgrounds.
- Good health and physical fitness to work under hard conditions.
- Openmindness and capacity to respect and adapt to local cultures and group life.

Desirable

- Experience in general laboratory management.
- Experience of working in emergencies.
- Working knowledge of language of the region.[8]
- Ability to provide laboratory training to local national staff once the situation stabilizes to some extent and the recovery phase starts.

[8] The employment of bilingual local staff or an interpreter may be needed.

In situations where a team of laboratory technicians (rather than one or two laboratory personnel) is deployed in response to an emergency, one of the team may be assigned as a coordinator. In addition, the coordinator should:

- have the skills and experience in setting up a functioning laboratory and capability in the organization of work in order to efficiently deliver the laboratory services required by the emergency response team
- be able to assess the needs and evaluate the resources as they relate to the situation and prepare a plan to deliver the necessary services accordingly
- be able to network and maintain liaison with reference laboratories, other organizations and suppliers (see Annex 17. Information on keeping a laboratory log book and contacting a reference laboratory)
- have effective communication skills and demonstrate flexibility and open management style
- have supervisory and monitoring abilities which will ensure that standard operating procedures, quality assurance and safe laboratory practice are properly applied and maintained all the time and at each step of the laboratory work
- be able to represent the laboratory at on-site meetings and inform the other members of the humanitarian action team of the available laboratory support
- be able to set up a system for laboratory statistics and monthly activities reporting.

3. Types of laboratory facility

3.1 General

The following are types of laboratory facility that could be used in disasters and emergencies.

- Portable laboratories. They are of relatively light weight so that they can be carried with ease.
- Mobile laboratories. A mobile laboratory has laboratory equipment that is contained within or transported by a vehicle to be deployed from place to place.
- Temporary stationary laboratory facilities: laboratories established in tents or available local premises, such as in a local house or school or community building.
- Existing (or constructed) fixed laboratory facilities.

3.2 Portable laboratories

Portable laboratories, whether commercially available or self-made, are self-contained diagnostic systems. They are compact and relatively lightweight. They are designed to perform a limited number of critical tests in locations inaccessible by vehicle. The configuration of the portable laboratory can be changed depending on the situation. They are particularly useful for epidemiological surveys in the field and performing water-testing.

Portable cases or plastic boxes containing laboratory materials may be used in combination with temporary or mobile laboratory facilities. Portable systems may be expensive, yet not well compiled. Therefore, they should be critically evaluated. It is advisable to use a well sealed case that will withstand environmental conditions such as rain, immersion in water and dust. The case should be sturdy enough to withstand the rigours of transport.

The inside of the case should be designed so that the equipment and supplies are easily accessible for use. Delicate equipment should be protected, either by securing it in position or by using shock-protective padding.

Important components of a portable laboratory are items for specimen collection and transport. Collected specimens can be transported to a base laboratory for analysis. Test results from these specimens and from onsite tests will help in identifying the appropriate modules for a laboratory kit (described in Chapter 6).

After its use for preliminary investigation, a portable laboratory can remain onsite to provide continuing support until a more comprehensive laboratory system can be set up.

3.3 Mobile laboratories

A mobile laboratory is mounted on or built into some form of carrier. The carrier may be a lorry or van, a trailer, a railway carriage, a boat, or a large self-supporting container-like unit that can be conveyed by truck, boat, plane or helicopter. All of these formats have been used very successfully. Mobile laboratories constructed with a metal housing (for example, a shipping container) must have some form of air conditioning as they can rapidly become excessively hot. It is not possible to perform most laboratory tests at high ambient temperatures. Planning authorities should give serious consideration to include in their emergency contingency plans mobile laboratories ready to go in aircraft or by other means to where they are needed; field laboratories can then be set up at the required location, if need be.

On the positive side, a mobile laboratory:

- is transportable
- is self-contained, usually with its own sources of electric power and utilities, such as water and gas
- is designed to be operable immediately upon arrival.

Disadvantages of a mobile laboratory include:

- cost
- it may be time-consuming to reach the emergency area and have limited capacity
- it needs air conditioning (or some special form of ventilation)
- it needs to be connected to a water source
- staff might not be familiar with the contents of the laboratory/container, thus having to spend time to familiarize themselves with it before it becomes operational.

Mobile laboratories can be configured for almost any type of investigation, including medical diagnostic tests and environmental investigations. Mobile laboratories must be procured for those areas were emergencies occur regularly (for example, epidemic belts, earthquake zones) before the onset of an emergency; ideally it should be budgeted as part of an emergency preparedness programme. This requires planning to decide and perhaps design what is needed for the area projected as a target. Personnel expected to work in these laboratories should receive periodic hands-on training so

that they can form an efficient functioning team. Actual work in the field is essential for solving potential problems in the system.

3.4 Temporary stationary laboratory facilities

3.4.1 Temporary, in locations without laboratory facilities

There are three types of temporary laboratory:

- existing building
- transportable rigid structure, for example, caravan, lorry
- tent or shelter constructed with available material, for example, bamboo, straw mats, plastic, poles and canvas.

Advantages

- Can be set up quickly, or uses current existing capacity.
- Staff can provide support in the construction/rehabilitation as needed.
- Uses local cheap resources.
- Water and power supplies might already be available.

Disadvantages

- Probably not completely suitable.
- Security problems.
- Equipment at risk of being affected by the elements.
- May not have an adequate water supply.
- Inadequate power outlets.
- Insufficient sinks.
- A poor location.
- Limited storage capacity and inadequate storage facilities.

This type of laboratory facility could be temporarily used until suitable location becomes available. A temporary laboratory in a room, a tent, or a specially constructed shelter should be located as near to the health facility as possible. An electricity generator is important as most laboratory equipment requires electricity. A storeroom should be situated on the cooler, shady side of the laboratory or in a separate location. It is essential that heat-sensitive tests and reagents are not exposed to high ambient temperatures. Portable cool boxes/fridges are recommended to store cold chain reagents or tests.

Lorries, caravans and similar facilities can become extremely hot and should be equipped with air conditioning. A system for safe disposal of specimens is critical (see Chapter 6). There should be a separate room for collecting samples.

3.4.2 Fixed, in existing building or other rigid structure

Provisions should be made to evaluate the capabilities of the structure: power, water, number of outlets, sinks, etc.

- Select a safe and clean location as close as possible to available power and water supplies.
- Avoid locating in rooms exposed to full sunlight and with poor ventilation.
- If possible avoid west-facing rooms.
- Preferably within an existing health facility.
- There must be a waste disposal system nearby.

The following are useful to consider when establishing a stationary laboratory.

1. Room size

- Ideally, there should be separate rooms for specimen collection, registration/dispatching results, a main laboratory area for bench work and a storage room.
- The main testing room should be sufficient to accommodate the recommended bench sizes and to provide an adequate space for the laboratory staff to move freely.

2. Walls

- The walls should be in good condition and painted.
- There should be provision to attach work aids (written procedures, pictures of typical malaria parasites, bench aids, etc.) to the wall, particularly next to the microscope and the staining area.

3. Heating/cooling

- In hot climates there should be provision for a working environment as cool as possible because many laboratory reagents and test kits cannot be stored and do not perform satisfactorily at high ambient temperatures. The laboratory must be well ventilated with access to windows.
- In very cold climates the laboratory rooms should be provided with heating during the colder months.

4. Benches

- Bench space
  - A minimum of 2.4 metres of bench space divided into two units – one bench (or desk or table) for microscopy, and a separate bench for staining and general materials.
  - A separate table for sample preparation at least 1.2 metres long.
  - An additional 1.2 metres of bench space for each additional laboratory person when the number of staff exceeds two persons.
- Bench construction
  - The bench should not move or vibrate. If necessary it should be fixed to a wall to make it firm.
  - The microscopists must be able to place their legs underneath the bench.
- Bench location
  - At least 1 metre (per microscope) of bench space should be located against a wall, and at least 1 metre of bench space should be located in front of a window. Electrically powered microscopes should not be placed directly in front of a window to avoid the microscopists continuously adjusting their vision between the bright background and the comparatively darker illumination when looking into the microscope. This can cause eye strain, headaches and fatigue.
  - When the laboratory has no choice other than to use temporarily a mirror with day light as a light source, the microscope will need to be placed in front of a window. Whenever possible reflect light from a white sunlit wall or white painted wall outside the laboratory window.
- Bench surfaces
  - It is recommended to construct a bench surface out of stainless steel, aluminium, Laminex or Formica so that the bench surface can be cleaned with disinfectants, including corrosive disinfectants such as bleach solution.
  - The bench surface should not have cracks, gaps or holes that can accumulate debris and cannot be cleaned with disinfectant.
- Bench heights
  - The bench height should be determined by the average height of the laboratory staff as this can vary significantly between different populations. The height should be set so that the laboratory staff can work comfortably when standing at the bench with their elbows bent at approximately 45° downwards.

- A lower bench should be provided for microscopy. The height of this bench should be determined by the seating provided. The microscopist must be able to sit comfortably with his feet resting on a solid surface, when using the microscope in the normal sitting position. A general bench height suggested for a microscopy bench is between 73 centimetres and 80 centimetres high.

5. Seating

- Ordinary laboratory chairs, without a back, are generally satisfactory for normal work. Their height should be such that when seated the laboratory staff can work comfortably with their elbows bent at approximately 45° downwards. In addition to a table to put the collecting items on, two seats are required (one for the collector and one for the patient) for blood collection and blood film preparation.

6. Lighting

- Good ambient lighting is required at all times (including in cloudy weather).
- Laboratories should have windows to allow in as much natural light as possible.
- However, the laboratory working space should be protected from direct sunlight. The windows should as a first preference be protected with exterior awnings. If this is not possible, windows exposed to direct sunlight should be fitted with blinds or curtains. When indicated, the windows should be fitted with mesh insect screens.
- The laboratory should have electric light for use in cloudy weather and at night.

7. Hand-washing facilities

- Minimum requirements include an adequate water supply, soap, a separate sink (or container) and paper towels.

8. Sample collection spot and registration area

- A table or bench to accommodate the materials is needed for sample collection.
- A waste disposal bin for contaminated materials.
- Sharps disposal container.
- Registration area for patients/samples and for dispatching of results (the area must be separate from main testing/bench area).

9. Adequate storage space

- There should be secure lockable storage for microscope(s), centrifuge(s) and other minor equipment.
- There should be sufficient storage for all other laboratory items.

10. Special consideration for tuberculosis testing

- It is critical to protect the laboratory staff against contamination of the main laboratory by infectious microdroplets that can be produced during the preparation of sputum smears.
- Good ventilation is necessary for the protection of laboratory staff from high risk of airborne infections caused by aerosols/microdroplets produced during collection procedures. If a biological safety cabinet is not available, sputum collection should be done outdoors in the open air (where aerosols are diluted and sterilized by direct sunlight) and away from other people. Precautions to lower this risk include instructing tuberculosis suspects to cover their mouth while coughing and collecting specimens. It may be important to erect a fence or similar barrier to prevent interested onlookers, particularly children, approaching the area. When outdoor sputum collection is not possible, sputum should be collected only in well ventilated areas, where the risk of exposing laboratory personnel and other patients is low, such as an area protected by a roof (for example, a tarpaulin, or the overhang of a roof, or a more solid structure) or a well ventilated separate laboratory room (not in small rooms such as toilets or enclosed areas) for sputum collection. After collection, specimens should be brought the laboratory for examination.
- In cold weather it may not be practical for laboratory staff to work outdoors. In such a situation the laboratory should be provided with a safety cabinet. As a minimum, the cabinet should have a glass or Perspex front cover and an exhaust fan that expels the contaminated air from the cabinet to the outside of the building. A safety cabinet must be installed and maintained correctly. In areas where power supply is not reliable staff must be cautioned not to use the cabinet during a power cut. Detailed information on biological safety cabinets is available in the WHO publication *Laboratory biosafety manual (18)*.

11. Waste disposal

- Assess for adequate/available waste disposal.
- Refer to Chapter 5.

12. Water, power/gas supply

3.5 Existing fixed laboratory facilities

Existing laboratory facilities should be prepared to provide emergency services wherever possible, particularly in situations such as epidemics not associated with disaster. Review of central and local laboratory facilities must be included in the preliminary assessment of the situation. It may be necessary to provide supplementary support to local laboratories in the management of specific diseases.

4. Testing water supplies

In emergencies, following a natural disaster or in places where dislocated people live, water supplies should be assumed to be contaminated. Sources of water are usually limited under such circumstances. Providing a sufficient quantity of water for personal and domestic hygiene as well as for drinking and cooking is important. In the WHO *Guidelines for drinking-water quality*[9] a number of overriding factors are recommended for consideration when providing drinking-water for a population affected by a disaster, including the following:

- the quantity of water available and the reliability of supply
- the equitability of access to water
- the quality of the raw water
- sources of contamination and the possibility of protecting the water source
- the treatment processes required for rapidly providing a sufficient quantity of potable water
- the treatment processes appropriate post-emergency
- disinfection of drinking-water supplies
- acceptability of the water provided
- the need for vessels to collect and store water
- epidemiological considerations.

Health laboratory facilities play an important role in the quality control of water, assessment of treatment requirements and epidemiological considerations.

4.1 Quantity of water

The supply of safe drinking-water in emergencies is of critical importance. During the first days of an emergency phase a minimum amount of 5 litres of water per person per day is required. During the next stage, a provision should be made for 15 to 20 litres of water per person per day for drinking, cooking and personal hygiene.

[9] Guidelines for drinking-water quality, third edition, incorporating the first and second addendum. Vol. 1, Recommendations. Geneva: World Health Organization; 2008 (http://www.who.int/water_sanitation_health/publications/gdwq3rd_2ndadd/en/).

4.2 Water quality

For use and consumption by humans, water must always be free from substances which provide a hazard to health. Sources of raw water and drinking-water should also be aesthetically attractive.

Water sources may be affected by:

- faecal pathogens, due to inadequate sanitation, hygiene and protection of water sources
- population density
- conflicts, man-made structurally damaging disasters
- damage from chemical and nuclear industrial installations
- spillage in transport
- natural disasters, such as earthquakes, volcanic eruption, landslides, hurricanes, floods, droughts
- natural contamination, such as groundwater in contact with toxic minerals (for example, natural arsenic).

There are piped water supplies and non-piped supplies. These categories help when allocating hazards, quality test methods, source selection and treatment requirements.

a) Piped water supplies

Earthquakes, mudslides and other structurally damaging disasters can impair:

- water production including water treatment
  - most likely untreated or partially treated water will be distributed, if damaged
- water storage
  - most likely contaminated water will be distributed, if damaged
- piped distribution systems
  - contamination of drinking water, if broken
  - water shortage at distribution points.

b) Non-piped water supplies

Hazardous situations potentially associated with various non-piped sources of water include the following:

- surface water
  - contamination by faecal pathogens, due to inadequate sanitation, hygiene and protection

- bore hole tube fitted with a hand pump
  - ingress of contaminated surface water directly into borehole
  - ingress of contaminants due to poor construction or damage to the lining
  - leaching of microbial contaminants into the aquifer
- simple protected spring
  - contamination directly through "backfill" area
  - contaminated surface water causes rapid recharge
- simple dug well
  - ingress of contaminants due to poor construction or damage to the lining
  - contamination introduced by buckets
- rainwater collection (for example, roof catchments)
  - bird and other animal droppings found on roof or in guttering
  - first flush of water can enter storage tank.

The most important practical approach to improving and maintaining the quality of water in emergencies is adequate sanitary protection, particularly when non-piped supplies are used. When underground sources of water are properly sited and adequately protected, the water quality improves significantly compared to unprotected sources. Emergencies that are appropriately managed tend to stabilize after some days or weeks. Temporary solutions can last for several years before a permanent supply concept is found.

There is a common understanding among health-care practitioners and front-line field workers in emergency situations: "all our efforts to improve water quality are in vain if people do not avail themselves of sufficient water and soap to wash their hands".

4.2.1 Quality of drinking-water

Due to limiting factors in disasters and emergencies, in many cases only a lower water quality level may be attained. The following features should be considered as minimum standard properties of water supplied in emergencies:

- not causing significant risk to health (free of pathogens and toxic substances); measurable limit indicators:
  - no faecal indicator bacteria[10] per 100 millilitres at the point of delivery

[10] Guidelines for drinking-water quality, third edition, incorporating the first and second addendum. Vol. 1, Recommendations. Geneva: World Health Organization; 2008 (http://www.who.int/water_sanitation_health/publications/gdwq3rd_2ndadd/en/). Faecal indicator bacteria are classified as *Escherichia coli*, thermotolerant coliform bacteria or total coliform bacteria. *E. coli* is considered as first choice and the most precise indicator; thermotolerant coliform bacteria are an acceptable alternative; total coliform bacteria are not an acceptable indicator.

  - in case of water treatment with disinfectant:
    - » free chlorine residual of 0.5 mg/L at the point of delivery
    - » turbidity is below 1 NTU[11] preceding the treatment process
- palatable, good taste without an unacceptable odour
- acceptable appearance (not muddy, not discoloured)
- consumer standards related to cultural practices.

4.2.2 Sampling of drinking-water

Water is sampled to control the quality of water prior to delivery of the bulk of water for drinking and other use. Sampling procedures are as important as water analysis. Care needs to be taken to ensure that there is no accidental contamination or change of properties of the sample during sampling and transportation (see Annex 4).

Drinking-water should be frequently sampled for testing in the initial stages of an emergency, and the intensity of testing can be progressively reduced as the water quality improves and stabilizes. Frequency of testing will also depend on the variability of the water source. A higher testing frequency will be useful as part of an investigation of a waterborne disease outbreak. Non-piped and damaged piped supply systems require a higher sampling frequency than functioning piped systems.

In non-piped systems, sampling is compulsory directly at the water source. Sampling at the treatment plant or at the head of a distribution system may be sufficient for parameters where concentrations do not change during the supply chain. However, for indicators that can change during distribution, sampling should be undertaken according to the behaviour and/or source of the specific substance. Samples should be taken at dispersed points near the remote ends of the distribution system and taps connected directly to the mains.

4.2.3 Assessment of water quality

Water-testing and analysis will disclose its constituents and supports the choice of a water source. It determines whether the raw water of an existing source must be treated to turn it into drinking-water. Water should be analysed at regular intervals over an extended period of time so as to assess the variability of its quality. In emergencies the following most important parameters should be determined:

- the absence of *Escherichia coli* and *thermotolerant coliform bacteria*, which indicate non-pollution of the water through human and animal waste (determination of MPN[12] index or the *E. coli* count in 100 millilitres water; see 4.3.1)

[11] NTU = nephelometric turbidity unit

[12] MPN = most probable number multi-tube method (microbial test method)

- measuring *turbidity* (suspended particles and colloids of chemical, mineral or plant origin) and *pH value*, if treatment is anticipated (*electrical conductivity* optionally)
- determination of *discoloration*, *odour*, *taste* and *temperature* of the water.

Simple bacteriological test kits and field analysis equipment (see Annex 5) enable personnel to carry out these tests.

Information on the surface and groundwater quality should be collected from the local population, other agencies and government institutions. Water quality should be monitored downstream from potential domestic, industrial and agricultural sources of pollution and waste disposal.

Practical guidance for the choice of sites from which palatable water can be drawn as well as for water treatment practices may be provided by the local population.

A survey during an epidemic can give a further indication of the nature of pollutants in the water.

Sanitary inspections are generally easier to perform than bacteriological and chemical water quality tests. The inspections can indicate the causes of pollution and the reaction of water users. Results of sanitary inspections may also help to identify appropriate quality test methods. Therefore, they should always be an essential part of water quality assessment activities.

4.2.4 Indicators for water treatment

The selection of a treatment process of treatment should be based on the quality of the existing water. A moderately effective water treatment that raises the levels of the most important quality parameters affecting health without meeting established standards may already mean an adequate solution. The most common low-cost treatment methods for biological treatment include slow sand filtration and/or chlorination. The multi-barrier approach is the best approach to drinking water treatment. It includes:

- source protection
- sedimentation
- filtration
- disinfection
- safe (distribution and) storage.

Chlorination can help avoid or limit recontamination in the distribution system. Ozone and ultraviolet treatment are other disinfection methods.

An overview of appropriate water purification methods for low quantity requirements of a laboratory is given in Chapter 9.

The nature of contaminants and likelihood of contamination can vary seasonally with rainfall and with other local conditions. Turbidity, pathogens and organic components of different origins reach the surface via storm run-off and through groundwater discharge. The concentration of these constituents in water depends on the amount of precipitation and can rise dramatically during the rainy season. Surface water almost always needs to be treated. Even water from shallow ground water resources (between 0 and 10 metres below ground) can be contaminated by faecal matter. Generally, groundwater, if lifted properly, is free from pathogens and turbidity and needs no treatment. However, in some regions groundwater is in contact with natural arsenic from minerals, thus being heavily contaminated.

Table 4.1 provides an overview on the necessity of treatment, based on the quality parameter *Escherichia coli* count. However, it must be recognized that achieving guideline standards may be difficult after some disasters, and faecal indicator bacteria alone are not the sole parameter for establishing biological water quality.

Table 4.1 The necessity of treatment, based on the quality parameter *Escherichia coli* count [a]

***Escherichia coli* [MPN[b]/100 mL]**	**Treatment process**
0	guideline compliant, no treatment required
1–10	tolerable or if possible disinfection (for example, boiling, chlorination, ultraviolet)
10–100	requires treatment
Greater than 100	unsuitable for consumption without proper treatment, for example, pretreatment and rapid filtration and disinfection

[a] Wisner E, Adams J, eds. Environmental health in emergencies and disasters: a practical guide. Geneva: World Health Organization; 2003.

[b] Guidelines for drinking-water quality, third edition, incorporating the first and second addendum. Vol. 1, Recommendations. Geneva: World Health Organization; 2008 (http://www.who.int/water_sanitation_health/publications/gdwq3rd_2ndadd/en/).

4.3 Quality control of drinking-water

The control of water production (including treatment), storage and distribution in piped and non-piped systems should be carried out under water microbiological, chemical, physical and aesthetic quality standards. Odour is an indicator of the effectiveness of different kinds of water treatment. Odour and taste, although subjective, are useful indicators of water quality, even though odour-free water is not

necessarily safe to drink, which is why it is only an additional part to microbiological, chemical, and physical testing. Odour as a secondary standard can be expressed in Threshold Odour Numbers (TONs) of water, which are whole numbers that indicate how many dilutions it takes to produce odour-free water. An example of how to determine Threshold Odour Numbers can be downloaded from: http://www.opcertschool.com/media//DIR_6501/ef44b18872f090cbffff823fffffe904.pdf. In emergencies and disasters the quality standards are individually set by a thorough consideration of the on-site situation.

Table 4.2 is an example of secondary drinking water standards.

Table 4.2 Secondary drinking water standards[a]

Contaminant	Secondary MCL[b]	Noticeable Effects above the Secondary MCL
Aluminum	0.05 to 0.2 mg/L[c]	coloured water
Chloride	250 mg/L	salty taste
Colour	15 colour units	visible tint
Copper	1.0 mg/L	metallic taste; blue-green staining
Corrosivity	Non-corrosive	metallic taste; corroded pipes/ fixtures staining
Fluoride	2.0 mg/L	tooth discoloration
Foaming agents	0.5 mg/L	frothy, cloudy; bitter taste; odour
Iron	0.3 mg/L	rusty colour; sediment; metallic taste; reddish or orange staining
Manganese	0.05 mg/L	black to brown colour; black staining; bitter metallic taste
Odour	3 TON[d]	"rotten-egg", musty or chemical smell
pH	6.5–8.5	low pH: bitter metallic taste; corrosion high pH: slippery feel; soda taste; deposits
Silver	0.1 mg/L	skin discoloration; graying of the white part of the eye
Sulfate	250 mg/L	salty taste
TDS	500 mg/L	hardness; deposits; colored water; staining; salty taste
Zinc	5 mg/L	metallic taste

[a] Reproduced with kind permission of the US Environmental Protection Agency (https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals).
[b] MCL: maximum contaminant level
[c] mg/L: milligrams of substance per litre of water
[d] TON: threshold odour number
[e] TDS: total dissolved solids

4.3.1 Microbial water quality

4.3.1.1 Indicators

Guideline values for *Escherichia coli* or thermotolerant coliform bacteria[13]

- For all water directly to be used for drinking (piped and non-piped water supplies):
- *Escherichia coli* or thermotolerant coliform bacteria *must not be detectable* in any 100 millilitre sample. Immediate investigative action must be taken if either of the faecal indicator bacteria is detected.
- For treated water entering the distribution system (piped and non-piped water supplies), *Escherichia coli* or thermotolerant coliform bacteria *must not be detectable* in any 100 millilitre sample. Immediate investigative action must be taken if either of the faecal indicator bacteria is detected.
- For treated water in the distribution system (piped water supplies): *Escherichia coli* or thermotolerant coliform bacteria *must not be detectable* in any 100 millilitre sample. Immediate investigative action must be taken if either of the faecal indicator bacteria is detected.

4.3.1.2 Test methods for microorganisms

- Membrane filtration method

  Features:

  – culture technique
  – complies with ISO Standard 9308-1:1990
  – compact portable test kits are available
  – confirming results within 18–24 hours
  – contaminating bacteria in the water can be counted easily
  – quantitative result and good precision if the number of colonies grown is adequate
  – unsuitable for use with turbid waters
  – culture medium comes in prepackaged form
  – monitors (Petri dishes) are disposable plastic
  – membrane filters and monitors can be incinerated
  – expensive

[13] See: Ashbolt NJ, Grabow WOK, Snozzi M. Indicators of microbial water quality. In: Fewtrell L, Bartram J, editors. Guidelines, standards and health: assessment of risk and risk management for water-related infectious disease. London, UK: IWA Publishing (on behalf of World Health Organization); 2001.

  - if a field incubator and plastic suction device (for water sampling) are available, the cost of membrane filter water test equipment can be considerably reduced.
- Multiple-tube most probable number (MPN) method

  Features:

  - culture technique
  - complies with ISO Standard 9308-2:1990
  - coliform density: MPN in 100 millilitres of water, called MPN index
  - uses selective lactose broth culture media
  - flexible sample volume range and applicable to all kinds of samples
  - can be used for turbid water
  - results take longer time than membrane filtration method
  - concentrated culture of bacteria requires sterilization and disposal
  - large volume of consumables
  - less expensive than membrane filtration method.
- Enzyme-fluorescence technology method

  Features:

  - chromogenic media-based technique
  - method detects viable bacteria in water through fluorescence, targeting enzymes produced by *Escherichia coli* and coliform bacteria.
  - simultaneous detection of thermotolerant coliform bacteria and *Escherichia coli*
  - can be used for presence/absence testing or quantification using multiple-tube MPN method
  - provides quick, confirmed test results (available in less than 24 hours)
  - simple, but expensive test method (especially for quantitative testing)
  - sterilization not necessary, but careful disposal required
  - large number of consumables required, reagents come in snap packs
  - incubator and fluorescent light required (as well as sealer for quantitative testing)
  - chromogenic media are sensitive to the effects of light and heat.

4.3.2 Chemical water quality

4.3.2.1 Chemical constituents

Assessment of the adequacy of the chemical quality of drinking-water relies on comparing the results of water quality analysis with reference values. Attention is

largely directed to the detection and estimation of certain toxic chemical substances which may affect health.

The following parameters are for several chemical substances monitored in determining water quality. One or more of these parameters may be of importance for monitoring water quality in an emergency, particularly for the selection and control of a treatment process.

- Free chlorine (after chlorination at point of delivery)

  Reference values (minimum target concentration):

  – 0.2 mg/L in normal circumstances
  – 0.5 mg/L in high-risk circumstances.

- Total chlorine

  Reference value: 5 mg/L

- Nitrate

  Reference value: maximum permissible level: 50 mg/L

- Nitrite

  Reference values: maximum desirable level: 0.5 mg/L; maximum permissible level: 3 mg/L.

4.3.2.2 Test methods for chemical constituents

Chemicals of concern may be tested at the end of the treatment process, in the distribution system or at the point of consumption (depending on whether the concentrations are likely to change in distribution). Various test methods are available:

- Colorimetric tests with colour comparison

  Features:

  – visual evaluation of individual indicators using reagents
  – colour match between the colour standard and the sample
  – practical for on-the-spot use
  – application-oriented measuring intervals
  – long shelf-life
  – low analytical costs.

- Colorimetric tests with portable comparator unit

  Features:

  – visual evaluation of individual indicators using reagents
  – colour match between the colour standard and the sample

– powered by standard-size battery or rechargeable battery pack.

- Photometer unit

Photometers are advanced equipment for chemical analysis. They are obtainable as portable microprocessor-controlled models for single parameter testing or as bench-type models for multiple parameter testing. All of them require specific test kits (reagents in liquid or powder form).

Features:

– pre-adjusted test and reagent systems
– display of the results directly in units of concentration
– digital display
– measuring interval: depending on the indicator
– powered by standard-size battery or rechargeable battery pack
– accessories.

4.3.3 Physical water quality

4.3.3.1 Indicators

Turbidity is one of the most important parameters for quality control of a water treatment process. Turbidity requires regular measurement. pH value, conductivity and temperature are additional important physical parameters.

- Turbidity

Turbidity is caused by suspended matter in water. Turbidity is used to assess the water treatment. It is an indicator of effective chlorination.

Guideline values:

– if no disinfection is required: < 1 NTU , not more than 5 NTU.[14]
– if disinfection is required: 0.1–0.2 NTU.

- pH value

pH value is a measure of the acidity or alkalinity of a solution. It influences reactions along the treatment process and has a corrosive effect on metals if pH < 7.

Guideline values:

– pH > 6.5 and < 9.5 (< 8.0 if disinfection with chlorine is required).

[14] WHO recommends that the turbidity of drinking water should not be more than 5 NTU, and should ideally be below 1 NTU. Turbidity should preferably be less than 1 NTU/JTU for chlorination to be effective (JTU: Jackson turbidity units read from the Jackson candle turbidimeter). Fact Sheet 2.33: Turbidity measurement: The importance of measuring turbidity. Available at: http://www.who.int/water_sanitation_health/sanitation-waste/fs2_33.pdf

- Electrical conductivity

Electrical conductivity is a measure of the concentration of ions in the water sample and thus an indicator of the corrosive effect of water on metals. The indicator should be monitored in water source locations close to the sea and in arid climates. The unit of conductivity measurement commonly used is one millionth of a Siemen per centimetre (micro-Siemens per centimeter or µS/cm).

Guideline values:

– < 2500 µS/cm at 20 °C.

4.3.3.2 Test methods for physical indicators

- Turbidity

The visual determination of turbidity (see Chapter 4.3.4.2) does not deliver quantitative results. A more sophisticated technical measuring method may be required using a turbidity meter, equipped with the following features:

– integrated optical sensing system using sample vials
– portable or bench-top type, rigid casing
– digital display
– measuring interval and accuracy required: < 5, 5, 10, 20, 50,100, 200 NTU /± 0.5 NTU or ± 5 % of reading
– powered by standard-size battery or rechargeable battery pack
– accessories: standardizing solution for calibration, a filter/syringe assembly, five sample vials, sample cup, permanent secondary standards of 0 and 10 NTU.

- pH value

Various test methods of different levels of sophistication are available, all of them requiring exact measurement of the water temperature for reliable analysis of test results:

– colorimetric measurement with indicator solutions
– electrode-type measurement.

Colorimetric measurements with indicator solutions allow rapid pH measurement on site. Calibration and checking is carried out using certified buffer solutions.

Electrode-type measurement requires a sophisticated but easy-to-use pH meter with the following features:

– integrated sensing system using flexible, detachable pH probe
– portable or bench-top type, rigid casing
– digital display

- measuring interval and accuracy required: 4–10, ± 0.1
- automatic temperature compensation of pH measurement
- display of sample temperature
- two-point calibration using certified buffer solutions
- powered by standard-size battery or rechargeable battery pack.

Electrode-type pH meters are offered as multipurpose measuring instruments, combining other parameters, such as electrical conductivity, dissolved oxygen and oxidation reduction potential (ORP; redox potential).

- Electrical conductivity

Sophisticated but easy-to-use test methods are available, all requiring exact measurement of the water temperature for reliable analysis:

Electrode-type conductivity meter with the following features:

- integrated sensing system using flexible, detachable conductivity probe
- portable or bench-top type, rigid casing
- digital display
- measuring interval: < 450, 450 to > 2500 µS/cm
- automatic temperature compensation of conductivity measurement
- display of sample temperature
- one-point calibration using certified standard solution
- powered by standard-size battery or rechargeable battery pack. Electrode-type conductivity meters are available as multipurpose measuring instruments, combining other parameters, such as pH value, dissolved oxygen and oxidation reduction potential (ORP; redox potential).

4.3.4 Sensor indicators related to water quality

4.3.4.1 Indicators

- Taste: drinking water should have an agreeable taste.
- Odour, smell: drinking water should be free of any smell (except chlorine when treated).
- Colour (visual test): drinking water should be clear and colourless.
- Turbidity (visual test): drinking water should be free of any suspended matter.

4.3.4.2 Test methods for sensor indicators

- Taste

  - If water is known to be potable, taste is tested during sampling but unknown or unsafe water should not be tasted.
  - Classification of intensity: tasteless–insipid–strong.
- Odour, smell
  - Fill a clean bottle (0.5–2 litres) with sampling water and shake the bottle well.
  - Remove cap and test odour immediately.
  - If in doubt warm a sample up to 40 °C and repeat procedure.
  - Classification of intensity: none–faint–strong.
- Colour
  - Fill a clean transparent bottle (1 litre) with sampling water.
  - Allow the particles to deposit.
  - Examine the water under diffuse illumination in front of a white background.
  - Classification of examination: colourless–faint–strongly dyed.
- Turbidity
  - Fill a clean transparent bottle (1 litre) with 0.7 litres of sampling water.
  - Check for sediments.
  - Swivel the bottle gently and immediately examine the water under diffuse illumination. Alternatively examine the water first in front of a black and then in front of a white background.
  - Classification of examination: clear–faint–cloudy–non-transparent

4.4 Establishment of a monitoring programme on water quality

Water quality should be monitored regularly during emergencies. The establishment of a monitoring programme requires a preceding situation analysis including planning, assessment of needs and existing services as well as the selection of appropriate staff (see Chapter 2).

4.4.1 Establishment of a routine monitoring procedure

Monitoring involves water safety as well as sanitary inspection:

- water sampling and analysis and sanitary inspection
- monitoring of water treatment processes, including disinfection
- monitoring of water quality at all water collection points and in facilities (health facilities, homes)
- water quality assessment during investigation of disease outbreaks.

The likelihood of faecal contamination of water sources can be assessed by a sanitary inspection. Water quality testing and sanitary inspection are complementary activities; the findings of each assist the interpretation of the other. Health information should also be monitored to ensure that water safety will be immediately investigated should the water quality be contributing to a health problem. Based on the observations, other water sources may be selected, and treatment processes, particularly disinfection, may be modified. It is recommended to plan and manage such a routine monitoring system as soon as possible to ensure that action is rapidly taken to protect health. There should be a standard reporting format for water quality testing and sanitary inspections to ensure that information is reliable and that the information gathered from different water sources is comparable.

4.4.2 Planning

4.4.2.1 Survey of exploitable ground water and surface water resources or existing supply systems

The assessment of piped and non-piped water supply systems (see Chapter 4.2) provides the basic information to support effective decision-making. Where water quality analysis cannot be performed, sanitary inspection can still provide valuable information. A sanitary inspection makes it possible to see what needs to be done to protect the water source. The procedure should be combined with microbial, chemical and physical testing. The immediate assessment of risk of contamination may be based on certain indicators such as a technical design of a supply system, the proximity to sources of faecal contamination (human or animal), colour and smell, the presence of dead fish or animals, the presence of foreign matter such as mud, ash or debris or the presence of a chemical or radiation hazard or wastewater discharge point upstream. The identification of sources and pathways of pollution can be an important tool for assessing the likelihood of contamination of a water source.

4.4.2.2 Selection of appropriate quality determinants

The following key questions can assist in the identification of appropriate quality determinants:

- What are the current or threatened water-related diseases?
- Is the water source contaminated or at risk of contamination (microbiological or chemical/physical)?
- Is the water palatable/aesthetically attractive?
- Is disinfection necessary, even if the supply is not contaminated?
- Is treatment necessary? Is treatment possible? What treatment is necessary?

4.4.2.3 Identification of test methods and procedures

Test procedures may be required for:

- raw water
- water treatment parameters
- drinking-water.

The appropriate test methods can be derived from the quality parameters (see Section 4.4.2.2). The operating procedure of each test should be described in a short instruction (or flow chart). Such instructions also include all aspects of the required general hygiene and cleanliness.

The operating instruction includes the forms for the documentation of test results. Such records are the basis for immediate and long-term decision-taking related to the available water quality and for subsequent technical measures. Form 4.1 shows a sample form for test results on water quality indicators.

4.4.2.4 Collection procedure for water samples

Formulation of working instructions (for sampling techniques see Annex 4).

Where to take the samples, how and by whom, when and how often?

4.4.2.5 Human resources requirements

All activities require a minimum number of skilled personnel of various professional levels. Onsite training may be required for particular duties in the programme.

4.4.2.6 Equipment and consumazbles requirements

Test procedures and human resources requirements determine the quantitative and qualitative needs of equipment and consumables. Equipment selection, procurement, commissioning, operation and maintenance should be organized thoroughly.

4.4.2.7 Infrastructure and transportation requirements

Another area of concern is the availability of an adequate infrastructure for the monitoring programme. Transportation may be crucial to sample collection and regular supply of consumables under emergency conditions. Criteria for transportation are proposed in Chapter 10.

Form 4.1 Water analysis

Organization/Institution:			**Location:**	
General sampling data				
Sample no.	Ambient temperature:	Date:	Time:	Name/signature of laboratory technician:

Microbial indicators			
Parameter	**Test method**	**Results**	**Guideline values[a, b]**
Temperature			
Turbidity			< 1 NTU, not more than 5 NTU (if no disinfectant is required) 0.1–0.2 NTU (if disinfection is required)
pH-value			pH > 6.5 and < 9.5 (< 8.0 if disinfection with chlorine is required)
Electrical conductivity			< 2500µS/cm at 20°C
Sensor indicators			
Parameter	**Test method**	**Results**	**Guideline values[a, b]**
Taste			agreeable taste
Odour, smell			free of any smell
Colour			clear and colourless
Turbidity (visual)			free of any suspended matter
Chemical constituents			
Parameter	**Test method**	**Results**	**Guideline values[a, b]**
Free chlorine			0.2 mg/L (normal circumstances) 0.5 mg/L (high-risk circumstances)
Total chlorine			5 mg/L
Nitrate			50 mg/L
Nitrite			0.5 mg/L (desirable level) 3 mg/L (maximum permissible level)

[a] Guideline values for drinking-water are those values derived for many chemical constituents of drinking-water. A guideline value usually signifies the concentration of a constituent that does not result in any significant risk to health over a lifetime of consumption. These values may differ from one country/state to another.

[b] Guideline values to be set according to international recommendations and considering the prevailing local conditions; figures shown are sample figures.

4.4.3 Operation of the monitoring programme

Immediately after the onset of an emergency, and in more detail after thorough planning of an effective water quality monitoring programme to provide data of a known quality for action planning or catchment-wide decision-making, the following operating steps should be carried out for water-testing:

1. sample collection
2. water-testing, carrying out the analysis
3. analysis of the results
4. documentation of results
5. disposing of cultured media in accordance with all applicable local, state and national regulations
6. publication of results (if required)
7. elaboration of recommendations related to the usability of available water and water treatment methods (if required)
8. maintenance of equipment (cleaning, servicing, calibration)
9. commissioning and store-keeping of consumables and equipment

5. Laboratory safety, disinfection and waste disposal

5.1 Laboratory safety

Personal hygiene and good laboratory practices are important to ensure personal safety. All biological specimens must be considered as potentially hazardous. Infection can occur by inhaling aerosols containing pathogenic microorganisms, risk of prick with needle or lancet, risk of burns with corrosive reagents. Aerosols are formed when containers break in centrifuges, when samples are opened, when cultures or specimens are spilled, during pipetting, and when flaming bacteriological loops. To minimize aerosol infection, liquid specimens should always be kept covered, with the cap on the container, and opened carefully. Avoid using snap-closing containers. When handling a sample with a high potential for creating infectious aerosols or when there is a risk of splashing or spraying infectious or other hazardous materials, laboratory work should be conducted in a safety cabinet or with face protection (goggles, mask, face shield or other splatter guards). Used needles and lancets should be discarded into a metal or sturdy plastic container, not paper or plastic bags. For safety and time effectiveness, the use of disposable lancets is highly recommended.

The following apply.

- It is recommended that all laboratory staff receive vaccinations depending on the pathogens to which they may be exposed.
- Do not eat, smoke or drink in the laboratory.
- Wear a laboratory gown or coat in the laboratory, and leave it in the laboratory when going out.
- Wear disposable gloves when handling hazardous material.
- Wash hands before, during and after laboratory work.
- Wear eye protection when working directly with infectious materials or with hazardous chemicals. Eye and face protection help to protect against splashes, for example, when handling hazardous chemicals including disinfectants. Protection aids include shatter-proof wide vision safety goggles, shatter-proof safety glasses (with side-pieces) able to fit over ordinary glasses or a face shield (visor). Standard surgical masks (fabric) may not tie as tightly around the face as particulate respirators and offer only limited protection against inhaling aerosols or chemical particles. Only certain certified respirators will protect against tuberculosis bacteria.

- A first aid kit should be provided in the laboratory.
- All samples should be processed within the contaminated/testing area.
- Fire safety. A fire blanket (made from cotton) and one or more fire extinguishers are required. Select a multipurpose dry chemical or carbon dioxide powder model (do not use a carbon dioxide fire extinguisher to extinguish a fire affecting batteries). A fire extinguisher should be secured to the wall near the door and in the room where flammable chemicals are stored.

Safe laboratory practice includes the following.

- One clean area for administrative work and one area for testing.
- No mouth pipetting. Safety pipetting devices should be included in the basic module.
- Clean and decontaminate benches each day. Fresh bleach that is prepared daily is recommended. (A bleach and water solution should be mixed daily to preserve its strength. Throw away any leftover solution from the day before).
- Sputum smears should always be prepared either outside the laboratory in a well ventilated area at a distance from other persons. When this is not practical (for example, in cold climates) a safety cabinet should be used. The safety cabinet should satisfy the appropriate standards for construction, maintenance and testing with a fan extraction system discharging to the outside of the laboratory. Home-made cabinets should not be considered, because they only increase the risk as well as giving the worker a false sense of security. Refer to the WHO Laboratory biosafety manual for detailed information on biological safety cabinets (see references and recommended literature).
- Wear an N95 respiratory mask (keeps out at least 95% of airborne particles) or equivalent when preparing smears.
- Specimens should be collected in leakproof wide-mouthed containers to avoid contaminating the outside surface of the container.
- Properly dispose of sharps, sputum containers and biohazardous waste in appropriate containers following correct disposal guidelines.

5.2 Disinfection

The term “disinfection” includes various physical and chemical procedures intended to clean laboratory surfaces, and equipment and decontaminate biological materials in order to prevent the spread of infective agents by inactivating or killing bacteria, fungi, protozoa and viruses. Waste, laboratory equipment and disposables are commonly

disinfected by chemical disinfectants or their aqueous or alcoholic solutions. For disinfection it is recommended to use bleach (sodium hypochlorite) solution for general use, alcohol (ethanol or isopropyl alcohol are used in a 70% solution) for metallic surfaces, and commercial disinfectants against viruses. For points to consider in bleach preparation, see Annex 16.

The three primary recommended disinfectants[15] for routine laboratory use are as follows:

Routine disinfection	Comment
Bleach approx 0.5%; for spills of blood, stool, or urine increase chlorine 5%	A solution of 0.5% chlorine is obtained by dissolving 7.5 grams of calcium hypochlorite in 1 litre of water.
70% ethanol for equipment	Not recommended for spills
Commercially available disinfectant against viruses	Dilute according to manufacturer's recommendation

Notes:

1. Hypochlorite solutions (sodium or calcium) are very active disinfectants and are therefore used for a number of laboratory, household and industrial applications (in the form of household bleaches). Hypochlorites are active disinfectants against the hepatitis and human immunodeficiency viruses. Hypochlorites are rapidly inactivated by sunlight, high temperatures and by particles such as dust and organic materials. Hypochlorite solution must be prepared from stock solutions each day. Hypochlorites cause irritation of the skin, eyes and lungs. They require contact time of 10 to 30 minutes (wet contact time). They are corrosive against metals, have toxic properties and are inactivated by organic matter. Avoid direct contact with skin and eyes. Bleach solutions give off chlorine. Prepare them in a well ventilated area. Washing bare hands with the strong solution (0.5%) can cause chlorine burns on hands.
2. Calcium hypochlorite (70% available chlorine), also known as chlorinated lime, is a solid (powder, granules). High test hypochlorite (HTH) is a white powder and contains a greater concentration of chlorine than ordinary bleaching powder. HTH is also more stable. Calcium hypochlorite is generally unstable and all forms lose potency over time. Calcium hypochlorite which has been stored badly, which may have deteriorated over time or which has been adulterated, should be tested to determine its available chlorine (see Module 4a-1: Core

[15] Phenol, which was found a useful disinfectant for tuberculosis bacteria, is now banned in many countries because of its toxicity.

items). It decomposes at a slower rate than sodium hypochlorite. A solution of 0.5% chlorine is obtained by dissolving 7.5 g of calcium hypochlorite in 1 litre of water (if the concentration of locally available bleach is not 5%, the 7.5 g measurement will not be correct). Clear water should be used because organic matter destroys chlorine. If only muddy water is available, add aluminium sulphate granules (alum) at a rate of about 5 g to 10 litres and allow the deposit to settle (see 8.6 Laboratory water purification systems). Alternatively, household bleach can be diluted to a concentration of 1:10, provided the stated concentration on the bottle is 5%. Additional points to be taken into consideration are given in Annex 16.

3. Alcohols are fast-acting but relatively expensive disinfectants. They are bactericidal, very effective against a range of viruses excluding hepatitis B, but they are not fungicidal. The penetrative power of alcohols is poor, so they are not recommended for use with organic material. Because they need water to be absorbed by bacteria, alcohols should be diluted with water to be used as disinfectants; normally this consists of 70% alcohol to water. Their shelf-life is greater than one week. They are not corrosive and are not inactivated by organic material.
4. Disinfectants are only active a short time after dilution. Increasing temperature causes faster inactivation; therefore, always dilute immediately before use. The optimal effect of disinfectants depends on the time and temperature of exposure.

5.3 Laboratory waste management

All materials (stains, reagents, etc.) used in the laboratory must be disposed of correctly and in a manner that does not harm the environment. Biological samples (stools, pus, sputum, blood, urine, etc.) must always be considered and treated as infectious. After examination they must be treated in such a way that the risk of infection is avoided.

For disposal of biohazardous waste the following are essential requirements.

- Biohazardous/contaminated waste must be separated from general waste.
- Any contaminated (potentially infectious) material must be securely packaged in waste containers compatible with the proposed treatment process.
- Waste containers should be correctly labelled to indicate the method of treatment intended to eliminate the biological hazard.
- Waste containers should be transported to the point of treatment or disposal by appropriately trained personnel.

- Biohazardous/contaminated waste must be appropriately treated to eliminate the biological hazard.

In principle all infectious waste materials should be decontaminated or autoclaved within the laboratory. After autoclaving, the material may be placed in transfer containers (preferably plastic) for transport to the incinerator. When an autoclave is not available, boiling for 30 minutes in a large pail containing a detergent (a strong solution of washing powder or 60 grams sodium carbonate per litre of water) is a satisfactory method of decontaminating most specimen containers (except for sputum containers; these should be disposed of ideally in a separate bag and incinerated). However, it does not kill spores and does not inactivate certain viruses. Should an autoclave be available, all potentially infectious autoclavable waste should be decontaminated by autoclaving. Incineration of infectious materials is an alternative to autoclaving only if the incinerator is under laboratory control.

Sharps should be placed in puncture-resistant sharps disposal containers (must not be filled to full capacity) and incinerated, with prior autoclaving if required. Staff should wear stout leather gloves when handling them in case sharps penetrate the container wall. Sharps disposal containers must not be discarded in landfills.

An incinerator is a device designed to completely burn up combustible materials, rendering them sterile ash. Simple but effective incinerators can be made onsite such as the incinerators designed at De Montfort University (Leicester, UK). Information is available at www.mw-incinerator.info/en/401_operation.html.

For details of decontamination and general disposal of laboratory waste, please refer to references *(18)* and *(34)* (as well as many other references on the topic).

6. Laboratory kits and modules

6.1 List of modules

Group 1: energy modules

Module 1a: Non-rechargeable batteries (primary cells)
Module 1b: Rechargeable batteries and battery chargers
Module 1c: Battery back-up system
Module 1d: Diesel/petrol generator with standard electric appliances and installation kit
Module 1e: Diesel/petrol generator with battery back-up system standard electric appliances and installation kit
Module 1f: Solar (photovoltaic) system with battery, standard electric appliances and installation kit

Group 2: core laboratory modules

Laboratory setup
Module 2a: Basic equipment and consumables
Blood sample collection
Module 2b: Capillary blood sample collection
Module 2c: Venepuncture blood sample collection

Group 3: transport of specimens (sample referral)

Module 3a: Transport of whole blood, serum, plasma and CSF specimens
Module 3b: Transport of stool samples – parasitic testing
Module 3c: Transport of stool samples – enteric pathogens
Module 3d: Transport of stool samples – viral testing
Module 3e: Transport of nasopharyngeal samples – upper respiratory infections
Module 3f: Tissue and biopsy specimens – histopathology

Group 4: blood transfusion

Module 4a: All donor blood collected externally and transported to the programme
4a-1: Core items
4a-2: ABO and Rh grouping – tile
4a-3: ABO and Rh grouping – tube
4a-4: Crossmatching – antihuman globulin (Coombs)
4a-5: Haemoglobin – portable meter
4a-6: Haemoglobin – spectrophotometer/colorimeter
4a-7: Bedside grouping cards
4a-8: Fresh frozen plasma

Module 4b: Collection of donor blood from local donors by the programme
4b-1: ABO and Rh grouping – tile donor blood group screening
4b-2: ABO and Rh grouping – tube donor blood group screening
4b-3: ABO and Rh grouping – tile donor blood group confirmation
4b-4: ABO and Rh grouping – Tube donor blood group confirmation
4b-5: Infectious diseases screening – enzyme immunoassays for hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2
4b-6: Infectious diseases screening – RDT testing hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2
4b-7: Infectious diseases screening – rapid diagnostic testing (syphilis)
4b-8: Donor blood collection

Group 5: specific test modules

Cholera

Module 5a: Cholera (vibrio) screening
Module 5a-SA: Cholera screening – stand-alone

Glucose

Module 5b: Glucometer
Module 5b-SA: Glucometer – stand-alone

Haemoglobin

Module 5c: Haemoglobin meter, portable
Module 5c-SA: Haemoglobin meter, portable – stand-alone
Module 5d: Haemoglobin spectrophotometer/colorimeter – laboratory instrument

Haematology

Module 5e: Automated haematology instrument
Module 5f: White blood cell count, manual
Module 5g: Erythrocyte sedimentation rate (ESR)
Module 5h: Blood film differential

Infectious disease screening

Module 5i: Infectious diseases screening – rapid diagnostic testing (RDT)
Module 5i-SA: Infectious diseases screening – rapid diagnostic testing (RDT) – stand-alone
Module 5j: Infectious diseases screening – enzyme immunoassays (EIA)
Module 5k: Syphilis – *Treponema pallidum* testing – RDT
Module 5k-SA: Syphilis – *Treponema pallidum* testing – RDT – stand-alone
Module 5l: Syphilis – *Treponema pallidum* testing – rapid plasma reagin testing

Malaria

Module 5m: Malaria – rapid diagnostic testing
Module 5m-SA: Malaria – rapid diagnostic testing – stand-alone
Module 5n: Malaria – thick and thin films
Module 5n-SA: Malaria – thick and thin films – stand-alone

Meningitis

Module 5o: Transport of CSF specimens – referral
Module 5p: Meningococcal/bacterial meningitis – serological testing – CSF
Module 5p-SA: Meningococcal/bacterial meningitis – serological testing – CSF – stand-alone
Module 5q: Meningitis – general laboratory testing – CSF
Module 5q-SA: Meningitis – general laboratory testing – CSF – stand-alone

Microbiology – general

Module 5r: Gram stain
Module 5s: Wet mount

Parasitology – Stool

Module 5t: Stool examination for ova, cysts and parasites – microscopy

Pre-natal

Module 5u: Prenatal testing
Module 5u-SA: Prenatal testing – stand-alone

Trauma

Module 5v: Trauma

Tuberculosis

Module 5w: Tuberculosis – direct sputum examination – acid fast bacilli
Module 5w-SA: Tuberculosis – direct sputum examination – acid fast bacilli – stand-alone

Urinanalysis

Module 5x: Urinalysis – test strips only
Module 5y: Urinalysis – by test strips and sediment

Water testing

Module aa: Water-testing – bacteriological testing and basic physical/chemical tests (chemical testing for: free and total chlorine, arsenic, ammonia, fluoride, nitrate, nitrite. This would be used in a river contamination disaster involving some of these chemicals).
Module ab: Water-testing – bacteriological testing and basic physical/advanced chemical tests
Module ac: Water-testing – portable meters for basic physical tests

6.2 Introduction to the use of modules and kits

For the purpose of this book, the following definitions for kits and modules are used.

Kit

A complete inventory of all materials required to set up a field laboratory and/or water-testing unit in an emergency or after a disaster to perform a specified range of testing. Because the requirement for laboratory and water-testing support will vary for different emergency responses, the composition of the testing kit to be transported to the field will also vary according to the situation. To enable this flexibility, kits are assembled by selecting and combining modules that address the specific testing needs of the context.

Module

An inventory of all materials required to perform or support a specific test or activity. Depending on the context, an emergency response kit may comprise either a single module or multiple modules.

Experience has shown that it is more efficient and cost-effective to select equipment and supplies according to specifically identified focused needs. This enables a more rapid and appropriate response, is more cost-effective and minimizes the quantity of materials that need to be delivered to the emergency site. The initial assessment by an experienced investigating disaster team should assess and prioritize the needs of the affected population, and this will direct the range of laboratory and water-testing required. In some contexts it may be necessary to assemble an initial laboratory kit and then at a later stage provide additional modules according to changing needs.

The modules have been designed to meet basic testing needs using methodologies appropriate for situations which could face the great majority of countries, and for countries with limited resources where few or no advanced facilities are available.

It should be emphasized that the modules are intended for emergencies and therefore may not necessarily represent what would be recommended for health laboratory services functioning under normal circumstances. Countries, regions or sites with available laboratory facilities using more advanced methodologies are encouraged to use them.

6.3 Guide for the selection of modules

Recommended steps

For clinical testing, first decide whether laboratory modules or stand-alone modules are most appropriate for the programme.

1. Can the programme setting provide active laboratory support?

Selecting laboratory modules is only recommended when:

- trained laboratory staff are available
- the laboratory can be located in close proximity to the patients
- it is more effective for testing to be performed by a laboratory rather than the clinical team.

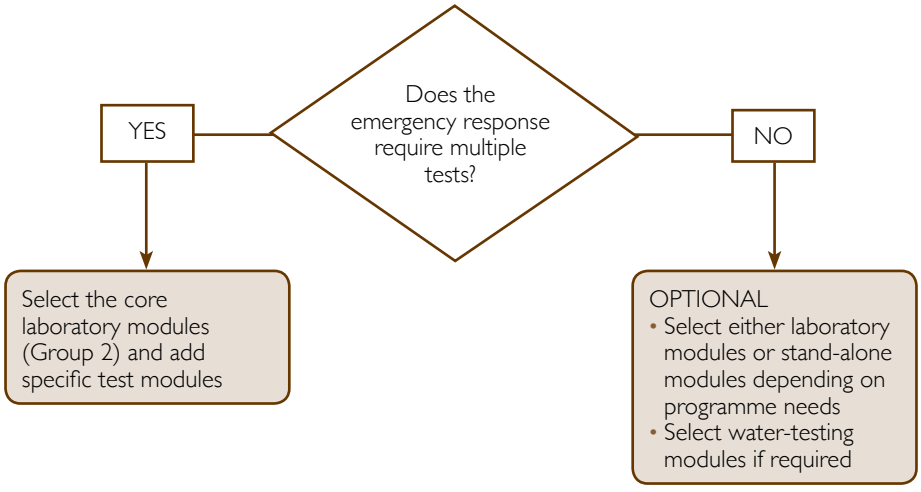
If the programme setting does not meet the above criteria then stand-alone modules should be selected. An example of a stand-alone kit is one used to control a malaria epidemic among refugees.

2. Will the programme be performing highly focused testing (vertical testing) or will the programme require a wider range of testing?

For focused testing it may be preferable to select stand-alone modules that can be used to perform single testing (for example malaria rapid diagnostic testing or malaria microscopy examination) rather than setting up a complete laboratory. However one disadvantage of this approach is that it may be more difficult to add additional testing if the need arises.

3. Will the programme perform water-testing?

Select the appropriate water-testing modules according to need.



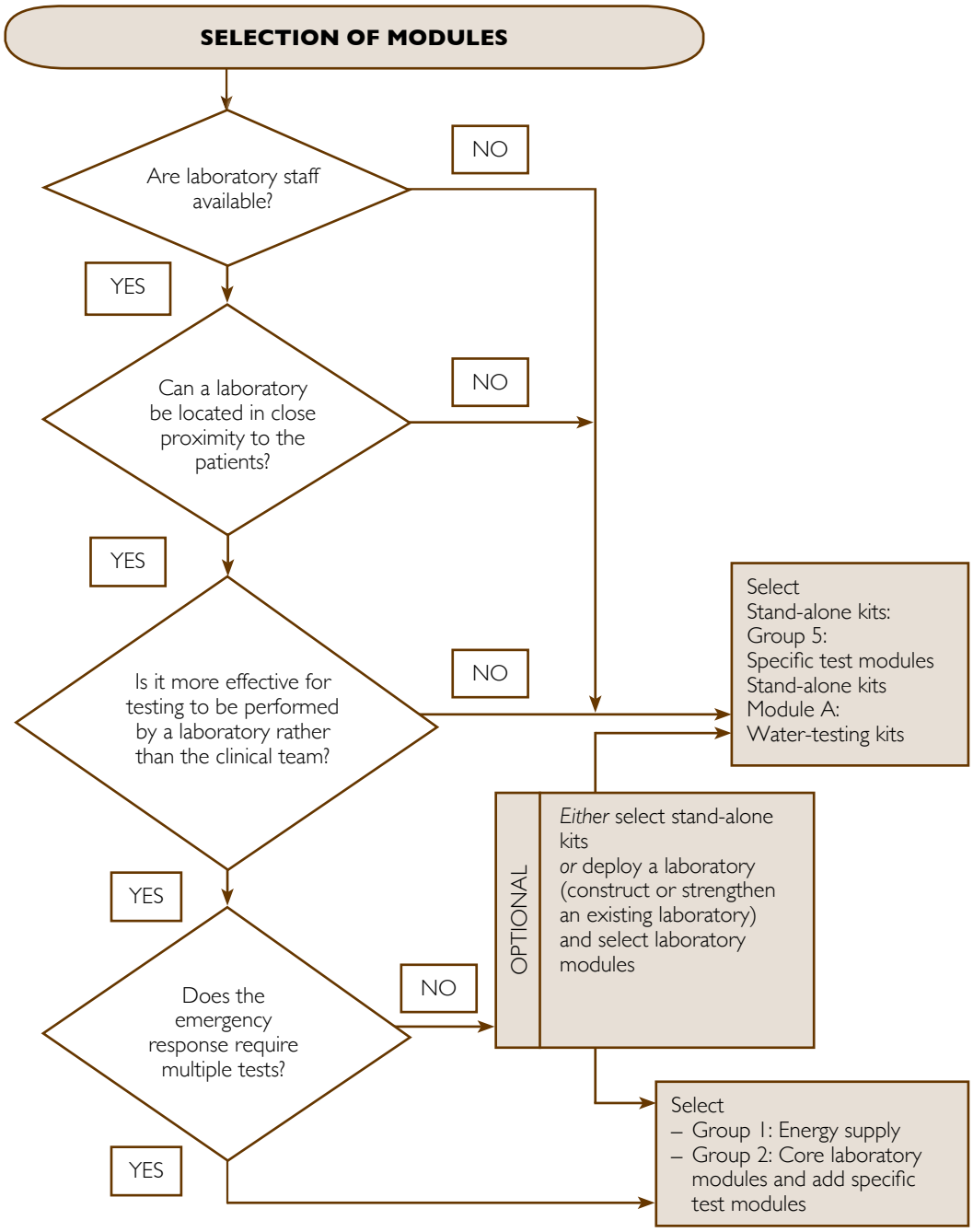

SELECTION OF MODULES
Are laboratory staff available?
NO
YES
Can a laboratory be located in close proximity to the patients?
NO
YES
Is it more effective for testing to be performed by a laboratory rather than the clinical team?
NO
YES
Does the emergency response require multiple tests?
NO
YES
Select
Stand-alone kits:
Group 5:
Specific test modules
Stand-alone kits
Module A:
Water-testing kits
OPTIONAL
Either select stand-alone kits
or deploy a laboratory (construct or strengthen an existing laboratory) and select laboratory modules
Select
– Group 1: Energy supply
– Group 2: Core laboratory modules and add specific test modules

Table 6.1 Guidelines for the selection of clinical testing modules

Question	Yes	No
Are you establishing a new laboratory?	Select Group 1, Energy modules, and Group 2, Core modules	No, strengthening an already existing laboratory. Compare the inventory of the existing laboratory with Group 1, Energy modules, and Group 2, Core modules, and select additional items required
	Sample referral	
Question	**Yes**	**No**
Will you refer samples to a reference laboratory or other test centre?	Select Group 3 modules	No action required
	Specific testing modules	
Question	**Yes**	**No**
Will the programme perform blood transfusions?	If all donor blood will be received from an external blood bank, select Module 4a If some or all of the donor blood will be collected from local donors by the programme, select both Modules 4a and 4b.	No action required
Will you be testing for suspected cholera?	Select Module 5a or 5a-SA	No action required
Will you be testing patients for glucose?	Select Module 5b or 5b-SA	No action required
Will you be performing haemoglobin testing?	For testing without laboratory support, select Module 5c-SA For laboratory use, select either Module 5c, 5d or 5e (refer to flowchart)	No action required
Will you be performing automated haematology?	Select Module 5e	No action required
Will you be performing manual leukocyte counting?	Select Module 5f	No action required
Will you be performing ESR testing?	Select Module 5g	No action required
Will you be performing blood film differential testing?	Select Module 5h	No action required

Will you be performing screening for infectious diseases (not including syphilis) using RDTs?	Select Modules 5i or 5i-SA	No action required
Will you be performing diagnostics for infectious diseases (not including syphilis) using immunoassays?	Select Module 5j	No action required
Will you be screening for syphilis?	For testing without laboratory support, select Module 5k-SA For laboratory use, select either Module 5k or 5l (refer to flowchart)	No action required
Will you be performing malaria diagnostics using RDT?	Select either Module 5m or 5m-SA	No action required
Will you be performing malaria diagnostics using malaria microscopy?	Select either Module 5n or 5n-SA	No action required
Will you be testing for meningitis?	If all samples will only be referred to a reference laboratory, select Module 5o If samples will only be tested in situ for bacterial meningitis outbreaks, select Modules 5o and 5p If samples will be tested in situ for bacterial meningitis outbreaks and full laboratory CSF testing will be performed, select Modules 5o, 5p and 5q If samples will be tested by the laboratory but serological testing for bacterial meningitis will not be performed, select Module 5q	No action required
Will you be performing Gram staining?	Select Module 5r	No action required
Will you be performing wet mount analysis?	Select Module 5s	No action required
Will you be performing stool examination for ova, cysts and parasites?	Select Module 5t	No action required
Will you be performing prenatal testing?	Select Modules 5u or 5u-SA	No action required

Will you be providing laboratory support for trauma?	Select Module 5v	No action required
Will you be performing direct sputum testing for tuberculosis?	Select Modules 5w or 5w-SA	No action required
Will you be performing urinalysis?	Select Modules 5x or 5y	No action required
Will you be performing water-testing?	For basic bacteriological testing and physical/chemical analysis, select Module aa For advanced bacteriological testing and physical/chemical analysis, select Module ab For single meter testing, select Module ac	No action required

6.4 Detailed modules

Legend:

[I] Information

[A] Alternatives

[O] Optional

[!] Cautions

[R] Recommendations

Important note

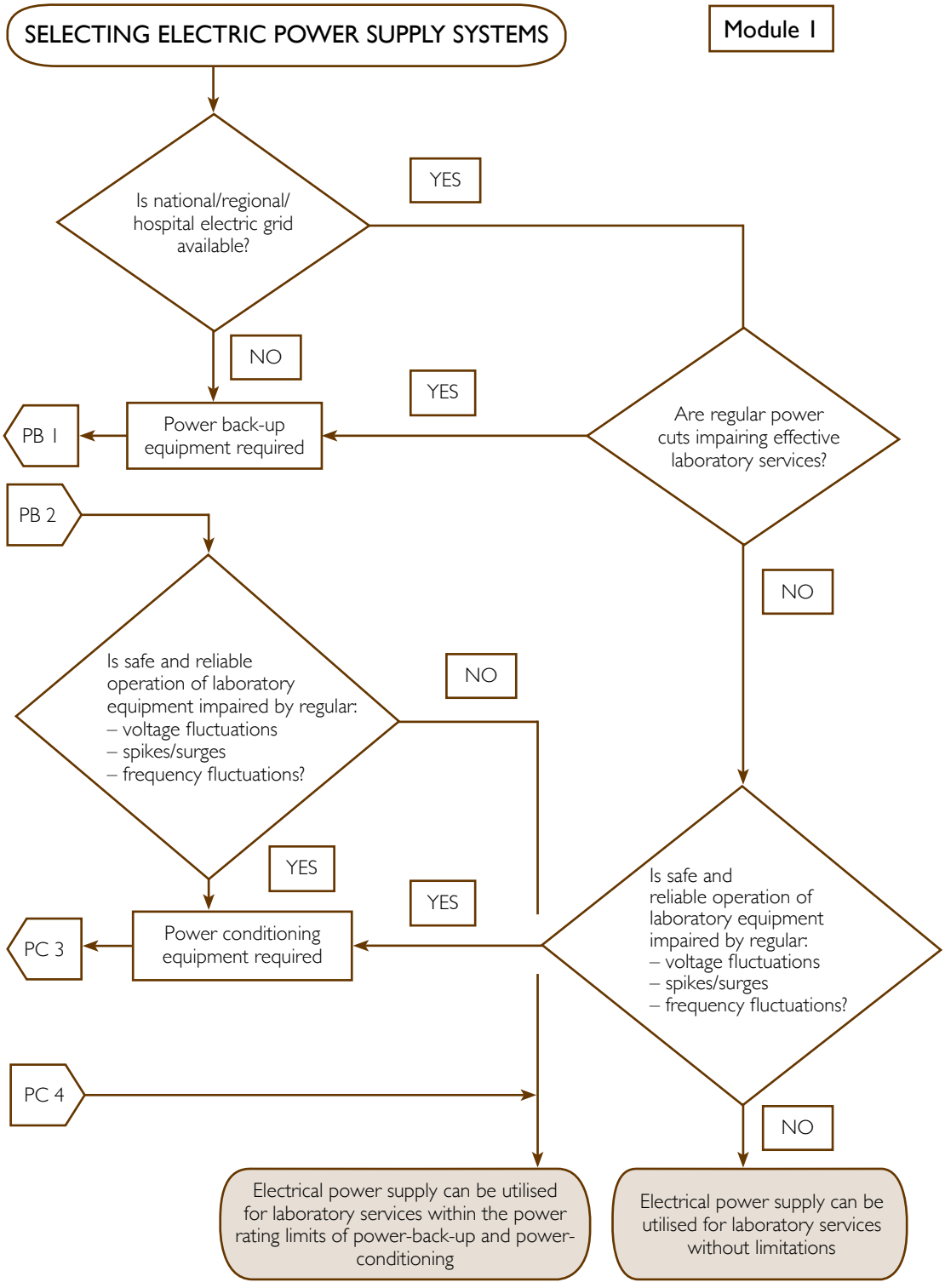
Quantities of consumables and additional reagents and items

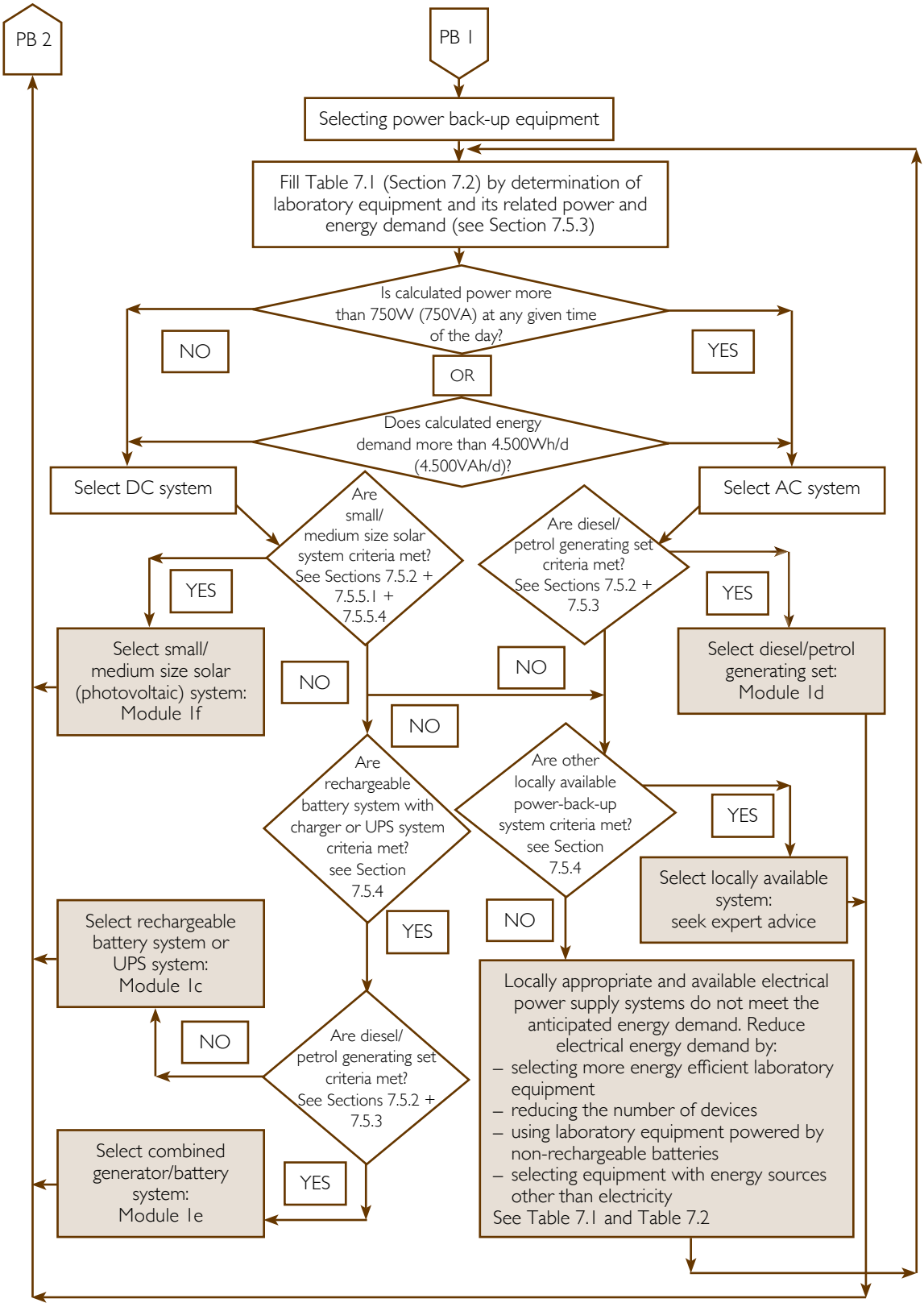
- Quantities of all consumables have been increased by 20% as a roughly estimated safety margin.
- When determining the number of tests the additional reagents required for quality control procedures should be taken into account
- Always order additional items required by the safety and quality protocols for the laboratory

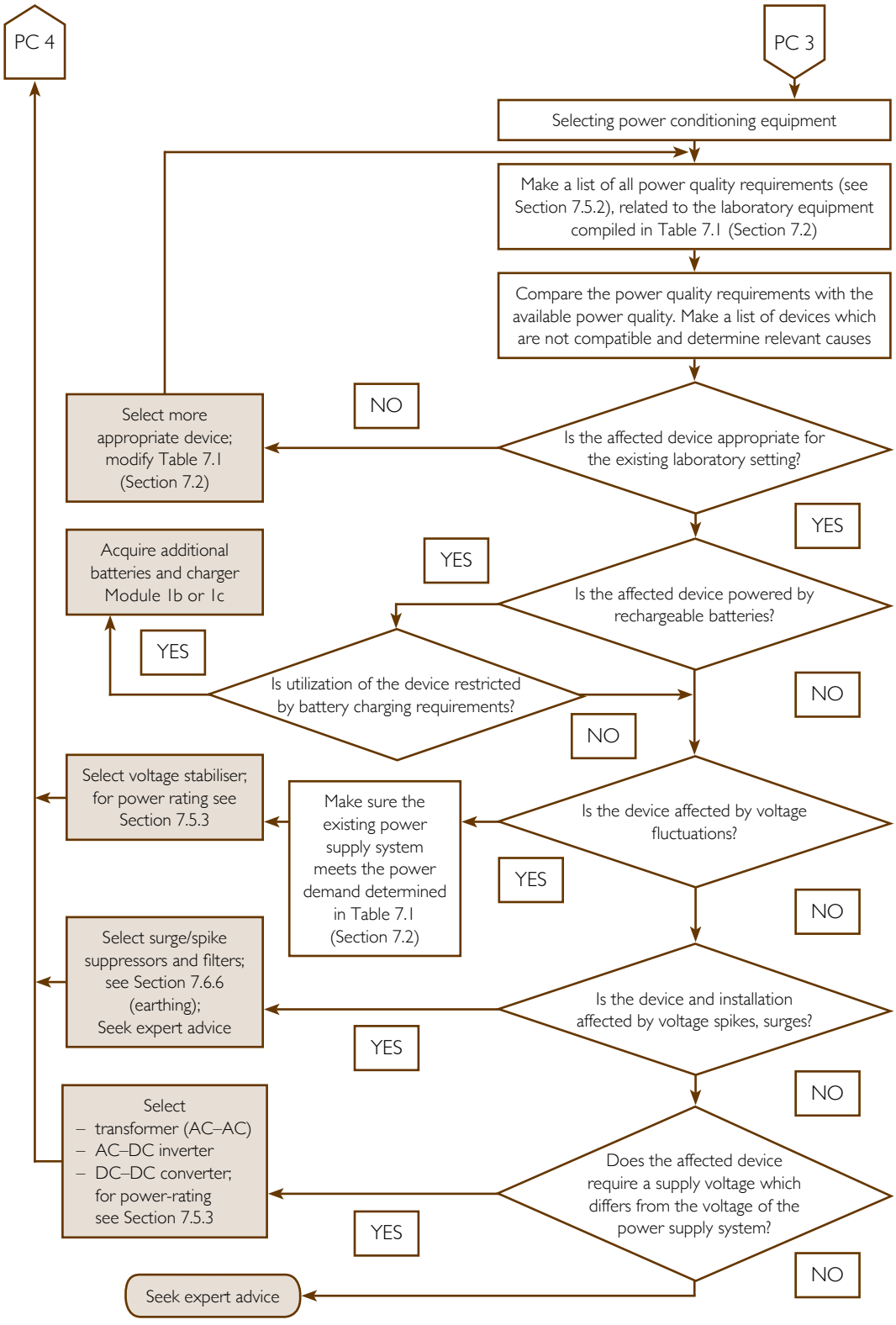
Repetition of certain details and necessary information

- This chapter of modules has been designed to work on its own, hence some details and necessary repetitions appear in some modules because the "need to know" information (such as detailed specifications of some equipment) makes it valuable for this information to be immediately available rather than searching for the required information in other sections of the book. This is especially important for those who would prepare modules and assemble kits
- If two or more modules have to be assembled in one kit, repetitive items should be deleted from the assembled list. It is advisable to develop software on a CD to be used as a companion to this publication to help in identifying repetitive items and ensuring avoiding duplication of items

Group 1: energy modules




PB 2
PB 1
Selecting power back-up equipment
Fill Table 7.1 (Section 7.2) by determination of laboratory equipment and its related power and energy demand (see Section 7.5.3)
Is calculated power more than 750W (750VA) at any given time of the day?
NO
YES
OR
Does calculated energy demand more than 4.500Wh/d (4.500VAh/d)?
Select DC system
Select AC system
Are small/ medium size solar system criteria met? See Sections 7.5.2 + 7.5.5.1 + 7.5.5.4
Are diesel/ petrol generating set criteria met? See Sections 7.5.2 + 7.5.3
YES
YES
Select small/ medium size solar (photovoltaic) system: Module 1f
Select diesel/petrol generating set: Module 1d
NO
NO
NO
Are rechargeable battery system with charger or UPS system criteria met? see Section 7.5.4
Are other locally available power-back-up system criteria met? see Section 7.5.4
YES
Select locally available system: seek expert advice
NO
YES
Select rechargeable battery system or UPS system: Module 1c
Are diesel/ petrol generating set criteria met? See Sections 7.5.2 + 7.5.3
NO
Locally appropriate and available electrical power supply systems do not meet the anticipated energy demand. Reduce electrical energy demand by:
– selecting more energy efficient laboratory equipment
– reducing the number of devices
– using laboratory equipment powered by non-rechargeable batteries
– selecting equipment with energy sources other than electricity
See Table 7.1 and Table 7.2
Select combined generator/battery system: Module 1e
YES


PC 4
PC 3
Selecting power conditioning equipment
Make a list of all power quality requirements (see Section 7.5.2), related to the laboratory equipment compiled in Table 7.1 (Section 7.2)
Compare the power quality requirements with the available power quality. Make a list of devices which are not compatible and determine relevant causes
Is the affected device appropriate for the existing laboratory setting?
NO
Select more appropriate device; modify Table 7.1 (Section 7.2)
YES
Is the affected device powered by rechargeable batteries?
YES
Acquire additional batteries and charger Module 1b or 1c
Is utilization of the device restricted by battery charging requirements?
YES
NO
NO
Is the device affected by voltage fluctuations?
YES
Make sure the existing power supply system meets the power demand determined in Table 7.1 (Section 7.2)
Select voltage stabiliser; for power rating see Section 7.5.3
NO
Is the device and installation affected by voltage spikes, surges?
YES
Select surge/spike suppressors and filters; see Section 7.6.6 (earthing); Seek expert advice
NO
Does the affected device require a supply voltage which differs from the voltage of the power supply system?
YES
Select
– transformer (AC–AC)
– AC–DC inverter
– DC–DC converter;
for power-rating
see Section 7.5.3
NO
Seek expert advice

Module 1a: Non-rechargeable batteries (primary cells)

[I]	Description/instructions	
	The following table contains standard-size non-rechargeable batteries for general purpose applications, such as calculators or haemoglobinometers (DC voltage); selection according to Section 7.5.4.1 and Table 7.2	
[A]	**Item**	**Quantity**
	Alkaline batteries, size AAA (micro), 1.5V, 1200 mAh[1]	10
	and/or	
	Alkaline batteries, size AA (mignon), 1.5V, 2700 mAh[1]	10
	and/or	
	Alkaline batteries, size C (baby), 1.5V, 8000 mAh[1]	10
	and/or	
	Alkaline batteries, size D (mono), 1.5V, 12 000 mAh[1]	10
	and/or	
	Alkaline batteries, 9-volt block, 500-600 mAh[1]	10

[1] MAh is the rating of energy storage capacity mAh = "milli-ampere hours". A higher rated mAh battery will give you longer running times between charges. The higher rating has no effect on electronic devices other than allowing longer term use.

Module 1b: Rechargeable batteries and battery chargers

[I]	Description/instructions	
	Refer to flow chart: Selecting electric power supply systems The following table contains standard-size rechargeable batteries for general purpose applications, such as calculators, haemoglobinometers (DC voltage); selection according to Section 7.5.4.2 and Table 7.2) and battery chargers according to Section 7.5.4.3	
[A]	**Item**	**Quantity**
	Nickel–metal hydride batteries (NiMH), size AAA (micro), 1.2 V, 1000 mAh *and/or* Nickel–metal hydride batteries (NiMH), size AA (mignon), 1.2 V, 2900 mAh *and/or* Nickel–metal hydride batteries (NiMH), size C (baby), 1.2 V, 6000 mAh *and/or* Nickel–metal hydride batteries (NiMH), size D (mono), 1.2 V, 10 000 mAh *and/or* Non-standard-size lithium-ion batteries (Li-ion); size, voltage and storage capacity for specific items of equipment (as appropriate)	Total quantity of these batteries of each size required for equipment used by the programme and two sets of batteries for the charging positions available in the battery charger
	Charger for standard NiMH batteries *Minimum specifications:* • Meeting safety standard EN 60601-1 • Input voltage: 100–240 V AC; input frequency: 50–60 Hz, mains plug according to local standard • Environmental conditions: operating temperature 0 °C to 40 °C; humidity: 5%–95% non-condensing • Output: compartments for four standard batteries: sizes AAA, AA, C and D • Automatic charge control: check and recovery stage, bulk (fast) charge, float (trickle) charge; charge detection for fully charged or faulty cells, timed cut-off as fail safe feature • Indicator lamps for standby, charging, ready, error condition *and/or* • Charger for Li-ion-batteries, provided by the manufacturer of specific equipment	Depending on the batteries in use and the equipment requirements (some equipment comes with integrated or plug-type battery chargers, thus independent parallel charging is not possible)

Module 1c: Battery back-up system

[I]	Description/instructions	
	Refer to flow chart: Selecting electric power supply systems Lead–acid/gel cell battery and charger for supply of laboratory equipment (DC voltage); see Section 7.4	
[!]	**Cautions**	
	Follow manufacturer's instruction manual for the safe handling of sealed lead–acid batteries.	
[A]	**Item**	**Quantity**
	Lead–acid/gel cell battery, sealed, for deep cycle discharge, for general purposes such as lighting, microscope, water-testing kit and small solar systems, not for starting of vehicles *Minimum specifications:* • Minimum five years design life at 20 °C • Maintenance-free during entire service life • Low self-discharge rate (< 3%/month at 20 °C) • Refer to Section 7.5.4 for determination of: – nominal voltage (V DC) – storage capacity (Ah) at the appropriate ambient temperature – dimensions – connector type and position	Depending on the daily energy profile of the laboratory equipment in use (see Table 7.1 and Sections 7.5.3 and 7.5.4)
	• Charger for lead–acid/gel cell batteries *Minimum specifications:* • Compliance with safety standard EN 60335 • Input voltage: 100–240 V AC • Input frequency: 50–60 Hz • Mains plug according to local standard • Environmental conditions: operating temperature 0 °C to 40 °C; humidity: 5%–95% non-condensing • Automatic charge control: check and recovery stage, bulk (fast) charge, float (trickle) charge • Temperature-compensated charge voltage, short circuit resistant, reverse polarity protection, over-voltage protection • Indicator lamps for standby, charging, ready, error condition • For output specification refer to battery manual (see above): – voltage – storage capacity – charging current and characteristics – battery arrangement – connector type	1

Module 1d: Diesel/petrol generator with standard electric appliances and installation kit

[I]	Description/instructions	
	Refer to flow chart: Selecting electric power supply systems Below is a specification of a stand-alone sample generating set and installation kit for the energy supply of an emergency laboratory, equipped with lighting, microscope, small centrifuge (AC voltage), according to Section 7.5.3	
[!]	**Cautions**	
	Generator should only be used in a well ventilated area (sheltered drip-proof environment) and never overloaded. Diesel/petrol is inflammable; store fuel safely! Always connect the generator to the earthing system (see Section 7.6.1) Precaution against theft: secure with a strong steel chain and padlock	
[R]	**Recommendations**	
	Because low power portable type generators (domestic type) have a limited continuous operating time (see manufacturer's instruction manual for maximum running hours), it is recommended that two generators should be operated alternatively if the required use exceeds the manufacturer's maximum operating time	
[A]	**Item**	**Quantity**
	Portable generating set, prime power: 750 VA , standby power: 850 VA *Minimum specifications:* • Continuous operating time: minimum 5 hours • Engine: diesel; hand starting (recoil or crank); single cylinder, forced air cooled, four-stroke, mechanical speed regulation, low noise level • Integrated fuel tank, sturdy roll-over frame • Alternator: 750/850 VA, 230 V AC, 50 Hz, single phase • Maximum voltage variation ±5% no load to full load • Standard switchboard with double-sockets, circuit-breaker, oil-alert system • Precaution against theft: secure with a strong steel chain and padlock (see Section 7.6.2.1)	2. Additional generators may be required depending on need
	Tube lamps and spare bulbs – energy saving compact fluorescent lamp 10W – supply voltage according to local supply conditions – robust lamp fitting for exterior or interior use; IP-rating: IP56; high-impact resistant prismatic polycarbonate cover	1 set per individual workplace; 2 spare bulbs

Switches, surface-mounted, rocker type, 10 A Sockets according to local standard	Depending on local requirements[1]
Cables, extension leads – for the determination of cable core nominal area, the power rating of supply system and the rating of allocated circuit-breakers must be taken into consideration; – for fixed installations in dry or damp premises use PVC non-armoured multi-core copper cables, rigid cores – for flexible applications use PVC non-armoured multi-core copper cables, stranded bare cores – for AC systems use three-core sheathed cables with earth-continuity conductor – for DC systems use two-core sheathed cables	Depending on local requirements[1]
Earthing rod with connector	Depending on local requirements[1]
Distribution boards, circuit-breakers	As required
Junction boxes and connectors	As required

[1] Request advice from local electrician.

Module 1e: Diesel/petrol generator with battery back-up system and standard electric appliances and installation kit

[I]	**Description/instructions**
	Refer to flow chart: Selecting electric power supply systems Specification of a generating set with battery back-up system and installation kit for the energy supply of an emergency laboratory, equipped with lighting, microscope, small centrifuge (AC voltage), according to Section 7.5.3. The proposed operating time of the generating set is 5 hours per day during working hours, simultaneously supplying both the laboratory equipment and the battery back-up system. During the rest of the day the battery back-up system is used to supply microscope and lighting. The battery back-up system comprises a sealed lead–acid battery, a battery charger and an inverter (for DC to AC conversion)
[!]	**Cautions**
	Generator should only be used in a well ventilated area (sheltered drip-proof environment) and never overloaded. Diesel/petrol is inflammable, store fuel safely! Always connect the generator to the earthing system (see Section 7.6.1) Follow manufacturer's instruction manual for the safe handling of sealed lead–acid batteries. Refer to equipment manual for: – nominal voltage (V DC) – storage capacity (Ah) at the appropriate ambient temperature – dimensions – connector type and position
[R]	**Recommendations**
	Due to the limited continuous operating time of low-power portable type generators (domestic type) a battery back-up system is included in this module. The charging energy for the back-up system during the generator operating time must be included in the power rating of the generator

[A]	Item	Quantity
	Portable generating set, prime power: 1200 VA, standby power: 1500 VA *Minimum specifications:* • Continuous operating time: minimum 5 hours • Engine: Diesel; hand starting (recoil or crank); single cylinder, forced air cooled, four-stroke, mechanical speed regulation, low noise level • Integrated fuel tank, sturdy roll-over frame • Alternator: 1200/1500 VA, 230 V AC, 50 Hz, single phase; maximum voltage variation ±5% no load to full load • Standard switchboard with double-sockets, circuit-breaker, oil-alert system • Precaution against theft: secure with a strong steel chain and padlock (see Section 7.6.2.1)	1
	Lead–acid/gel cell battery, sealed, for deep cycle discharge, for general purpose such as lighting, microscope, water-testing kit and small solar systems, not for starting of vehicles *Minimum specifications:* • Minimum five years design life at 20 °C • Maintenance-free during entire service life • Low self-discharge rate (< 3%/month at 20 °C) • Nominal voltage: 12 V DC • Storage capacity: 30 Ah • Ambient temperature: 35 °C • Dimensions: -- • Connector type and position: cylindrical poles	2
	Charger for lead–acid batteries *Minimum specifications:* • Compliance with safety standard EN 60335 • Input voltage: 100–240 V AC • Input frequency: 50–60 Hz • Mains plug according to local standard • Environmental conditions: operating temperature 0 °C to 40 °C; humidity: 5%–95% non condensing • Automatic charge control: check and recovery stage, bulk (fast) charge, float (trickle) charge; temperature compensated charge voltage, short-circuit resistant, reverse polarity protection, over-voltage protection • Indicator lamps for standby, charging, ready, error condition • Output voltage: 12 V • Charging current and characteristics: 6 A • Battery arrangement: parallel • Connector type: clamp-on connector	2

DC–AC inverter *Minimum specifications:* • Complies with safety standard EN 60335 • Output: – power rating (minimum): continuous 500 VA; peak (10 minutes) 750 VA – voltage: 240 V AC ± 10%; frequency: 50 Hz ± 0.1% – wave form: pure sine wave – socket according to local standard; – standby on–off threshold: at 10 W • Input: – voltage: 10–15 V DC ± 10% – low voltage disconnect: 10.5 V – high voltage disconnect: 15.5V • Low self-consumption (< 500 mA on no load) • Excess temperature protection • Environmental conditions: operating temperature 0 °C to 40 °C; humidity: 5%–95% non condensing • Enclosure: > IP20[1]	2
Tube lamps and spare bulbs – energy-saving compact fluorescent lamp 10 W – supply voltage according to local supply conditions – robust lamp fitting for exterior or interior use; IP-rating: IP56; high-impact resistant prismatic polycarbonate cover;	1 set per individual workplace; 2 spare bulbs
Switches, surface-mounted, rocker type, 10 A	Depending on local requirements[2]
Sockets according to local standard	
Cables, extension leads – for the determination of cable core nominal area the power rating of supply system and the rating of allocated circuit-breakers must be taken into consideration – for fixed installations in dry or damp premises use PVC non-armoured multi-core copper cables, rigid cores – for flexible applications use PVC non-armoured multi-core copper cables, stranded bare cores; – for AC systems use three-core sheathed cables with earth-continuity conductor – for DC systems use two-core sheathed cables	Depending on local requirements[2]
Earthing rod with connector	Depending on local requirements[2]
Distribution boards, circuit-breakers	As required
Junction boxes and connectors	As required

[1] IP20: 'ingress protection' rating symbolizing protection from solid objects (approximately 12mm in size) but no (zero) protection against liquids

[2] Request advice from local electrician.

Module 1f: Solar (photovoltaic) system with battery, standard electric appliances and installation kit

[I]	Description/instructions	
	Refer to flow chart: Selecting electric power supply systems Specification of a medium-size solar energy supply system for an emergency laboratory, equipped with lighting, microscope and refrigerator, according to Section 7.5.5.4	
[!]	**Cautions**	
	Follow manufacturer's instruction manual for the safe handling of sealed lead–acid batteries	
[A]	**Item**	**Quantity**
	Solar panel *Minimum specifications:* • High-efficiency wafer-based crystalline silicon cells • Nominal power: 40 Wp[1] • Nominal voltage: 12 V DC • Maximum power current (or maximum power-point current): 2.3 A • Temperature cycling interval: 0 °C to 85 °C, humidity: 5%–95% • Clear universal frame, junction box, mounting accessories	12
	Solar charge regulator for deep discharge solar batteries (see below) *Minimum specifications:* • Nominal voltage: 12 V DC • Nominal power: 360 W • Nominal current: 30 A • Automatic charge control: check and recovery stage, bulk (fast) charge, float (trickle) charge • Temperature-compensated charge voltage, short circuit resistant, reverse polarity protection, overcharging and deep discharge protection • Indicator lamps for charging, ready, error conditions • Digital display of battery volts, charge and load currents	2
	Solar battery *Minimum specifications:* • Nominal voltage: 12 V DC • Storage capacity: 130 Ah • Ambient temperature: 30 °C • Clamp-on connectors, valve regulated for deep cycle discharge; minimum five-year design life at 20 °C, maintenance-free during entire service life, low self-discharge rate (< 3%/month at 20 °C)	3

Tube lamps and spare bulbs – energy saving compact fluorescent lamp 10W – supply voltage according to local supply conditions – robust lamp fitting for exterior or interior use; IP-rating: IP56; high-impact resistant prismatic polycarbonate cover	1 set per individual workplace; 2 spare bulbs
Switches, surface-mounted, rocker type, 10 A Sockets according to local standard	Depending on local requirements[2]
Cables, extension leads – for the determination of cable core nominal area the power rating of supply system and the rating of allocated circuit-breakers must be taken into consideration – for fixed installations in dry or damp premises use PVC non-armoured multi-core copper cables, rigid cores – for flexible applications use PVC non-armoured multi-core copper cables, stranded bare cores – for AC systems use three-core sheathed cables with earth-continuity conductor – for DC systems use two-core sheathed cables	Depending on local requirements[2]
Earthing rod with connector	Depending on local requirements[2]
Distribution boards, circuit-breakers	As required
Junction boxes and connectors	As required

[1] Wp: watt peak capacity (which is not the regular power output but the maximum capacity (peak power) of a module under optimal conditions)

[2] Request advice from local electrician.

Group 2: core laboratory modules

Module 2a: Basic equipment and consumables

[I]	Description/instructions	
	Refrigeration The selection of the refrigerator will be dependent on the power supply available *Waste disposal* An incinerator does not need to be included if there is access to a general programme incinerator. The requirement for an autoclave will depend on the national protocol for the disposal of infectious materials (such as sputum)	
[!]	**Cautions**	
	The laboratory will require access to a sharps pit and general waste management of stains and hazardous chemicals (such as azides used as preservatives in reagents)	
[R]	**Recommendations**	
	Microscope(s) The efficiency of the laboratory will often be dependent on the number of available microscopes. Depending on the workload and setting, it is recommended that one microscope be provided for each laboratory staff member who will perform microscopy *Refrigerator* • To minimize power consumption, select the smallest-size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable • An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator • If blood transfusion services are provided, a separate dedicated refrigerator should be procured *Centrifuge* • To minimize power consumption, select the smallest-size centrifuge needed to accommodate the workload • A swing-out rotor with buckets is preferred to a fixed-angle rotor	
[A]	**Item**	**Quantity**
	Equipment and low-use consumables	
	Basin, plastic, diameter 285–310 mm[s]	2
	Beaker, glass, low form, spouted, 100 mL	2
	Beaker, glass, low form, spouted, 500 mL	2
	Beaker, plastic, low form, spouted, 1 000 mL	1
	Beaker, plastic, spouted, 50 mL	4

Binocular light microscope *Recommended minimum specifications:* • Strong construction, stable base • Optics anti-fungus treated • Binocular head inclined to approximately 30°, and rotatable for 360° and adjustable for inter-pupillary distance • Condenser, Abbe type with iris and filter holder • Centring screws or an alternative system provided by the manufacturer Blue filter • 10× eyepieces widefield (FN 18) with tube caps • Rubber eye shelters for both eye pieces • 100× oil immersion (spring-loaded) objective, minimum NA 1.25 • Parfocal DIN infinity-corrected plan achromat, 10×, 40× (spring-loaded) objectives, minimum 10×/NA 0.25, 40×/NA 0.65, 100×/NA 1.25. Power supply: supply voltage: 110/230 V AC; battery-powered: minimum three hours of operation at full intensity per battery charge; low battery warning Accessories: 1 battery charger or mains adaptor 1 battery pack, rechargeable 1 connection lead with car adapter 12 V DC/crocodile clamps and optionally operated on a solar panel Illumination Illumination unit with graduated lamp brightness control, light source: halogen lamp (luminous flux: minimum 700 lm; 20 W) *or* white LED lamp (luminous flux: minimum 700 lm, service life: minimum 15 000 hours) *and* back-up (daylight) mirror unit, plane and concave, mounted for angling and rotating *and* spare bulbs: three spare bulbs (if halogen) • Coaxial fine and coarse focus controls on both sides • A built-in stage with a mechanism for mounting object slide. Fixed graduated mechanical and coaxial controls • Supplied with non-drying immersion oil • Dust cover	Dependent on workload. One recommended for each laboratory technical staff who will perform microscopy reading
Blood tube mixer, flat, rocker type[1]	1
Bottle[gs], high-density polyethylene, brown, screw-cap, 500 mL	6
Bottle, swan-neck jet, plastic, 250 mL	6
Bowl, plastic	4
Broom	1
Scrubbing brush	2
Bucket, metal (10–12 L)	2

	Cabinet, hazardous material cabinet, medium size	1
	Calculator	1
	Calculator batteries, spare	4
	Centrifuge, electric, bench-top model *Recommended selection:* • Swing-out rotor • Smallest centrifuge capable of accommodating tube requirements • If selecting fixed-angle rotor, consider two smaller centrifuges *Minimum specifications:* • Robust construction • Power supply: 110/230 V AC • Brushless drive induction motor • Suction-cup feet • Minimum size able to accommodate 3–15 mL tubes • The lid should have a safe lid interlock and a mechanical lid release mechanism. • Supplied with sealable buckets or sealable fixed-angle rotor • Centrifugal force–adjustable from 500× g to 2000× g (note: this is not the rpm rating) • Timer and alarm • An imbalance detector • Electronic meter displaying rpm and g-force. • Operating manual • Full spare part list and manufacturer's maintenance manual • One-year manufacturer's guarantee	1
	Centrifuge, manufacturer's recommend spare parts	1 set
[A]	Centrifuge, rotors and buckets Recommended: swing-out rotor with bucket inserts suitable for 3–7 mL blood tubes and 10–15 mL urine tubes[2] or Equivalent fixed-angle rotors suitable for 3–7 mL blood tubes and 10–15 mL urine tubes	Minimum 2 for each size tube described
	Clock, wall-mounted	
	Cold box (isotherm container), vaccine carrier, overall dimensions: 24 × 24 × 33 cm, internal dimensions: 15 × 15 × 19 cm, storage capacity 1.7 L, ice packs (two sets of ice packs per cold box; one set to be frozen while the other set is being used)	1
	Counting chamber, Neubauer, new improved bright line, double grid	2
	Cylinder, with clear graduations, polypropylene, spout, 10 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 50 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 100 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 500 mL	1
	Cylinder, with clear graduations, polypropylene, spout, 1000 mL	1

Dropper staining bottles (for example, TK) brown and clear[3]	2 of each
Fire blanket	1
Eye-shield (goggles, clear shatter-resistant polycarbonate and fitted with side shields)	2
Fire extinguishers, multipurpose dry chemical or carbon dioxide powder models	2
First aid kit	1
Forceps, stainless steel, blunt end, 105 mm long	1
Funnels, polypropylene, 65 mm diameter	2
Funnels, polypropylene, 90 mm diameter	2
Gas stove, small	1
Gas, cylinder, for gas stove	1
Glass bottle approximately 500 mL[r]	1
Gloves, rubber, heavy duty (for cleaning)	2 (or 4 if more than one technician)
Gloves, stout leather (for taking sharps containers to incinerator)	2 (or 4 if more than one technician)
Glycerol ≥ 100 mL[r]	1
Autoclave	1
Incinerator	1
Lamp (spirit burner), 65–100 mL, with cap	2
Lamp, spirit wick (spare for spirit lamp), 7 mm diameter	10
Maximum–minimum thermometer, minimum recommended temperature interval –10 °C to 50 °C[r]	1
Measuring jug, polypropylene, graduated tall jug, 5 L	1
Metal container (saucepan or similar) with sufficient size to accommodate a metal test tube rack to accommodate 10–12 mL tubes	1
Microscope, immersion oil, non-drying high quality	2L
Microscope, lens-cleaning paper, sheet	200
Microscope, lens-cleaning solution	1 L
Microscope, lint-free cleaning cloth	2
Microscope, dropper bottle for immersion oil, 50 mL	2
Microscope, fuses	4
Microscope, halogen lamps as specified by the microscope manufacturer (not needed if LED microscope)	4
Mop	1
Mortar, porcelain, 150 mL and pestle	1
Pencil sharpener	2
Petri dish, approximately 120 mm diameter, with lids	5

	Pipette filler, with thumb-wheel lever (Pi-pump), 10 mL (green)	1
	Pipette tips, yellow, box including tray for 100 tips (empty)	2
	Pipette, automatic, 10–200 µL tip	1 000
	Pipette, automatic, 100–1000 µL tip	500
	Pipette, automatic, adjustable volume, 100–1000 µL,	1
	Pipette, automatic, adjustable volume, 20–200 µL,	1
	Pipettes, graduated, polypropylene, 1 mL	5
	Pipettes, graduated, polypropylene, 10 mL	5
	Pipettes, graduated, polypropylene, 5 mL	5
	Rack, drying, plastic or wood (for slides)[4]	2
	Rack, for tubes 100–125 × 15–20 mm diameter	2
	Rack, for tubes 50–100× 5–15 mm diameter	2
	Rack, for tubes 75 ×10–13 mm diameter	2
	Rack, for tubes 63 × 9.5 mm diameter	2
	Reagent bottles, high density polyethylene, leak-proof cap, 250 mL, clear and opaque	10 each
	Receptacle, waste, with attached lid stainless steel, 12 L; foot operated	2
[A]	Refrigerator *Minimum specifications:* • Size: 140 L (size may vary based on the needs at the site) • Internal air temperature; 2 °C to 10 °C • One-year manufacturer's guarantee • Important: should have a separate freezer compartment, non-automatic defrost (not a freezer located inside the refrigerator cabinet) • Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas-powered *or* Kerosene-powered	1
	Rod, glass, 250 mm diameter 6–7 mm	2
	Rods, stainless steel adjustable length rods (for slide staining) in holders with levelling screws, for fitting across sink, minimum length 290 mm[5]	1 set
	Ruler, 30 cm	2
	Scissors, 17 cm, blunt ends	1
	Scissors, domestic, pointed ends	2
	Scissors, sharp tip	1

Slide holder, cardboard, flat, capable of holding 20 slides	10
Slide mailer, polyethylene or cardboard, with integral push-in lid	10
Spatulas, polypropylene, length 100 mm	2
Stain dispensing containers, 500 mL, clear and opaque plastic	10 of each
Tally counter, hand, manual, plastic- or metal-cased	2
Test-tube brush, nylon or bristle head, large size, 70–90 mm diameter head	1
Test tube brush, large 50 mm diameter	1
Test tube brush, medium 18 mm diameter	1
Test tube brush, small 12 mm diameter	2
Thermometer, maximum–minimum, at least 0 °C to 40 °C	1
Thermometer, maximum–minimum, at least –30 °C to 0 °C	1
Thermometer, –10 °C to 110 °C, red spirit	2
Thermometer, alcohol stem, minimum recommended temperature interval –10 °C to 50 °C	1
Timer, mechanical, 1–60 minutes, with ringer	2
Tool kit (See Annex 6)	1 set
Tube, centrifuge, 15 mL, conical bottom	20
Tube, standard, 15 mL × 160 mm	20
Wash bottles, 250 mL, 500 mL, polythene	6
Water purification, brush, stiff bristles (to clean filters)	1
Water purification, gravity water filter, 10 L, fountain, four self-sterilizing ceramic elements (candle filter)[5]	1
Water purification, spare candle filter, 18 cm	2
Water storage container, polyethylene, 20 L, with handle and removable tap	1
Consumables	
Applicator stick, wooden, box of 100	5
Bag for hazardous waste	200
Bag, autoclave, 20 L	50
Bags, plastic bags, self-sealing, medium size	50
Bags, plastic, self-sealing, small	50
Bleach (household 5%) or commercial (see Chapter 5[d])	5 L
Capillaries, plain	3 boxes
Capillaries, heparinized	3 boxes
Container, sharps, 5 L, cardboard for incineration	50
Containers, polypropylene, 25–60 mL capacity, leak-proof screw-cap, wide-neck[6]	100
Containers, polypropylene, 60–120 mL capacity, leak-proof screw-cap, wide-neck[7]	100
Containers, triple packs IATA compliant, sample transport	10

	Cotton wool, hydrophilic, roll, 500 g	4
	Cover glasses, 20 × 20 mm, preferably No. 1½ thickness	10 boxes
	Disinfectant solution, hand-washing, waterless cleaner	1 L
	Disinfectant, commercial, directed against viruses[d]	2 L
	Eraser (rubber), for erasing marking by pencil	2
	Ethanol, 70% v/v[d]	1 L
	Eye wash, solution, 1 bottle and eye cup	2
	Film, sealing plastic (parafilm) roll, 10 cm × 38 m	2
	Filter paper, circles, 12.5 cm, general purpose	100
	Filter paper, sheet, large, general purpose	50
	Gloves, examination, non-latex, disposable, large/medium/small *Size requirements vary from country to country; select distribution of large, medium and small as appropriate* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	According to setting
	Hydrochloric acid, concentrated	500 mL
	Labels, permanent self-adhesive (general purpose labelling)	100
	Paperclips, package	10
	Pen, ballpoint, black	12
	Pen, ballpoint, red	6
	Pen, permanent marker, black	12
	Pen, permanent marker, red	6
	Pencil, HB or 2H preferred	12
	pH paper/strips, 4.0–8.0 interval	100
	Phenol[d]	500 g
[A]	Physiological saline, laboratory grade, plastic bottles *or* Physiological saline, clinical infusion bags/bottles	5 L
	Pipettes, transfer, non-sterile, polyethylene, 3 mL, 0.5 mL graduation	1000
	Protection paper for bench, absorbent, 50 cm × 50 m	2
	Protective clothing, laboratory coats or gowns *minimum 2 per staff member*	According to setting
[A]	Registration books for recording patient details and test results Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed	Quantity to be determined according to the projected patient numbers, and whether separate registration books are used for different tests
	Request forms	As required
	Sides, microscope, with frosted ends	10 boxes (100 slides each)

Sodium hydroxide pellets	100 g
Stapler, paper, hand-held	2
Staples, size compatible with stapler	1000
Steel wool pads, non-detergent[c]	60
Swabs, transport, cotton	100
Toilet paper, rolls[s]	50
Titrator, digital (Hach Company). Detection range for chlorine: 20–70 000 mg/L	1 titrator
• WataTest reagent kit (Fondation Antenna Technologies). Detection range for chlorine: 1000–7000 mg/L	1 WataTest
• Serim Monitor for Chlorine test strip (Serim Research Group). Detection range: 100–750 mg/L[8]	2 Serim
Tool box; see Annex 6: General purpose tool kit laboratory use	

Notes:
[d] For disinfection
[s] Staining
[gs] General storage
[c] Cleaning
[r] It is recommended that the temperature of the refrigerator should be monitored using a thermometer immersed in a container of glycerol. This provides a better measurement of the core temperature of the contents of the refrigerator than the air temperature.
FN: The field number referring to the diaphragm size of eyepiece in mm which defines the image area of specimen
NA: The numerical aperture of a microscope objective
[1] Used for mixing venous blood samples prior to testing
[2] Preferably the buckets themselves should remain the same size and only the inserts changed for different uses
[3] Dropper bottles, one translucent and one amber polythene; 15 mL container with plug and cap. Suitable for physiological saline and dispensing immersion oil.
[4] Staining
[5] Ceramic (earthenware) element filters are self-sterilizing and last for 6–12 months. They require weekly cleaning with a stiff-bristled brush and clear water (with no detergent).
[6] General purpose; containers for specific testing urine/stool are included in the specific test modules
[7] General purpose; containers for specific testing sputum are included in the specific test modules
[8] The number of chlorine testing kits needed to be included in the modules will vary according to the disinfectant needs in each emergency, but there must be a sufficient number to get going. In certain situations such as ebola or cholera epidemics, a larger number of kits would be needed.

Module 2b: Capillary blood sample collection

Note: quantities are given for 1 patient. The number of patients will be determined by the individual test modules (including a 20% safety margin). Multiply the quantities by the total number of patients.

[I]	Description/instructions	1 patient	Once only
	Companion module to Module 2c: Venepuncture blood sample collection		
[!]	**Cautions**		
	Some modules will be able to be performed on the same blood sample. This will need to be adjusted. However collection items are low cost and when in doubt consider individual test modules to be performed independently. This will result at times in an over-supply; however this is preferred to a stock shortage		
[A]	**Equipment and low-use consumables**		
	Waste bin		1
	Sharps container, small	1 per 50 collections	
[A]	**Consumables**		
	Swab, alcohol, (wipes), disposable[1]	1	
	Cotton-wool balls[2]	2	
	Lancet, disposable, sterile, standard type	1	

[1] Can substitute alcoholic disinfectant, ethanol and isopropanol at 70%–80% v/v
[2] Can substitute cotton wool, hydrophilic, roll or 2 in × 2 in cotton pads

Module 2c: Venepuncture blood sample collection

Note: quantities are given for one patient. The number of patients will be determined by the individual test modules (including a 20% safety margin). Multiply the quantities by the total number of patients

[I]	Description/instructions	1 patient	Once only
	Companion module to Module 2b: Capillary blood sample collection Determine the ratio of adult and paediatric patients and select needle gauges and butterfly sets accordingly		
[A]	**Equipment and low-use consumables**		
	First aid kit: add as a one-off if venous blood collection to be performed separately from the core laboratory or without immediate access to clinical staff		1
	Tourniquet		10
[A]	**Consumables**		
	Swab, alcohol, (wipes), disposable[1]	1	
	Cotton-wool balls[2]	1	
	Bandage, plastic, small	1	
	Vacuum system holder and 21G/23G/butterfly needles supplied by the same manufacturer	1[3]	
	Tube, vacuum, EDTA, 3–5 mL	1	
	Sharps container, large	1 per 50 collections	

[1] Can substitute alcoholic disinfectant, ethanol and isopropanol at 70%–80% v/v
[2] Can substitute cotton wool, hydrophilic, roll or 2 in × 2 in cotton pads
[3] If paediatric samples will be collected

Group 3: transport of specimens (sample referral)

Module 3a: Transport of whole blood, serum, plasma and CSF specimens

[I]	Description/instructions	10 patients
	Must comply with international and national regulations. Refer to Chapter 10	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen or do not refrigerate.	
	Collection	
	Add number of patients to Module 2c: Venepuncture blood sample collection for blood samples For CSF collection: no action	12
[A]	**Consumables**	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Tube, tight-fitting screw-cap, sterile, 10–12 mL	24
	Transfer pipettes, 3 mL, sterile	12

Module 3b: Transport of stool samples – parasitic testing

[I]	Description/instructions	10 patients
	Must comply with international and national regulations. Refer to Chapter 10	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen or do not refrigerate Collect fresh stool samples unmixed with urine–minimum volume 10 mL. Immediately refrigerate prior to transport	
[A]	**Consumables**	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Containers (for stool), polypropylene, 60–120 mL capacity, wide-neck, tight-fitting, leak-proof screw-cap (without disinfectant or detergent residue)	12

Module 3c: Transport of stool samples – enteric pathogens

[I]	Description/instructions	10 patients
	Must comply with international and national regulations. Refer to Chapter 10	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen or do not refrigerate. Collect fresh rectal swabs (moisten swabs in an appropriate transport medium) or prepare swabs of fresh stool. Immediately transfer to Cary-Blair solution vials with indicators for preservation and transport Refrigerate swabs in transport media at 4 °C prior to transport	
[A]	**Consumables**	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Rectal swabs, sterile	12
	Cary-Blair solution vials, with indicators for preservation and transport of specimens; (can be procured as a combined system of swab and Cary-Blair)	12

Module 3d: Transport of stool samples – viral testing

[I]	Description/instructions	10 patients
	Must comply with international and national regulations. Refer to Chapter 10	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen or do not refrigerate Collect fresh stool samples unmixed with urine; minimum volume 10 mL. Immediately refrigerate prior to transport If possible store portion of each stool specimen frozen at less than –15 °C for antigen or PCR testing. Transport sealed specimens on ice or with frozen refrigerant packs in an insulated box.	
[A]	**Consumables**	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Containers (for stool), polypropylene, 60–120 mL capacity, wide-neck, tight-fitting, leak-proof screw-cap (without disinfectant or detergent residue)	24

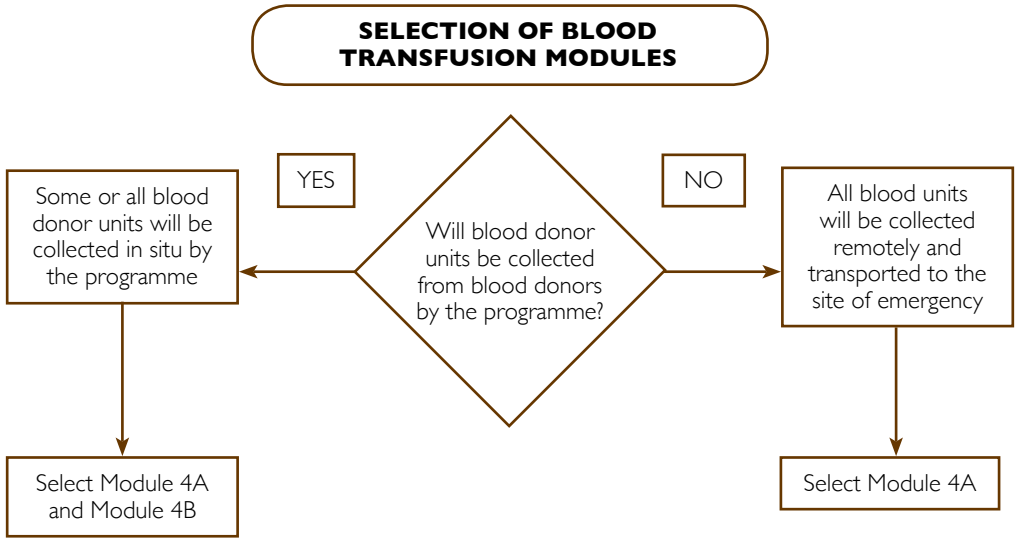
Module 3e: Transport of nasopharyngeal samples – upper respiratory infections

[I]	Description/instructions	10 patients
	Must comply with international and national regulations. Refer to Chapter 10	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen, or do not refrigerate.	
[A]	**Consumables**	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Swabs, sterile	24
	Universal transport medium (Copan)	12

Module 3f: Tissue and biopsy specimens – histopathology

[I]	Description/instructions	10 patients
	Must comply with international and national regulations. Refer to Chapter 10	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen or do not refrigerate	
[A]	**Consumables**	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Containers, polypropylene, 60–120 mL capacity, wide-neck, tight-fitting, leak-proof screw-cap (without disinfectant or detergent residue)	24
	Formalin	1 L

Group 4: blood transfusion



Module 4a: All donor blood collected externally and transported to the programme

To accommodate a range of commonly used alternative testing procedures this module is designed as a series of submodules:

4a – 1: Core items
4a – 2: ABO and Rh grouping–tile
4a – 3: ABO and Rh grouping–tube
4a – 4: Crossmatching–antihuman globulin (Coombs)
4a – 5: Haemoglobin–portable meter
4a – 6: Haemoglobin–spectrophotometer/colorimeter
4a – 7: Bedside grouping cards
4a – 8: Fresh frozen plasma

Select only the submodules applicable to the programme
The total supplies required is the sum of the submodules selected

Selection of submodules

Programme activity		Include	Exclude
1. All programmes performing blood transfusion		Select 4a-1	
2. Will ABO and Rh grouping be performed by tile or tube?	Tile only	Select 4a-2	Do not include 4a-3
	Tube only	Select 4a-3	Do not include 4a-2
	Both tile and tube	Select both Modules 4a-2 and 4a-3 and adjust test numbers[1]	
3. Will crossmatching be performed using antihuman globulin (Coombs)?	Yes	Select 4a-4	
	No	No action	Do not include 4a-4
4. Will haemoglobin testing be performed by a hand-held meter or a laboratory spectrophotometer/colorimeter	Hand-held meter	Select 4a-5	Do not include 4a-6
	spectrophotometer/ colorimeter	Select 4a-6	Do not include 4a-5
5. Will the programme use bedside blood grouping cards?	Yes	Select 4a-7	
	No	No action	Do not include 4a-7
6. Will the programme store fresh frozen plasma?	Yes	Select 4a-8	
	No	No action	Do not include 4a-8

[1] For example, if the programme will check the blood group of the blood bags using a tile but perform blood grouping on recipients by tube.

4a-1: Core items

[I]	Description/instructions	50 donors	Once only
	Required		
[R]	**Recommendations**		
	The refrigerator *must not* have a freezer located within the refrigeration cabinet Highly recommended that the donor storage refrigerator be supplied with a built-in temperature monitor, a temperature alarm system and transparent display doors		
	Equipment and low-use consumables		
	Registration books; suggest separate registers for donor selection, laboratory pre-transfusion testing, donor collection and patient transfusion		3
	Rack, for tubes 100–125 × 15–20 mm diameter		2
	Scissors, domestic, blunt end		2
[A]	Refrigerator, blood bank – able to provide an internal air temperature of 2 °C to 8 °C[1] *Minimum specifications:* • First preference: Electric (compression type) (standard electric) 110/230 V AC blood bank refrigerator *or* Electric (compression type) 110/230 V AC, photovoltaic *or* • Second preference: Gas-powered *or* • Third preference: Kerosene powered		1
	Thermometer, alcohol stem, minimum recommended temperature interval –10 °C to 50 °C		1
	Maximum–minimum thermometer, minimum recommended temperature range –10 °C to 50 °C[2]		1
	Glass bottle approximately 500 mL[3]		1
	Glycerol, ≥ 100 mL[3]		1

[O] **[A]**	Refrigerator, standard (reagent and supply storage) *Minimum specifications:* • Size: 140 L (size may vary based on the needs at the site) • Internal air temperature: 2 °C to 8 °C • One-year manufacturer's guarantee/warranty • Important: should have a separate freezer compartment, non-automatic defrost (not a freezer located inside the refrigerator cabinet) • Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered	
	Protective clothing, laboratory coats or gowns	2 per staff member
	Bottle, swan-neck jet, plastic 250 mL	2
	Bowl, plastic	2
	Broom	1
	Brush, scrubbing brush	2
	Clock, wall-mounted	1
	Gloves, rubber, heavy duty (for cleaning)	2
	Mop	1
	Receptacle, waste, with attached lid, stainless steel, 12 L foot operated	2
	Ruler, 30 cm	2
	Test tube brush, small 12 mm diameter	2
	Timer, mechanical, 1–60 minutes, with ringer	2
	Water purification, brush, stiff bristles (to clean filters)	1
	Water purification, gravity water filter, 10 L, fountain, four self-sterilizing ceramic elements (candle filter)	1
	Water purification, spare candle filter, 18 cm	2
	Water storage container, polyethylene, 20 L, with handle and removable tap	1
	Pen, ball-point, black	12
	Pen, ball-point, red	12
	Pen, permanent marker, black	6
	Pen, permanent marker, red	6

Protection paper for bench, absorbent, 50 cm × 50 m		2
Stapler, paper, hand-held		2
Staples, size compatible with stapler		1000
Cold box, vaccine carrier, overall dimensions: 24 × 24 × 33 cm, internal dimensions: 15 × 15 × 19 cm, storage capacity 1.7 L, ice packs (two sets of ice packs per cold box; one set to be frozen while the other set is being used)		2
Consumables		
Blood administration set with 180 micron filter infusion device	60	
Gloves, examination, latex, disposable, large/medium/small *size requirements vary from country – select distribution of large, medium and small as appropriate*	400	
Bleach (household 5%) or commercial; refer to Chapter 5 and Annex 16[d]	1 L	
Chlorine test strips, high-level	600 pce	
Titrator, digital (Hach Company). Detection range for chlorine: 20–70 000 mg/L		1 titrator
• WataTest reagent kit (Fondation Antenna Technologies). Detection range for chlorine: 1000–7000 mg/L		1 WataTest
• Serim Monitor for Chlorine test strip (Serim Research Group) Detection range: 100–750 mg/L[4]		2 Serim
Disinfectant solution, hand-washing, waterless cleaner	500 mL	
Request forms	60	
Bag, biohazard	2	

[d] For disinfection

[1] The volume of the refrigerator should be adjusted according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable for around 30 450 mL blood packs.

[2] This is an additional maximum–minimum thermometer to the one included in the general Module 2a.

[3] It is recommended that the alcohol-stem thermometer be placed in a glycerol solution, rather than placed on a wall or a shelf. This better reflects the core temperature of the blood donor units rather than the air temperature of the refrigerator.

[4] Because of the importance of chlorine testing items, and in order to ensure that at least half of the items arrive at their destination, these items have been divided into two equal shipment batches – one half in Module 2A and the other half in module 4a-1.

4a-2: ABO and Rh grouping – tile

Note: when determining the number of tests, the additional reagents required for controls and other quality control procedures should be taken into account.

[I]	Description/instructions	50 donors	Once only
	Alternative to submodule 4a-3: ABO and Rh grouping – tube The quantities in this module assume blood grouping is performed twice for patients and once for donor bags, and a transfusion rate of one donor unit for one patient		
[!]	**Cautions**		
	If you will perform both tile and tube ABO and Rh grouping then adjust quantities The quantities of blood grouping reagents are based on using two drops per test; reduce quantities by 50% if the programme will use only one drop of blood grouping reagent		
[R]	**Recommendations**		
	Tube blood grouping is recommended		
	Collection		
	Add number of patients to Module 2c: Venepuncture blood sample collection for blood samples[1]	60	
	Equipment and low-use consumables		
	Lunchbox, small, local purchase (moist box)		1
	Blood grouping tile, with wells, minimum 5 wells		4
	Consumables		
	Test, blood grouping, monoclonal anti-A, dropper bottle	18 mL[2]	
	Test, blood grouping, monoclonal anti-B, dropper bottle.	18 mL[2]	
	Test, blood grouping, monoclonal/polyclonal blend anti-D, dropper bottle	18 mL[2]	
	Rh negative control, dropper bottle	18 mL[2]	
[O]	Test, blood grouping reverse, A1 and B cells (20%), set	6 mL[3]	
	Transfer, pipette, graduated, plastic, non-sterile	360	
	Applicator stick, wooden	360	
	Plastic bulb pipettes, 3 mL	100	
	White tile	2	

[1] Capillary blood collection not included as a venous blood sample will be required from the recipient for crossmatching.
[2] Based on volume of 1 drop = 50 µL, and blood grouping performed twice for recipients and once for donor bags (total 6 drops)
[3] Optional; include only if programme performs reverse grouping. Based on 1 drop and only performing reverse grouping (twice) on recipients.

4a-3: ABO and Rh grouping – tube

Note: when determining the number of tests, the additional reagents required for controls and other quality control procedures should be taken into account

[I]	Description/instructions	50 donors	Once only
	Alternative to submodule 4a-2: ABO and Rh grouping – tile The quantities in this module assume blood grouping is performed twice for patients and once for donor bags, and a transfusion rate of one donor unit for one patient		
[!]	**Cautions**		
	If you will perform both tile and tube ABO and Rh grouping then adjust quantities The quantities of blood grouping reagents are based on using two drops per test; reduce quantities by 50% if the programme will use only one drop of blood grouping reagent Reverse grouping is included (optional)		
[R]	**Recommendations**		
	Tube blood grouping is recommended		
	Collection		
	Add number of patients to Module 2c: Venepuncture blood sample collection for blood sample	60	
	Equipment and low-use consumables		
	Bottle, swan-neck jet, plastic, 250 mL		2
	Centrifuge, blood bank serology, specialized low g-force centrifuge		1
	Rack, tubes, size 13/14 mm, 10 × 4 tubes		2
	Consumables[1]		
	Test, blood grouping, monoclonal anti-A, dropper bottle.	18 mL[2]	
	Test, blood grouping, monoclonal anti-B, dropper bottle.	18 mL[2]	
	Test, blood grouping, monoclonal/polyclonal blend anti-D, dropper bottle	18 mL[2]	
	Rh negative control, dropper bottle	18 mL[2]	
[O]	Test, blood grouping reverse, A1 and B cells (3%–5%), set	6 mL[3]	
	Transfer, pipette, graduated, plastic, non-sterile	360	
	Plastic bulb pipettes, 3 mL	100	
	White tile	2	
	Physiological saline solution, sodium chloride, 0.9% Alternatively clinical infusion physiological saline packs[5]	1 L[4]	
	Tube, standard, 10 × 75mm or 12 × 75mm, glass	1 200[4,6]	

[1] Anti A, B reagents are not included in the module because, according to the AABB technical manual (16th edition), "Commercially available anti-A, and anti-B for red cell typing are extremely potent and will agglutinate most antigen positive red cells directly, even without centrifugation. Most monoclonal typing reagents have been formulated to detect many weak ABO subgroups (see manufactures' inserts for specific reagent characteristic). Additional reagents (anti-A1 and anti-A,B) and special techniques to detect weak ABO subgroups are not necessary for routine testing but are helpful in resolving ABO typing discrepancies".
[2] Based on volume of 1 drop = 50 µL, and blood grouping performed twice for recipients and once for donor bags (total 6 drops)
[3] Optional; include only if programme performs reverse grouping. Based on 1 drop and only performing reverse grouping (twice) on recipients
[4] Based on two groupings forward and reverse for recipients and one forward grouping on the donor bag
[5] Provision for washing donor/recipient red cells
[6] Assumes tubes are not rewashed. Based on tubes required for anti-A, anti-B, anti-RhD, Rh-control, A1 cells, B cells, and preparation of a 3%–5% red cell suspension

4a-4: Crossmatching – antihuman globulin (Coombs)

Note: when determining the number of tests the additional reagents required for controls and other quality control procedures should be taken into account.

[I]	Description/instructions	50 donors	Once only
	Only include if antihuman globulin (AHG, Coombs) testing is performed The same materials included in 4a-2: Blood grouping – tile can be used if only a direct tile compatibility test is performed		
[!]	**Cautions**		
	Antibody screening cells not included; if added would require additional tubes, AHG reagent, Coombs control cells and saline		
[R]	**Recommendations**		
	AHG (Coombs) testing is recommended for crossmatching		
	Collection		
	None (included in blood grouping)		
	Equipment and low-use consumables		
	Water bath, 2 L, microprocessor controlled, visual temperature minimum interval of 30 °C to 40 °C		1
[O]	Automated blood bank cell washer		1
	Thermometer, –10 °C to 110 °C, red spirit		2
	Consumables		
	Coombs control cells (for antihuman globulin test)	6 mL	
	Coombs reagent (antihuman globulin) polyclonal	12 mL[1]	
	Transfer, pipette, graduated, plastic, non-sterile	100	

	Physiological saline solution, sodium chloride, 0.9%. Alternatively, clinical infusion physiological saline packs *Minimum specifications:* • Clear, no particulate matter • pH 7.0 • Minimal cation content (to prevent precipitation of phosphate buffers as calcium/magnesium phosphates) • Free of heavy metals	1.25 L
	Tube, standard, 10 × 75 mm or 12 × 75 mm, glass	120[2]

[1] Based on volume of 1 drop = 50 µL, and a crossmatch includes one donor sample and one auto-control (total 4 drops)
[2] Assumes tubes are not rewashed. Based on tubes required for preparation of 3%–5% cell suspensions and testing of a donor sample and auto-control (with a 20% safety margin)

4a-5: Haemoglobin – portable meter

[I]	Description/instructions	50 donors	Once only
	Alternative to submodule 4a-6: Haemoglobin – spectrophotometer/colorimeter		
	Collection		
	None (included in blood grouping)		
	Equipment and low-use consumables		
	Haemoglobinometer *Minimum specifications:* • Self-calibrating • Able to auto-check for lipaemia • Able to be operated at > 30 °C (if applicable) • Tropicalized,[1] non-condensing (if applicable)		2
	Haemoglobinometer, battery set/pack, spare suitable for purchased meter		2
	Consumables		
	Test cuvettes compatible with the haemoglobin meter[2]	60	
	Quality/safety		
	Quality control to be used in accordance with manufacturer's instructions[3]	As applicable	

[1] In regions where high relative humidity is likely to occur, equipment manufacturers should apply conformal coating material (protection against high humidity) to equipment such as: haemoglobinmeters, spectrophotometers, colorimeters (see page 109) and also balances, pH meters, haematology analysers, blood gas analysers, serofugers, and cell washers.
[2] When applicable, more consumables may be needed for daily/weekly maintenance of the portable meter. For example, HemoCue sells single-use cleaners to remove blood and dust from the reading chamber.
[3] Including standard Hb controls

4a-6: Haemoglobin – spectrophotometer/colorimeter

[I]	Description/instructions	50 donors	Once only
	Alternative to submodule 4a-5: Haemoglobin – portable meter		
[R]	**Recommendations**		
	Testing must be supported with a quality control system		
	Collection		
	None (included in blood grouping)		
	Equipment and low-use consumables		
	Spectrophotometer, colorimeter, haemoglobinometer		1
	Ammonia solution, concentrated		1 L[1]
	Cylinder, 1 L[2]		1
	Glass bottle, amber[2]		1
	Graph paper		1 pad
	Flexible ruler		1
	Pipette, automatic, adjustable volume, 20–200 µL		1
	Test tubes, 7–10 mL, glass		20
	Parafilm, 4–6 cm wide		1
	Tube rack, suitable for 7–10 mL tubes		2
	Dispenser, 1 L with plunger calibrated 1–10 mL delivery		1
	Consumables		
	Test cuvettes compatible with the haemoglobinometer[3]	60	
	Water, bottled	600 mL	
	Pipette, automatic, 10–200 µL tip	120	
	Quality/safety		
	Testing must be supported by a quality control system	As applicable	

[1] 1 L of ammonia solution is sufficient for >20 000 tests
[2] To prepare and store stock solution of ammonia. Diluted ammonia is stable 6 months
[3] Assumes disposable cuvettes

4a-7: Bedside grouping cards

[I]	Description/instructions	50 donors	Once only
	Select only if used by the programme		
	Collection		
	Add number of patients to Module 2c: Venepuncture blood sample collection for blood samples	60	
	Consumables		
	Bedside blood grouping cards[1] (intended for use to reconfirm ABO compatibility at time of transfusion between patient and selected unit[2])	60	

[1] Depending of source of procurement, saline might be needed to solubilise the dry reagents.
[2] Avoid misusing bedside blood grouping cards for initial grouping; for reconfirming ABO compatibility, a system without Rh is recommended due to reports of difficult interpretation.

4a-8: Fresh frozen plasma

[I]	Description/instructions	50 units	Once only
	Select only if used by the programme		
	Equipment and low-use consumables		
	Freezer, stand-alone, chest type. Capacity: small but generally > 50 L Capable of reaching < –20 °C May use any available freezer if temperature requirement met		1
	Water-bath 20 L, microprocessor controlled (temperature adjustable), either steel with integrated heating or Perspex with separate heater able to be clamped to the wall of the water-bath, able to be heated to a maximum of 42 °C		1
	Thermometer, –30 °C to 0 °C or similar, red spirit thermometer recommended		1
	Consumables		
	Sealable plastic bags, 1 L	60	

Module 4b: Collection of donor blood from local donors by the programme

IMPORTANT

Module 4b is *additional* to Module 4a.

Instructions:

Select Module 4b

Add items in Module 4b to those selected in Module 4a

To accommodate a range of commonly used alternative testing procedures this module is designed as a series of submodules:

4b-1: ABO and Rh grouping–tile donor blood group screening
4b-2: ABO and Rh grouping–tube donor blood group screening
4b-3: ABO and Rh grouping–tile donor blood group confirmation
4b-4: ABO and Rh grouping–tube donor blood group confirmation
4b-5: Infectious diseases screening–enzyme immunoassays for hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2
4b-6: Infectious diseases screening–RDT testing hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2
4b-7: Infectious diseases screening–rapid diagnostic testing (syphilis)
4b-8: Donor blood collection

Select only the sub-modules applicable to the programme

The total supplies required = Module 4a + sum of Module 4b submodules selected

Selection of sub-modules

Programme activity		Include	Exclude
1. All programmes performing blood transfusion		Select Module 4A	
2. Will potential donors be screened for ABO and Rh grouping by tile or tube?	Tile	Select 4b-1	Do not include 4b-2
	Tube	Select 4b-2	Do not include 4b-1
3. Will the confirmation ABO and Rh grouping of reaccepted donors be performed by tile or tube?	Tile	Select 4b-3	Do not include 4b-4
	Tube	Select 4b-4	Do not include 4b-3
4. How will the programme screen donors for hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2?	By enzyme immunoassays; strongly recommended	Select 4b-5	Do not include 4b-6
	By RDT testing; strongly not recommended (except when there is no choice)	Select 4b-6	Do not include 4b-5
5. Select screening for syphilis		Select 4b-7	
6. Select donor blood collection		Select 4b-8	

4b-1: ABO and Rh grouping – tile donor blood group screening

[I]	Description/instructions	50 donors	Once only
	Alternative to submodule 4b-2: ABO and Rh grouping – tube blood group screening Because Module 4b is an addition to Module 4a, this submodule adds only the blood grouping reagents required for a forward grouping (cell grouping) on the 20% (assumed rejection rate) of donors[1]		
[!]	**Cautions**		
	The module assumes a 20% donor rejection rate; adjust as applicable The quantities of blood grouping reagents are based on using two drops per test; reduce quantities by 50% if the programme will use only one drop of blood grouping reagent		
[R]	**Recommendations**		
	Tube blood grouping is recommended		
	Collection		
[A]	Add number of donors to Module 2b: Capillary blood sample collection[2] *or* Add number of donors to Module 2c: Venepuncture blood sample collection[2]	72	
	Consumables		
	Test, blood grouping, monoclonal anti-A, dropper bottle	1.5 mL[3]	
	Test, blood grouping, monoclonal anti-B, dropper bottle.	1.5 mL[3]	
	Test, blood grouping, monoclonal/polyclonal blend anti-D, dropper bottle	1.5 mL[3,4]	
	Rh negative control, dropper bottle	1.5 mL[3,4]	
	Transfer, pipette, graduated, plastic, non-sterile	30	
	Applicator stick, wooden	30	

[1] Forward grouping for the determination of ABO antigens found on a patient's red blood cells using reagent antisera. It can determine missing or weak antigens: subgroups of A (or B) cells affected by disease.
[2] If 50 donors will be collected and the rejection rate is 20%, 60 potential donors will need to be screened: an additional 10 tests = 12 tests with a 20% safety margin.
[3] Based on volume of 1 drop = 50µL
[4] One drop of antiserum needs to be used. Some use two drops (which we think is a waste of reagents); if the latter is practised, the quantity needs to be calculated accordingly.

4b-2: ABO and Rh grouping – tube donor blood group screening

[I]	Description/instructions	50 donors	Once only
	Alternative to submodule 4b-1: ABO and Rh grouping – tile donor blood group screening Because Module 4b is an addition to Module 4a, this submodule adds only the blood grouping reagents required for a forward grouping (cell grouping)[1]		
[!]	**Cautions**		
	The module assumes a 20% donor rejection rate; adjust as applicable The quantities of blood grouping reagents are based on using two drops per test; reduce quantities by 50% if the programme will use only one drop of blood grouping reagent		
[R]	**Recommendations**		
	Tube blood grouping is recommended		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of donors (if not supplied in the testing kit) and additionally include a 20% safety margin[2] *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of donors (if not supplied in the testing kit) and additionally include a 20% safety margin[2]	72	
	Consumables		
	Test, blood grouping, monoclonal anti-A, dropper bottle	1.5 mL[3]	
	Test, blood grouping, monoclonal anti-B, dropper bottle	1.5 mL[3]	
	Test, blood grouping, monoclonal/polyclonal blend anti-D, dropper bottle	1.5 mL[3]	
	Rh negative control, dropper bottle	1.5 mL[3]	
[O]	Test, blood grouping reverse, A1 and B cells (3%–5%), set	0.75 mL[3]	

	Transfer, pipette, graduated, plastic, non-sterile	30
	Physiological saline solution, sodium chloride, 0.9%	250 mL
	Alternatively clinical infusion physiological saline packs	
	Tube, standard, 10 × 75 mm or 12 × 75 mm, glass	100[4]

[1] Forward grouping is performed to determine ABO antigens found on a patient's red blood cells using reagent antisera. It can determine missing or weak antigens: subgroups of A (or B) cells affected by disease. In forward grouping, a person's RBCs are mixed with reagent Anti-A and Anti-B; in reverse grouping, a person's serum is mixed with reagent A 1 and B RBCs. ABO discrepancies occur when the forward and reverse groupings do not agree. Problems with forward grouping (extra antigen present, weak antigens) could be caused by acquired B phenotype, polyagglutination, rouleaux, ABO subgroups, transfusion of non-type specific blood, and bone marrow or stem-cell transplants.
[2] If blood donations will be collected from 50 donors and the rejection rate is 20%, 60 potential donors will need to be screened: an additional 10 tests = 12 tests with a 20% safety margin.
[3] Based on volume of 1 drop = 50 µL
[4] Optional – include only if programme performs reverse grouping. Based on one drop and only performing reverse grouping (twice) on recipients

4b-3: ABO and Rh grouping – tile donor blood group confirmation

[I]	**Description/instructions**	**50 donors**	**Once only**
	Alternative to sub-module 4b-4 ABO and Rh tube donor blood group confirmation		
[!]	**Cautions**		
	The quantities of blood grouping reagents are based on using two drops per test; reduce quantities by 50% if the programme will use only one drop of blood grouping reagent		
[R]	**Recommendations**		
	Tube blood grouping is recommended.		
	Collection		
	None (included in Module 4A)		
	Consumables		
	Test, blood grouping, monoclonal anti-A, dropper bottle.	6 mL[2]	
	Test, blood grouping, monoclonal anti-B, dropper bottle.	6 mL[2]	
	Test, blood grouping, monoclonal/polyclonal blend anti-D, dropper bottle	6 mL[2]	
	Rh negative control, dropper bottle	6 mL[1]	
[O]	Test, blood grouping reverse, A1 and B Cells (20%), set	3 mL[2]	
	Transfer, pipette, graduated, plastic, non-sterile	120	
	Applicator stick, wooden	120	

[1] Based on volume of 1 drop = 50 µL
[2] Optional – include only if programme performs reverse grouping. Based on 1 drop and only performing reverse grouping (twice) on recipients

4b-4: ABO and Rh grouping – tube donor blood group confirmation

[I]	Description/instructions	50 donors	Once only
	Alternative to Sub-module 4b-3 ABO and Rh tile blood donor confirmation		
[!]	**Cautions**		
	The quantities of blood grouping reagents are based on using two drops per test; reduce quantities by 50% if the programme will use only one drop of blood grouping reagent Reverse grouping is included (optional)		
[R]	**Recommendations**		
	Tube blood grouping is recommended		
	Collection		
	None (included in Module 4a)		
	Consumables		
	Test, blood grouping, monoclonal anti-A, dropper bottle	6 mL[1]	
	Test, blood grouping, monoclonal anti-B, dropper bottle	6 mL[1]	
	Test, blood grouping, monoclonal/polyclonal blend anti-D, dropper bottle	6 mL[1]	
	Rh negative control, dropper bottle	6 mL[1]	
[O]	Test, blood grouping reverse, A1 and B cells (3%–5%), set	3 mL[2]	
	Transfer, pipette, graduated, plastic, non-sterile	120	
	Physiological saline solution, sodium chloride, 0.9% Alternatively clinical infusion physiological saline packs	1 L[3]	
	Tube, standard, 10 × 75 mm or 12 × 75 mm, glass	420[4]	

[1] Based on volume of 1 drop = 50 µL
[2] Optional – include only if programme performs reverse grouping. Based on one drop and only performing reverse grouping (twice) on recipients
[3] Provision for washing donor/recipient red cells
[4] Assumes tubes are not rewashed. Based on tubes required for anti-A, anti-B, anti-RhD, Rh-control, A1-cells, B-cells, and preparation of a 3%–5% red cell suspension

4b-5: Infectious diseases screening – enzyme immunoassays for hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2

Note: when determining the number of tests the additional reagents required for controls and other quality control procedures should be taken into account.

[I]	Description/instructions	50 donors	Once only
	EIA testing for HIV, HBV, HCV		
[R]	**Recommendations**		
	It is strongly recommended that only enzyme immunoassays (EIA) or combination antigen–antibody immunoassay should be used for screening blood donors for transfusion[1]		
	Collection		
	None (included in Module 4a)		
	Equipment and low-use consumables		
	EIA analyser, washer, incubator (complete system), to include printer		1
	Pipettes, multi-channel (depends on system purchased) 50–200 µL		2
	Pipette, single channel, adjustable, 50–200 µL		3
	Waste, bin		1
	Rack, tube for 13 × 80 mm tubes		2
	Consumables		
	Commercial HBsAg EIA kits compatible with EIA analyser	60 tests	
	Commercial anti-HCV kits compatible with EIA analyser	60 tests	
	Highest-possible sensitive and specific HIV-1 and HIV-2 immunoassay or HIV combination antigen–antibody immunoassay[2] kits compatible with EIA analyser	60 tests	
	Consumables associated with kits (consult manufacturer)		

[1] "The use of rapid/simple assays is generally not recommended for blood screening as they are designed for the immediate and rapid testing of small numbers of samples, mainly for diagnostic purposes" *(29)*.

[2] "For the screening of blood donations, both sensitivity and specificity should be the highest possible or available" *(29)*; WHO recommends that the "minimum evaluated sensitivity and specificity levels of all assays used for blood screening should be as high as possible and preferably not less than 99.5%" *(27)*.

4b-6: Infectious diseases screening–RDT testing hepatitis B surface antigen (HBsAg), hepatitis C antibody, HIV-1, HIV-2[1]

Note: when determining the number of tests the additional reagents required for controls and other quality control procedures should be taken into account

[I]	Description/instructions	50 donors	Once only
	RDT testing for HIV, HBV, HCV		
[!]	**Cautions**		
	RDT tests for HBV and HCV may have unacceptable sensitivity and specificity; always confirm the sensitivity of any test selected		
[R]	**Recommendations**		
	It is strongly recommended that only enzyme immunoassays (EIA) should be used for screening blood donors for transfusion Timers are of great use when using RDTs (already included in the module 2a: Basic equipment and consumables)		
	Collection		
	None (included in Module 4a).		
	Consumables		
	Commercial rapid HIV 1, 2 kit test 1[2, 3]	60 tests	
	Commercial rapid HIV 1, 2 kit test 1[2, 3]	60 tests	
	Commercial rapid HBsAg test[2]	60 tests	
	Commercial rapid anti-HCV kit[2]	60 tests	

[1] In situations where the use of rapid tests is dictated by necessity and not by choice, such as in situations where equipment and other facilities required for EIA are lacking, rapid tests with highest possible sensitivity and specificity may be used.

[2] A minimum of two tests should be used; any serum found reactive on the first assay should be retested with a second ELISA or simple/rapid assay based on a different antigen preparation and/or different test principle.

[3] Important: some tests may require additional MES buffer (2-(N-morpholino)ethanesulfonic acid) for finger-stick testing. Check the full requirements of any test selected with the manufacturer or supplier. Some tests require that the user supply the required pipette. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test.

4b-7: Infectious diseases screening – rapid diagnostic testing (syphilis)[1]

Note: when determining the number of tests the additional reagents required for controls and other quality control procedures should be taken into account

[I]	Description/instructions	50 donors	Once only
	Rapid diagnostic testing (RDT) for syphilis		
[!]	**Cautions**		
	Select other test methods if required by the national protocol		
[R]	**Recommendations**		
	For a full discussion of the characteristics of syphilis RDT tests refer to the WHO–TDR evaluation. For additional assistance contact a regional WHO office[2]		
	Collection		
	None (included in Module 4a)		
	Consumables		
	Commercial syphilis TP rapid kit	60 tests	

[1] Important: some tests may require the additional buffer for finger-stick testing. Check the full requirements of any test selected with the manufacturer or supplier.

[2] Evaluation of rapid diagnostic tests: syphilis available at: https://globalhealthdiagnostics.tghn.org/site_media/media/articles/Evaluation_of_rapid_diagnostic_tests._syphilis.pdf

Important: some tests require that the manufacturer/supplier supply the required pipette. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test.

4b-8: Donor blood collection

[I]	Description/instructions	50 donors	Once only
	Collection of donor blood		
	Collection		
	N/A		
	Equipment and low-use consumables		
	Registration book; separate register for blood donors		1
	Scale (bathroom scale)		1
	Scale, spring balance for weighing blood		2
	Scissors		2
	Stethoscope		2
	Blood pressure cuff		4
	Thermometer, clinical		2
	Forceps		2
	Tourniquet, rubber band, 100 × 1.8 cm		2
	Tube stripper: device for stripping blood from tubing (used to strip blood from donor tubing into the blood collection container)		2

[A]	Metal clips and hand sealer *or* Dielectric sealer		1
	Plasma extractor		1
[A]	Blood trip scale with 585 ± 2 g trip counterweight or HemoFlow *or* Blood bag mixer, electric with auto shut off, (alternative to trip scale)		1
	Consumables		
	Donor health screening questionnaire; for example, AABB Full-Length Donor History Questionnaire v1.1 (Annex 13)	60	
	Adhesive tape, zinc oxide, 75 mm × 5 m	6	
	Arm scrub solution: Disposable povidone–iodine scrub, 0.75% *or* Disposable povidone–iodine swab-stick/packs, 10%	60	
	Arm preparation solution: Povidone–iodine, 10% *or* Povidone–iodine scrub, 0.75% *or* Disposable povidone–iodine swab-stick/packs, 10% *or* 2% chlorohexidine with 70% isopropanol swab-stick/packs		
	Cotton wool, roll	1	
	Label to write patient's name and identification on blood bags to be issued to patients	60	
	Labels (assigned blood unit number in a systematic manner), donors' blood group (A, B, AB or O) and RhD type (positive/negative) and labels indicating tested non-reactive to HIV1/2. HBV, HCV and syphilis serology markers	60	
	Blood bags with anticoagulant and attached needle 450 mL with integrated second pack for plasma collection Blood bags with anticoagulant and attached needle 350 mL with integrated second pack for plasma collection Blood bags with anticoagulant and attached needle 250 mL with integrated second pack for plasma collection[1]	Total of 60 need for a combination large and smaller volume donor bags	

Aprons/laboratory coat, disposable plastic	60
Sterile gauze for arm prep[2]	60
4 in x 4 in gauze pads or equivalent[2]	60
4 in x 4 in gauze pads or equivalent[2]	120
Hand-sanitizer, waterless or equivalent	1 L
First aid kit	1
Gloves, examination, non-latex, disposable, large/ medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate*	300 pairs

[1] Penta bags are also of great use, especially for paediatric transfusion. A penta bag is 1 × 450 mL collection bag attached to 4 × 100 mL bags in which blood is redistributed.

[2] These items may be able to be replaced by a commercial collection set including donor bags packaged together with sterile 4 in × 4 in gauze (in most developing countries, sterile gauzes are frequently unavailable due to lack of autoclave or heat disinfection equipment). Commercial packages may also contain collection tubes for laboratory testing.

Group 5: specific test modules

Module 5a: Cholera (vibrio) screening

IMPORTANT

The number of tests needed to confirm a cholera outbreak will depend on the national protocol; this number is usually between 5 and 20 test-confirmed cases. Therefore, when calculating the quantities for this module, it is important to include the number of tests that will be performed and not the anticipated number of cholera cases. After confirmation, cholera cases can be diagnosed clinically.

IMPORTANT

No specific test is recommended. Test selection should include at least the following criteria.

- The test should be able to be used directly with stool samples, and preferably validated for direct testing of stool samples.
- The test should be able to detect the serogroups of Vibrio cholerae likely to be encountered in the region.
- The test should have a high as sensitivity as possible to enable the detection of low concentrations of pathogenic vibrio species.
- The test should be simple to use.

Some tests require that the user supply additional items. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test.

Test volume: 20 tests

Assumed access to incinerator

[I]	Description/instructions	20 tests	Once only
	In situ screening for cholera plus referral of samples for reference laboratory confirmation testing. If the programme will *only* collect and refer samples to a reference laboratory for testing then do not include the *Vibrio cholerae* testing kit Alternative to Module 5a-SA: Cholera screening – stand-alone		
[!]	**Cautions**		
	This module can only be used in conjunction with a core laboratory		
	Collection		
	Containers (for stool), polypropylene, 60–120 mL capacity, wide-neck, tight-fitting, leak-proof screw-cap (without disinfectant or detergent residue)	50	

	Equipment and low-use consumables		
	Cold box, vaccine carrier, overall dimensions: 24 × 24 × 33 cm, internal dimensions: 15 × 15 × 19 cm, storage capacity 1.7 L, ice packs. For example, the cold box/vaccine carrier supplied by UNICEF Supply Division,[1] large, long range, 15–25 litres; choose the largest available. Each cold box should include two sets of ice packs per cold box (one set to be frozen while the other set is being used)		2
	Gloves, rubber, heavy duty (for cleaning)		4
	Container, plastic, 12–20 L (for soaking materials in bleach after use)		2
	Consumables		
[!]	Test kit for *Vibrio cholerae* O1[2]	24 tests	
	Cary-Blair transport medium, bottles or tubes	24	
	Filter paper discs 15 cm	24	
	Re-sealable plastic bags	24	
	Swabs, sterile cotton or polyester-tipped	24	
	Gloves, examination, non-latex, disposable, large/medium/small	2 boxes each size (50 pairs of gloves per box)	
	Autoclave bags or non-leak bags suitable for incineration	5	
	Disinfectant, bleach, at least 5% available chlorine	1 L	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10	

[1] UNICEF Supply Division only supplies vaccine carriers and cold boxes that fulfil the quality requirements set by WHO, documented in the WHO PQS manual, available at: http://apps.who.int/immunization_standards/vaccine_quality/pqs_catalogue/index.aspx

[2] Omit if testing will not be performed by the programme.

Module 5a-SA: Cholera screening – stand-alone

Test volume: 20 tests

[I]	Description/instructions	20 tests	Once only
	In situ screening for cholera plus referral of samples for reference laboratory confirmation testing If the programme will *only* collect and refer samples to a reference laboratory for testing then do not include the *Vibrio cholerae* testing kit Alternative to Module 5a: Cholera (vibrio) screening Refrigeration will be needed for the storage of the cholera test kit (if included) and the samples prior to transport; the selection of the refrigerator will be dependent on the power supply available. See Group 1 Modules *Waste disposal* An incinerator does not need to be included if the laboratory has access to a general programme incinerator		
[!]	**Cautions**		
	Access to refrigeration and an incinerator will be required		
[R]	**Recommendations**		
	Refrigerator To minimize power consumption, select the smallest-size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator. Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered		
	Collection		
	Containers (for stool), polypropylene, 60–120 mL capacity, wide-neck, tight-fitting, leak-proof screw-cap (without disinfectant or detergent residue)	50	

	Equipment and low-use consumables		
	Cold box, vaccine carrier, overall dimensions: 24 × 24 × 33 cm, internal dimensions: 15 × 15 × 19 cm, storage capacity 1.7 L, ice packs[1] (two sets of ice packs per cold box)		2
	Gloves, rubber, heavy duty (for cleaning)		4
	Container, plastic, 12–20 L (for soaking materials in bleach after use)		2
	Mop		1
	Pipette, automatic, adjustable volume, 100–1000 µl,		1
	Pipette, automatic, adjustable volume, 20–200 µl,		1
	Receptacle, waste, with attached lid stainless steel, 12 L; foot operated		1
	Scissors, 17 cm, blunt ends		1
	Scissors, sharp tip		1
	Timer, mechanical, 1–60 minutes, with ringer		1
	Consumables		
[1]	Test kits for *Vibrio cholerae* O1 and O139[2]	24 tests	
	Cary-Blair transport medium, bottles or tubes	24	
	Filter paper discs 15 cm	24	
	Re-sealable plastic bags	24	
	Swabs, sterile cotton or polyester-tipped	24	
	Gloves, examination, non-latex, disposable, large/ medium/small.	2 boxes each size (50 pairs per box)	
	Autoclave bags or non-leak bags suitable for incineration	5	
	Disinfectant, bleach, at least 5% available chlorine	1 L	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10	
	Pipette, automatic, 10–200 µL tip	100)	
	Pipette, automatic, 100–1000 µL tip	40	
	Applicator stick, wooden	40	
	Disinfectant solution, hand-washing, waterless cleaner	1 L	
	Ethanol, 70% v/v d	1 L	
	Film, sealing plastic (parafilm) roll, 10 cm × 38 m	1	

Gloves, examination, non-latex, disposable, large/ medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	100 pairs
Labels, permanent self-adhesive (general purpose labelling)	25
Pen, ball-point, black	2
Pen, ball-point, red	2
Pen, permanent marker, black	2
Pen, permanent marker, red	2
Pipettes, transfer, non-sterile, polyethylene, 3 mL, 0.5 mL graduation	40
Protection paper for bench, absorbent, 50 cm × 50 m	1
Protective clothing, laboratory coats or gowns *Minimum two per staff member*	According to setting
Registration books for recording details of patients and test results. Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed	1
Stapler, paper, hand-held	1
Staples, size compatible with stapler	100
Steel wool pads, non-detergent[c]	5
Toilet paper, rolls[s]	1

[d] For disinfection
[s] Staining
[c] Cleaning
[1] Primary purpose for the storage of test kits and samples prior to referral to a reference laboratory. It can be substituted by access to a refrigerator.
[2] Omit if testing will not be performed by the programme.

Module 5b: Glucometer

[I]	Description/instructions	100 tests	Once only
	Testing for glucose levels using a hand-held glucometer supported by a core laboratory Electric power must be available to recharge the instrument batteries. Refer to Group 1, Energy, and Module 1b		
[R]	**Recommendations**		
	Highly recommended to use a hospital-grade point-of-care instrument		
	Collection		
	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients (if not supplied in the testing kit) and additionally include a 20% safety margin Important: some kits for glucometer testing include collection materials. Omit this section if collection materials are provided with the glucometer strips	120	
	Equipment and low-use consumables		
	Glucometer, hospital-grade, point-of-care *Minimum specifications:* • Able to record and store user ID • Lock-out function if quality control not performed • Able to record and store the lot number of test reagent • Must have manufacturer's supplied quality control system		2 Consider need for additional units to maximum testing efficiency
	Glucometer battery set/pack spare suitable for use in purchased glucometer		2
	Consumables		
	Bag for hazardous waste	1	
	Test strips compatible with the glucometer	120 tests	
	Quality/safety		
	Quality control to be used in accordance with manufacturer's instructions		

Module 5b-SA: Glucometer – stand-alone

[I]	Description/instructions	100 tests	Once only
	Testing for glucose levels using a hand-held glucometer – as a stand-alone module.		
	Refrigeration will be needed for the storage of the glucose control solutions (normal and abnormal). Most test strips do not require refrigeration and can be stored at room temperature. However, avoid exposing strips to extreme heat		
	The selection of the refrigerator will be dependent on the power supply available; see Group 1 Modules		
	Waste disposal An incinerator and a sharps pit do not need to be included if there is access to a general programme incinerator and sharps pit		
	Electric power must be available to recharge the instrument batteries. Refer to Group 1, Energy, and Module 1b		
[!]	**Cautions**		
	Highly recommended to use a hospital-grade point-of-care instrument Access to refrigeration, an incinerator and a sharps pit will be required		
[R]	**Recommendations**		
	Refrigerator		
	To minimize power consumption, select the smallest-size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example, 140 L or thereabouts) is suitable		
	An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator.		
	Electric, compression type, 110/230 V AC, standard electric		
	or		
	Electric, compression type, photovoltaic		
	or		
	Gas powered		
	or		
	Kerosene powered		

Collection		
Add Module 2b: Capillary blood sample collection. As quantities in Module 2b is given for one patient/ donor, multiply the quantities by the expected total number of patients (if not supplied in the testing kit)	120	
Important: some kits for glucometer testing include collection materials. Omit this Section if collection materials are provided with the glucometer strips		
Equipment and low-use consumables		
Glucometer, hospital-grade, point-of-care *Minimum specifications:* • Able to record and store user ID • Lock-out function if quality control not performed • Able to record and store the lot number of test reagent • Must have manufacturer-supplied quality control system		2 Consider need for additional units to maximum testing efficiency
Glucometer battery set/pack spare suitable for use in purchased glucometer		2
Registration books for recording patient details and test results. Standard registration books used in-country or Exercise books, A4, ruled, preferably hard-backed		Quantity to be determined according to the projected patient numbers
Receptacle, waste, with attached lid stainless steel, 12 L; foot operated		1
Ruler, 30 cm		1
First aid kit		1
Consumables		
Pen, ball-point, black	2	
Container, sharps, 5 L, cardboard for incineration	1	
Disinfectant solution, hand-washing, waterless cleaner	500 mL	
Gloves, examination, non-latex, disposable, large/ medium/small	100 pairs	
Size requirements vary from country to country – select distribution of large, medium and small as appropriate		
Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months		
Request forms	As required	

	Bag for hazardous waste	1
	Test strips compatible with the glucometer	120 tests
	Quality/safety	
	Quality control to be used in accordance with manufacturer's instructions	

Haematology

Guide for the selection of haematology modules

- **For laboratory testing *only*:**

A key decision is whether the programme will use an automated haematology instrument or perform manual testing.

Automated haematology

Advantages	Disadvantages
Enables the testing of erythrocyte indices (at least MCV, MCH, MCHC)	More expensive instrument Requires more consumables Requires more maintenance
Enables accurate platelet counting	Requires stable 110/230 V electric power
Accommodates workloads	Requires advanced quality control Controls have short shelf-life Requires cold chain for controls

Manual haematology

Advantages	Disadvantages
Low-cost instrumentation	Labour intensive; difficult to accommodate high workloads
Does not requires stable 110/230 V electric power	Cannot test for erythrocyte indices (MCV, MCH, MCHC)
Simple quality control	Platelet counting less accurate (not included in modules)

- Will the laboratory perform automated haematology?
  - → If yes, select Modules 5e: Automated haematology instrument and Module 5h: Blood film differential and (if required) Module 5g: Erythrocyte sedimentation rate (ESR)

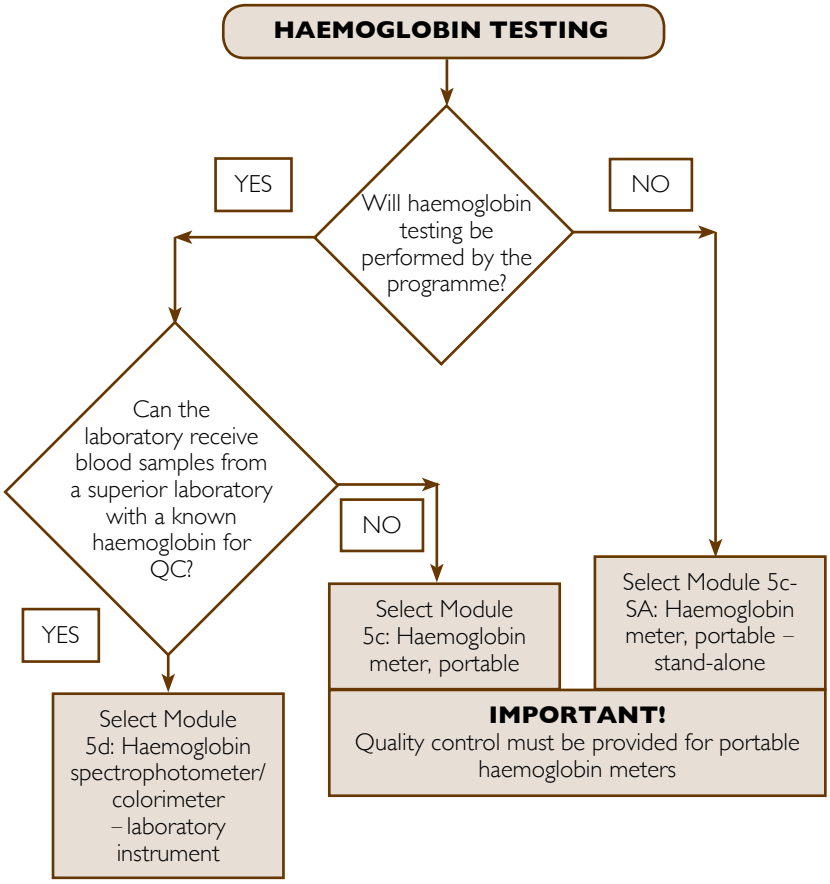
- Will the programme perform manual haematology for:
  - Haemoglobin? → If yes, select Module 5c or 5d (see decision flowchart)
  - White blood cell counting → If yes, select Module 5f
  - Erythrocyte sedimentation rate (ESR)? → If yes, select Module 5f
  - Blood film differential? → If yes, select Module 5h

- **For testing not performed by a laboratory:**

For example, in a clinic or an outreach programme → select Module 5c-SA (testing of erythrocyte indices not included in the available modules)

Guide for the selection of haematology modules

Note: not applicable if automated haematology is selected



Module 5c: Haemoglobin meter, portable

[I]	Description/instructions	100 tests	Once only
	Portable hand-held meter for haemoglobin measurement for use with a core laboratory		
[R]	**Recommendations**		
	It is highly recommended to select an instrument supported with manufacturer's quality control reagents		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Haemoglobinometer *Minimum specifications*: • Self-calibrating • Able to auto-check for lipaemia • Able to be operated at > 30 °C (if applicable) • Tropicalized, non-condensing (if applicable)		2
	Haemoglobinometer battery set/pack, spare suitable for purchased meter		2
	Consumables		
	Test cuvettes compatible with the haemoglobin meter	120	
	Bag for hazardous waste	1	
	Sharps box	1	
	Quality/safety		
	Quality control to be used in accordance with manufacturer's instructions	As applicable	

Module 5c-SA: Haemoglobin meter, portable – stand-alone

[I]	Description/instructions	100 tests	Once only
	Portable hand-held meter for haemoglobin measurement – stand-alone Refrigeration may be needed for the storage of the haemoglobin test strips – check the manufacturer's specifications; the choice of the refrigerator if required will be dependent on the power supply available – see Group 1 modules *Waste disposal* An incinerator and a sharps pit do not need to be included if there is access to a general programme incinerator and sharps pit Electric power must be available to recharge the instrument batteries. Refer to Group 1, Energy, and Module 1b		
[!]	**Cautions**		
	Access to refrigeration, an incinerator and a sharps pit will be required		
[R]	**Recommendations**		
	It is highly recommended to select an instrument supported with manufacturer's quality control reagents Refrigerator (if required by the manufacturer's specifications for the storage of test cuvettes): To minimize power consumption, select the smallest size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered		

	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Haemoglobinometer *Minimum specifications:* • Self-calibrating • Able to auto-check for lipaemia • Able to be operated at > 30 °C (if applicable) • Tropicalized, non-condensing (if applicable)		2
	Haemoglobinometer battery set/pack, spare suitable for purchased meter		2
	Registration books for recording details of patients and test results. Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed		Quantity to be determined according to the projected patient numbers
	Receptacle, waste, with attached lid stainless steel, 12 L; foot operated		1
	Ruler, 30 cm		1
	First aid kit		1
	Consumables		
	Test cuvettes compatible with the haemoglobin meter	120	
	Pen, ball-point, black	2	
	Container, sharps, 5 L, cardboard for incineration	1	
	Disinfectant solution, hand-washing, waterless cleaner	500 mL	

Gloves, examination, non-latex, disposable, large/ medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	100 pairs
Request forms	As required
Bag for hazardous waste	1
Quality/safety	
Quality control to be used in accordance with manufacturer's instructions	As applicable

Module 5d: Haemoglobin spectrophotometer/colorimeter – laboratory instrument

[I]	Description/instructions	100 tests	Once only
	Laboratory testing using a spectrophotometer or colorimeter using the oxyhaemoglobin methodology		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Spectrophotometer, colorimeter, haemoglobinometer		1
	Ammonia solution, concentrated		1 L[1]
	Graph paper		1 pad
	Flexible ruler		1
	Pipette, automatic, adjustable volume, 20–200 µL		1
	Test tubes, 7–10 mL, glass		20
	Parafilm, 4–6 cm wide		1
	Tube rack, suitable for 7–10 mL tubes		2
	Dispenser, 1 L with plunger calibrated 1–10 mL delivery		1
	Consumables		
	Test cuvettes compatible with the spectrophotometer, colorimeter, haemoglobinometer [2]	60	
	Water, bottled	600 mL	
	Pipette, automatic, 10–200 µL tip	120	
	Biohazard bag	1	
	Quality/safety		
	Testing must be supported by a quality control system	As applicable	

[1] 1 L of ammonia solution is sufficient for > 20 000 tests
[2] Assumes disposable cuvettes

Module 5e: Automated haematology instrument

[I]	Description/instructions	100 tests	Once only
	Laboratory testing using an automated haematology analyser		
[!]	**Cautions**		
	Requires stable 110/230 V AC electric power		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Haematology analyzer, automated		1
	Graph paper		1 pad
	Tube rack, suitable for 7–10 mL tubes		2
	Consumables		
	Manufacturer-supplied reagents	As specified	
	Biohazard bag	1	
	Quality/safety		
	Quality control materials supplied by the manufacturer	As specified	

Module 5f: White blood cell count, manual

[I]	Description/instructions	1000 tests	Once only
	Manual testing for white cells (leucocytes)		
	Collection		
	None. Assumes a blood sample will be collected for other haematology tests		
	Equipment and low-use consumables		
	Ethanoic acid, glacial, 1 L, bottle		1
	Methylene blue, Kinyoun stain, 100 mL, bottle		1
	Bottle, glass, brown, with 1–10 mL bottle top dispenser, 1 L		1
	Tube, standard, 12 × 75 mm, glass, screw-cap, 5 mL		20
	Rack, capable of holding 12 × 75 mm tubes		1
	Counting chamber, Neubauer, new improved bright line, double grid		1
	Cover, glass, for counting chamber, 20 × 26 mm		10

Module 5g: Erythrocyte sedimentation rate (ESR)[1]

Requires Module 2c: Venepuncture blood sample collection

[I]	Description/instructions	100 tests	Once only
	Erythrocyte sedimentation rate testing Three methods are included: A1. Recommended safety method using ESR vacuum tubes A2. Standard collection, disposable ESR tubes and pipettes A3. Standard collection, non-disposable Westergren pipettes		
[R]	**Recommendations**		
	An ESR vacuum system is strongly recommended Alternatively disposable ESR pipettes/tubes are recommended		
	Collection		
	Add number of patients to Module 2c: Venepuncture blood sample collection	120	
	Equipment and low-use consumables		
	Timer		1
[A]	A1 only ESR vacuum system		1
[A]	A2 only ESR rack (to fit the ESR tubes) Pipette filler, with thumb-wheel lever (Pi-pump), green 10 mL (to be used with A3, may not be necessary with A2)		1 1
[A]	A3 only ESR rack ESR tubes Pipette filler, with thumb-wheel lever, (Pi-pump), green 10 mL		1 10 1
	Consumables		
[A]	A1 only ESR vacuum tubes (same manufacturer as Module 2c)	120	
[A]	A2 only Disposable ESR tubes	120	
	Quality/safety		

[1] The ESR is a marker of inflammation. It is an easily performed and inexpensive nonspecific test; ESR results must be used along with other clinical findings. ESR testing has its limitations, and the C-reactive protein (CRP) test, which is another marker of inflammation, could be used instead if this will be practical and effective in the setting. Materials needed to perform CRP testing include: a CRP test kit(s), patient and control serum specimens, timer and other materials as directed by the reagent product package insert for the kit(s). Rapid CRP tests are commercially available and can be considered as alternative to ESR.

Module 5h: Blood film differential

[I]	Description/instructions	100 tests	Once only
	Blood film differential testing		
	Collection		
	None. Assumes a blood sample will be collected for other haematology tests		
	Equipment and low-use consumables		
	Counter, mechanical differential, five keys with totalizer		1
	Haematology atlas/reference books		1
	pH meter Recommended: portable *Minimum specifications*: • Measuring interval pH: 6–8, measured value resolution: 0.02 pH[1] • Temperature-compensated measurement • Calibratable • Rugged casing • Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low battery warning • Auto shut-off after 10 minutes of non-use • Ambient conditions: up to 90% humidity (non-condensing), 0 °C to 50 °C temperature • If detachable electrodes: spare electrode • Electrode cleaning solution • Operating manual • pH meter calibration solution set, pH 4, 7, 10 (or + 0.01); 500 mL each		1 1 set
	Consumables		
[A]	Leishman stain, high quality (or Wright or May–Grünwald/Giemsa stain)	400 mL	
	Buffer tablets, pH 6.8	2[2]	
	Bottled water	1 L	
	Slide, 76 × 26 mm, 1–1.2 mm thickness, frosted ends both sides	120	
	Box, slide, plastic (for 50 slides)	2	

[1] Resolution is the smallest value that is shown on the display, in this case 0.2 pH. It is then a value.
[2] Assuming 1 buffer tablet will prepare 1 L of buffer

Module 5i: Infectious diseases screening – rapid diagnostic testing (RDT)

[I]	Description/instructions	100 tests	Once only
	RDT testing for infectious diseases including HIV, hepatitis B surface antigen, hepatitis C antibody, dengue, brucellosis, typhoid and others. To be used in conjunction with a core laboratory		
[!]	**Cautions**		
	RDT tests for some disease markers may have unacceptable sensitivity and/or specificity; always confirm the performance characteristics of any test selected		
	Some tests may require cold chain transport. Check the manufacturer's specifications		
	HIV testing will require at least two, and often three, independent tests for the identification of HIV-positive patients. Check with the national protocol		
	Some tests may require the additional buffer for capillary blood testing. Check the full requirements of any test selected with the manufacturer or supplier		
	Some tests require that the user supplies the required pipette. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test		
	Some RDT tests may be supplied with collection materials		
[R]	**Recommendations**		
	Only enzyme immunoassays (EIA) should be used for screening blood donors		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	or		
	Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients (if not supplied in the testing kit) and additionally include a 20% safety margin		

	Equipment and low-use consumables	
	None (see cautions)	
	Consumables	
	Commercial rapid diagnostic tests	120 tests

Module 5i-SA: Infectious diseases screening – rapid diagnostic testing (RDT) – stand-alone

[I]	Description/instructions	100 tests	Once only
	RDT testing for infectious diseases including HIV, hepatitis B surface antigen, hepatitis C antibody, dengue, brucellosis, typhoid and others as stand-alone tests Refrigeration may be needed for the storage of the haemoglobin test strips – check the manufacturer's specifications; the choice of the refrigerator if required will depend on the power supply available – see Group 1 modules *Waste disposal* An incinerator and a sharps pit do not need to be included if there is access to a general programme incinerator and sharps pit		
[!]	**Cautions**		
	Access to refrigeration, an incinerator and a sharps pit will be required RDT tests for some disease markers may have unacceptable sensitivity and/or specificity; always confirm the performance characteristics of any test selected Some tests may require cold chain transport and storage. Check the manufacturer's specifications HIV testing will require at least two, and often three, independent tests for the identification of HIV-positive patients. Check with the national protocol Some tests may require the additional buffer for capillary blood testing. Check the full requirements of any test selected with the manufacturer or supplier Some tests require that the user supplies the required pipette. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test Some RDT tests may be supplied with collection materials		

[R]	**Recommendations**		
	Only enzyme immunoassays (EIA) should be used for screening blood donors for transfusion		
	Refrigerator (if required by the manufacturer's specifications for the storage of test cuvettes):		
	To minimize power consumption, select the smallest size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Registration books for recording details of patients and test results. Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed		Quantity to be determined according to the projected patient numbers
	Receptacle, waste, with attached lid stainless steel, 12 L; foot operated		1
	Ruler, 30 cm		1

	First aid kit		1
	Other: see cautions		Dependent on RDT
	Consumables		
	Commercial rapid diagnostic tests	120 tests	
	Pen, ball-point, black	2	
	Container, sharps, 5 L, cardboard for incineration	1	
	Disinfectant solution, hand-washing, waterless cleaner	500 mL	
	Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	100 pairs	
	Request forms	As required	
	Bag for hazardous waste	1	

Module 5j: Infectious diseases screening – enzyme immunoassays (EIA)

[I]	Description/instructions	100 tests	Once only
	RDT testing for infectious diseases including HIV, hepatitis B surface antigen, hepatitis C antibody, dengue, brucellosis, typhoid and others		
[R]	**Recommendations**		
	Only enzyme immunoassays (EIA) should be used for screening blood donors for transfusion		
	Collection		
	Add number of patients to Module 2c: Venepuncture blood sample collection	120	
	Equipment and low-use consumables		
	EIA analyser, washer, incubator (complete system), to include printer		1
	Pipettes, multi-channel (depends on system purchased) 50–200 µL		2
	Pipette, single channel, adjustable, 50–200 µL		3
	Waste, bin		1
	Rack, tube for 13 × 80 mm tubes		2
	Consumables		
	Commercial EIA test kits compatible with EIA analyser	120 tests	
	Consumables associated with kits (consult manufacturer)		
	Quality/safety		
	As recommended by the manufacturer or the national protocol		

Syphilis: *Treponema pallidum* screening

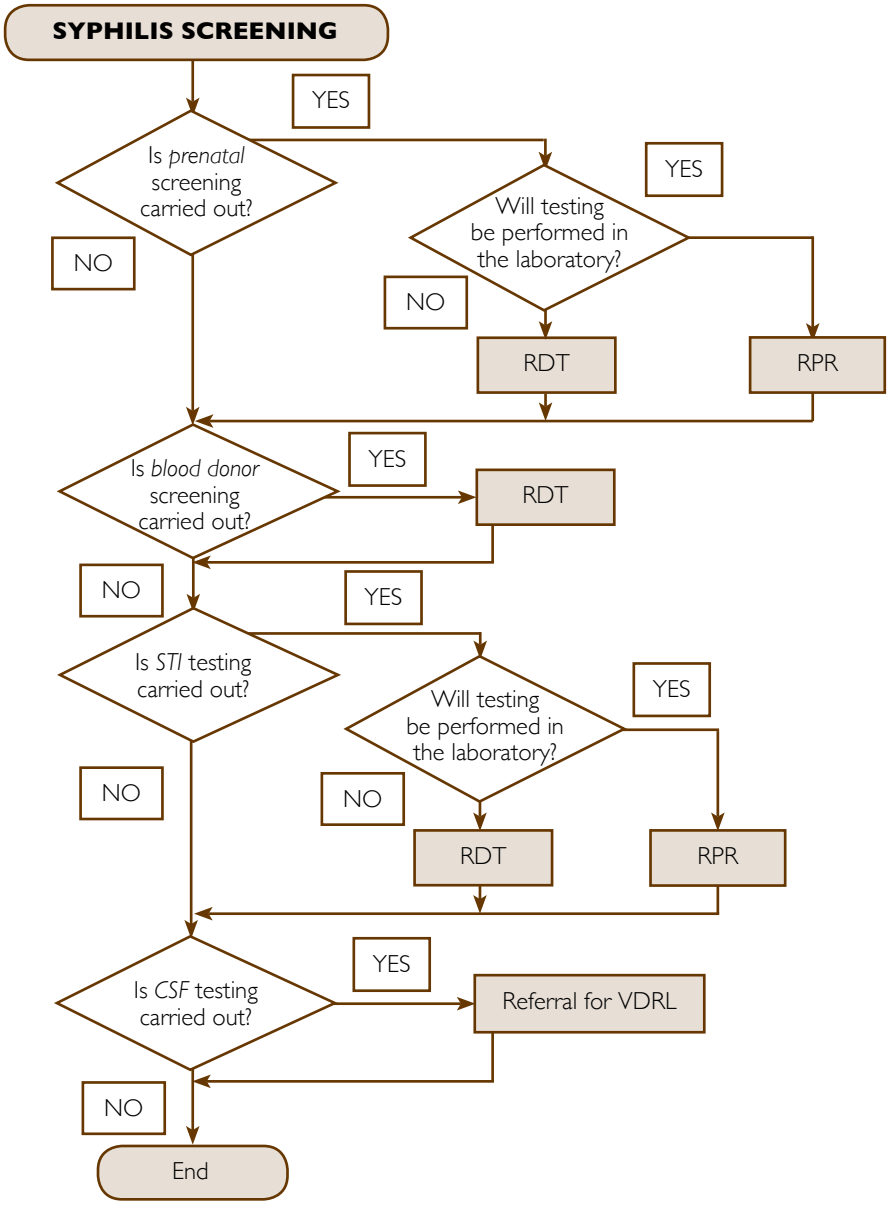
Recommendations

For blood donor screening always select Module 5k: Syphilis – *Treponema pallidum* testing – RDT screening

Prenatal testing

When testing will be performed by a laboratory, Module 5l: Syphilis – *Treponema pallidum* testing – rapid plasma reagin testing should be selected

When testing will be performed by clinical staff outside a laboratory always select Module 5k: Syphilis – *Treponema pallidum* testing – RDT screening



Module 5k: Syphilis – *Treponema pallidum* testing – RDT

[I]	Description/instructions	100 tests	Once only
	RDT testing for syphilis screening. To be used in conjunction with a core laboratory Important: for a full discussion of the characteristics of syphilis RDT tests refer to the WHO – TDR evaluation. For additional assistance contact a regional WHO office		
[!]	**Cautions**		
	Some tests may require cold chain transport. Check the manufacturer's specifications Some tests may require the additional buffer for capillary blood testing. Check the full requirements of any test selected with the manufacturer or supplier Some tests require that the user supply the required pipette. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test Some RDT tests may be supplied with collection materials		
[R]	**Recommendations**		
	See flow chart for recommended test selection		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	None (see cautions)		
	Consumables		
	Commercial syphilis TP rapid diagnostic test kit	120 tests	

Module 5k-SA: Syphilis – *Treponema pallidum* testing–RDT – stand-alone

[I]	Description/instructions	100 tests	Once only
	RDT testing for syphilis screening as a stand-alone test Refrigeration may be needed for the storage of the RDTs – check manufacturer's specifications; the choice of the refrigerator if required will depend on the power supply available – see Group 1 modules *Waste disposal* An incinerator and a sharps pit do not need to be included if there is access to a general programme incinerator and sharps pit		
[!]	**Cautions**		
	Access to refrigeration, an incinerator and a sharps pit will be required		
	Some tests may require cold chain transport and storage. Check the manufacturer's specifications		
	Some tests may require the additional buffer for capillary blood testing. Check the full requirements of any test selected with the manufacturer or supplier		
	Some tests require that the user supply the required pipette. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test		
	Some RDT tests may be supplied with collection materials		
[R]	**Recommendations**		
	See flow chart for recommended test selection *Refrigerator* (if required by the manufacturer's specifications for the storage of test cuvettes): To minimize power consumption, select the smallest size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable. An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator		

	Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered		
	Collection		
[A]	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin *or* Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit), and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Registration books for recording details of patients and test results. Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed		Quantity to be determined according to the projected patient numbers
	Receptacle, waste, with attached lid stainless steel, 12 L; foot operated		1
	Ruler, 30 cm		1
	First aid kit		1
	Other: see cautions		Dependent on RDT
	Consumables		
	Commercial syphilis TP rapid diagnostic test kit	120 tests	
	Pen, ball-point, black	2	
	Container, sharps, 5 L, cardboard for incineration	1	
	Disinfectant solution, hand-washing, waterless cleaner	500 mL	

	Gloves, examination, non-latex, disposable, large/ medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	100 pairs
	Request forms	As required
	Bag for hazardous waste	1

Module 5l: Syphilis – *Treponema pallidum* testing – rapid plasma reagin testing

[I]	Description/instructions	100 tests	Once only
	RPR testing for syphilis screening. To be used in conjunction with a core laboratory		
[R]	**Recommendations**		
	See flow chart for recommended test selection It is strongly recommended to only select RPR test kits that are supplied with quality control reagents		
	Collection		
	Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Rotator, orbital type, for agglutination test, 100 rpm, 110/230 V		1
	Plates for RPR test, 8 rings per plate (unless included in the test kit)		6
	Consumables		
	Commercial syphilis RPR tests	120	
	Quality/safety		
	As supplied by the manufacturer		

Module 5m: Malaria – rapid diagnostic testing

[I]	Description/instructions	100 tests	Once only
	Malaria test-based diagnosis using a commercial rapid diagnostic test (RDT) as a laboratory test		
[!]	**Cautions**		
	Test selection: the selection of appropriate malaria RDT depends on multiple factors. For a full discussion of the characteristics of malaria RDT tests refer to the WHO/TDR/FIND Malaria rapid diagnostic test performance: results of WHO product testing of malaria RDTs: round 1 (2008). Geneva: World Health Organization; 2009 (http://www.who.int/tdr/publications/tdr-research-publications/rdt-performance/en/). For additional assistance contact the regional WHO office		
	Collection		
	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Registration book (for recording details of patients and test results)		1
	Consumables		
	Test kit, malaria	120 tests	
	Container, sharps, 5 L, cardboard for incineration	1	
	Gloves, examination, non-latex, disposable, large/medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate*	120 pairs	
	Request forms	As required	
	Bag for hazardous waste	1	
	Quality/safety		
	WHO wall charts for malaria RDT testing		1

Module 5m-SA: Malaria – rapid diagnostic testing – stand-alone

[!]	Description/instructions	100 tests	Once only
	Malaria test-based diagnosis using a commercial rapid diagnostic test (RDT) as a stand-alone module		
[!]	**Cautions**		
	Test selection: the selection of appropriate malaria RDT depends on multiple factors. For a full discussion of the characteristics of malaria RDT tests refer to the WHO-TDR-FIND Malaria rapid diagnostic test performance: results of WHO product testing of malaria RDTs: round 1 (2008). Geneva: World Health Organization; 2009 (http://www.who.int/tdr/publications/tdr-research-publications/rdt-performance/en/). For additional assistance contact the regional WHO office.		
	Important: some tests require that the user supplies additional items. Check with the manufacturer or supplier if there is a need to provide any additional items of equipment or reagents to use the test		
	Many malaria RDTs require cold chain storage. Ensure there is access to refrigeration if tests must be stored refrigerated		
	Collection		
	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Registration book (recording details of patients and test results)		1
	Clock, wall-mounted		1
	Protective clothing, laboratory coats or gowns *Minimum two per staff member*		2 minimum
	Consumables		
	Test kit, malaria	120 tests	
	Pen, ball-point, black	1	
	Container, sharps, 5 L, cardboard for incineration	1	

	Disinfectant solution, hand-washing, waterless cleaner	500 mL	
	Gloves, examination, non-latex, disposable, large/ medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate*	120 pairs	
	Request forms	as required	
	Bag for hazardous waste	1	
	Quality/safety		
	WHO wall charts for malaria RDT testing		1

Module 5n: Malaria – thick and thin films

[I]	Description/instructions	750 tests	Once only
	Microscopy malaria diagnostic testing using Giemsa stain[1]		
[R]	**Recommendations**		
	The efficiency of the laboratory will often be dependent on the number of available microscopes. Depending on the workload and setting it is recommended that one microscope is provided for each laboratory staff member who will perform microscopy A slide warmer (commercially available) is strongly recommended for programmes operating in high humidity conditions		
	Collection		
	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/ donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	850	
	Equipment and low-use consumables		
	Registration books for recording patient details and test results		1
	Rack, slide drying		1
[O]	Slide warmer[2]		1
	Slide holder, cardboard, flat, capable of holding 20 slides		2
	Timer, mechanical, 1–60 minutes, with ringer (dedicated)		1
	Bottle, 1 L		2

Cylinder, with clear graduations, polypropylene, spout, 10 mL	2
Cylinder, with clear graduations, polypropylene, spout, 50 mL	2
100 mL measuring cylinder	2
pH meter Recommended: portable, hand-held, long stem *Minimum specifications:* • Measuring interval: minimum 6–8 pH, resolution: 0.02 pH • Temperature-compensated measurement • Calibratable • Rugged casing • Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or 500 measurements; low battery warning • Auto shut-off after 10 minutes of non-use • Ambient conditions: up to 90% humidity (non-condensing), 0 °C to 50 °C temperature • If detachable electrodes: spare electrode • Electrode cleaning solution if specified by the manufacturer • Operating manual	1
pH meter calibration solution set, pH 4, 7, 10 (or + 0.01); 500 mL each	1 set
Film, sealing plastic (parafilm) roll, 10 cm × 38 m	1
Bottle, swan-neck jet, plastic, 250 mL (dedicated)	2
Hand-tally counter, mechanical hand counter, plastic- or metal-cased (dedicated)	1 per reader
Immersion oil 500 mL	1 L
Beaker, plastic, spouted, 50 mL	2
Microscope, immersion oil, high quality	2 L
Microscope, lens-cleaning paper, sheet	200
Microscope, lens-cleaning solution	1 L
Microscope, lint-free cleaning cloth	2
Microscope, dropper bottle for immersion oil, 50 mL	2
Microscope, fuses	4
Microscope, halogen lamps as specified by the microscope manufacturer (not needed if LED microscope)	4
Rack, drying, plastic or wood (for slides)[s]	4

	Tally counter, hand, manual, plastic- or metal-cased		2 for each laboratory technical staff member who will perform microscopy reading
	Timer, mechanical, 1–60 minutes, with ringer		2
	Consumables		
	Box, slide, plastic, for 100 slides[3]	8	
	Absolute methanol AR	500 mL	
	Giemsa stain, solution, high quality	500 mL	
	Buffer tablets, pH 7.2, one tablet to make 100	50	
	Transfer pipette 3 mL	250	
[O]	Water, bottled water[4]	5 L	
	Slides, 76 × 26 mm, 1–1.2 mm thickness, plain	850 or 1700[5]	
	Bag for hazardous waste	10	
	Container, sharps, 5 L, cardboard for incineration	10	
	Request forms	as required	

[s] Staining

[1] Field stain and other alternative stains are not addressed. Substitute as required.

[2] Slide warmer optional but strongly recommended for programmes operating in high humidity conditions (commercially available)

[3] Slides should be stored for a minimum of four weeks to allow for quality control sampling. However, it is also strongly recommended that all slides be kept for a longer period, for example three to six months, to allow slides to be examined during supervisory visits as part of the quality control programme.

[4] Dependent on the cation concentration (hardness) of the local water; excessive cations may precipitate phosphate buffers.

[5] Depending if thick and thin films are prepared together (850 slides) or on separate slides (1700 slides)

Module 5n-SA: Malaria – thick and thin films – stand-alone

[I]	Description/instructions	750 tests	Once only
	Microscopy malaria diagnostic testing as a stand-alone using Giemsa stain[1] Electric power will be required for the microscope(s) *Waste disposal* An incinerator does not need to be included in the laboratory module if the laboratory has access to a general programme incinerator		
[!]	**Cautions**		
	The laboratory will require access to a sharps pit and general waste management of stains.		
[R]	**Recommendations**		
	The efficiency of the laboratory will often be dependent on the number of available microscopes. Depending on the workload and setting it is recommended that one microscope is provided for each laboratory staff member who will perform microscopy A slide warmer (commercially available) is strongly recommended for programmes operating in high humidity conditions		
	Collection		
	Add Module 2b: Capillary blood sample collection. As quantities in Module 2b are given for one patient/donor, multiply the quantities by the expected total number of patients/donors (if not supplied in the testing kit) and additionally include a 20% safety margin	600	
	Equipment and low-use consumables		
	Registration books for recording patient details and test results		1
	Rack, slide drying		1
[O]	Slide warmer 1		1
	Slide holder, cardboard, flat, capable of holding 20 slides		2
	Timer, mechanical, 1–60 minutes, with ringer (dedicated)		1
	Bottle, 1 L		2
	10 mL measuring cylinder		1
	50 mL measuring cylinder		1
	100 mL measuring cylinder		1
	pH meter Recommended: portable *Minimum specifications:* • Measuring interval pH: 6–8, resolution: 0.02 pH • Temperature-compensated measurement • Calibratable • Rugged casing		1

• Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low battery warning • Auto shut-off after 10 minutes of non-use • Ambient conditions: up to 90% humidity (non-condensing), 0 °C to 50 °C temperature • If detachable electrodes: spare electrode • Electrode cleaning solution • Operating manual	
pH meter calibration solution set, pH 4, 7, 10 (or + 0.01); 500 mL each	1 set
Hydrochloric acid, concentrated	500 mL
Sodium hydroxide pellets	100 g
Beaker, glass, low form, spouted, 500 mL	1
Beaker, plastic, low form, spouted, 1000 mL	1
Film, sealing plastic (parafilm) roll, 10 cm × 38 m	1
Bottle, swan-neck jet, plastic, 250 mL (dedicated)	2
Hand-tally counter, mechanical hand counter, plastic- or metal-cased (dedicated)	1 per reader
Immersion oil 500 mL	1 L
Basin, plastic, diameter 285–310 mm[s]	2
Beaker, plastic, spouted, 50 mL	2
Binocular light microscope *Recommended minimum specifications:* • Strong construction, stable base • Optics anti-fungus treated • Binocular head inclined to approximately 30°, and rotatable for 360° and adjustable for inter-pupillary distance • Condenser, Abbe type with iris and filter holder • Centring screws or an alternative system provided by the manufacturer • Blue filter • 10× eyepieces widefield (FN 18) with tube caps • Rubber eye shelters for both eye pieces • 100× oil immersion (spring-loaded) objective, minimum NA 1.25 • Parfocal DIN infinity-corrected plan achromat, 10×, 40× (spring-loaded) objectives, minimum 10×/NA 0.25, 40×/NA 0.65, 100×/NA 1.25. Power supply: supply voltage: 110/230 V AC; battery-powered: minimum three hours of operation at full intensity per battery charge; low battery warning	Dependent on workload

Accessories: 1 battery charger or mains adaptor
1 battery pack, rechargeable
1 connection lead with car adapter
12 V DC/crocodile clamps and optionally
operated on a solar panel

Illumination

- Illumination unit with graduated lamp brightness control, light source: halogen lamp (luminous flux: minimum 700 lm; 20 W)
  or
  white LED lamp (luminous flux: minimum 700 lm, service life: minimum 15 000 hours)
  and
  back-up (daylight) mirror unit, plane and concave, mounted for angling and rotating
  and
  spare bulbs: three spare bulbs (if halogen)
- Coaxial fine and coarse focus controls on both sides
- A built-in stage with a mechanism for mounting object slide. Fixed graduated mechanical and coaxial controls
- Supplied with non-drying immersion oil
- Dust cover

Bottle, high density polyethylene, brown, screw-cap, 500 mL[g, s]	2
Broom	1
Brush – scrubbing brush	2
Calculator	1
Calculator batteries – spare	4
Clock, wall-mounted	1
Cylinder, with clear graduations, polypropylene, spout, 10 mL	2
Microscope, immersion oil, non-drying high quality	2 L
Microscope, lens-cleaning paper, sheet	200
Microscope, lens-cleaning solution	1 L
Microscope, lint-free cleaning cloth	2
Microscope, dropper bottle for immersion oil, 50 mL	2
Microscope, fuses	4
Microscope, halogen lamps as specified by the microscope manufacturer (not needed if LED microscope)	4
Mop	1
Rack, drying, plastic or wood (for slides)[s]	4
Receptacle, waste, with attached lid stainless steel, 12 L; foot operated	2
Rod, glass, 250 mm, diameter 6–7mm	2
Rods, stainless steel adjustable length rods (for slide staining) in holders with levelling screws, for fitting across sink, minimum length 290 mm	1 set

	Ruler, 30 cm		2
	Tally counter, hand, manual, plastic- or metal-cased		2 for each laboratory technical staff member who will perform microscopy reading
	Timer, mechanical, 1–60 minutes, with ringer		2
	Water purification, brush, stiff bristles (to clean filters)		1
	Water purification, gravity water filter, 10 L, fountain, four self-sterilizing ceramic elements (candle filter)		1
	Water purification, spare candle filter, 18 cm		2
	Water storage container, polyethylene, 20 L, with handle and removable tap		1
	Box, slide, plastic, for 100 slides[5]	8	
	Absolute methanol AR	500 mL	
	Giemsa stain, solution, high quality	500 mL	
	Buffer tablets, pH 7.2, one tablet to make 100 mL	50	
	Transfer pipette 3 mL	250	
[O]	Water, bottled water[3]	5 L	
	Slides, 76 × 26 mm, 1–1.2 mm thickness, plain	850 or 1700[4]	
	Bag for hazardous waste	10	
	Bleach[d] (household 5%) or commercial (refer to Chapter 5)	1 L	
	Container, sharps, 5 L, cardboard for incineration	10	
	Disinfectant solution, hand-washing, waterless cleaner	1 L	
	Pen, ball-point, black	6	
	Pen, ball-point, red	6	
	Pen, permanent marker, black	4	
	Pen, permanent marker, red	4	
	Protection paper for bench, absorbent, 50 cm × 50 m	2	
	Protective clothing, laboratory coats or gowns *Minimum two per staff member*	Dependent on number of laboratory staff	
	Request forms	As required	
	Toilet paper, rolls[s]	20	

[d] For disinfection
[s] Staining
[c] Cleaning
[1] Field stain and other alternative stains are not addressed. Substitute as required.
[2] Slide warmer optional but strongly recommended for programmes operating in high humidity conditions (commercially available)
[3] Dependent on the cation concentration (hardness) of the local water; excessive cations may precipitate phosphate buffers.
[4] Depending if thick and thin films are prepared together (850 slides) or on separate slides (1 700 slides)
[5] Slides should be stored for a minimum of four weeks to allow for quality control sampling. However, it is also strongly recommended that all slides be kept for a longer period, for example three to six months, to allow slides to be examined during supervisory visits as part of the quality control programme.

Meningococcal/bacterial meningitis, central spinal fluid (CSF)

Note: CSF collection is not included as this is a clinical procedure

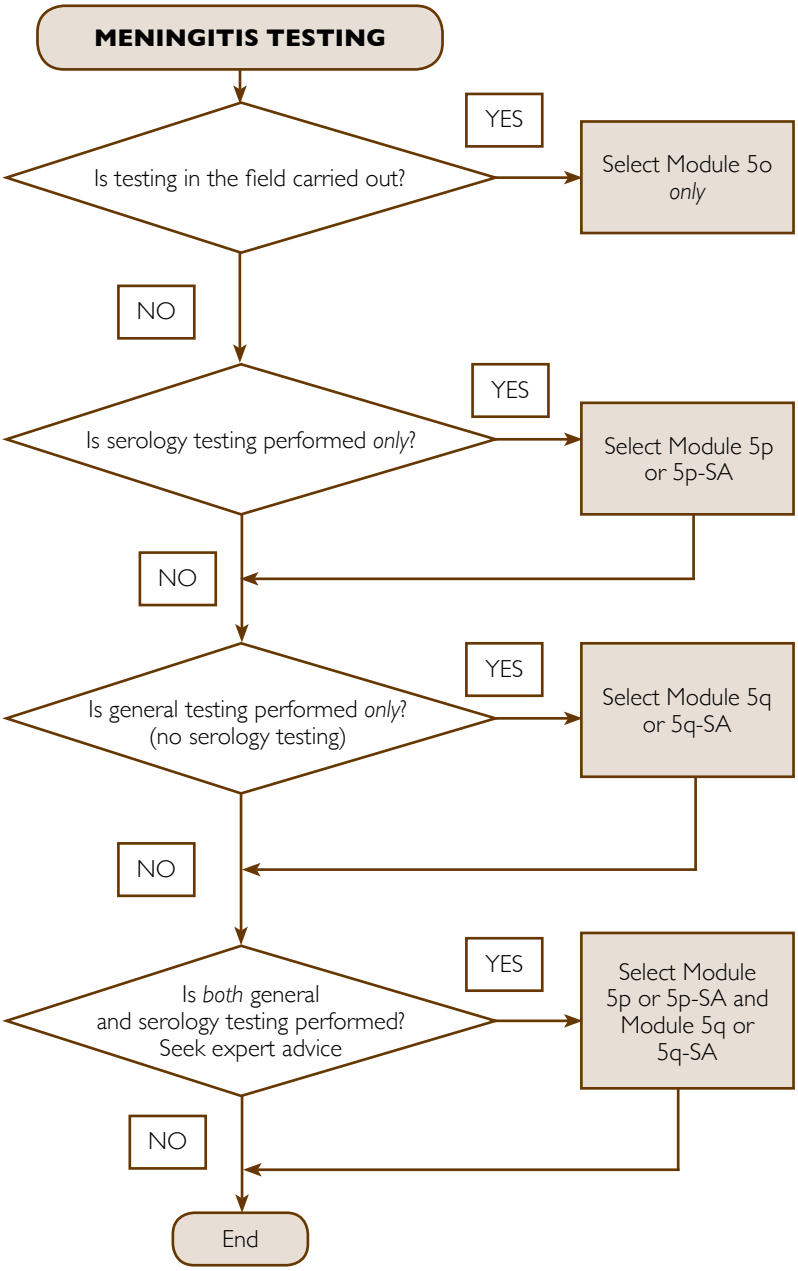
Programmes should select modules as follows depending on programme needs and setting:

- Programmes that will only refer samples for testing: select Module 5o: Transport of CSF specimens – referral
- Programmes that will only perform serological testing: select
  Module 5p: Meningococcal/bacterial meningitis – serological testing – CSF or 5p-SA
  +
- Module 5o: Transport of CSF specimens – referral
- Programmes that will perform both serological testing and full laboratory testing: select Module 5p: Meningococcal/bacterial meningitis – serological testing – CSF or 5p-SA
  +
- Module 5q: Meningitis – general laboratory testing – CSF or 5q-SA
  +
- Module 5o: Transport of CSF specimens – referral

Note: this will require a laboratory

- Programmes that will perform only full laboratory testing (no serological testing): select
  Module 5q: Meningitis – general laboratory testing – CSF or 5q-SA

Note: this will require a laboratory


MENINGITIS TESTING
Is testing in the field carried out?
YES
Select Module 5o *only*
NO
Is serology testing performed *only*?
YES
Select Module 5p or 5p-SA
NO
Is general testing performed *only*? (no serology testing)
YES
Select Module 5q or 5q-SA
NO
Is *both* general and serology testing performed? Seek expert advice
YES
Select Module 5p or 5p-SA and Module 5q or 5q-SA
NO
End

Module 5o: Transport of CSF specimens – referral

[I]	Description/instructions	10 patients
	Referral of CSF specimens to a reference or higher laboratory	
[R]	**Recommendations**	
	On the outside of the box, specify how the specimen should be stored: refrigerated, frozen, or do not refrigerate. Must comply with IATA requirements. Refer to Chapter 10	
	Collection	
	None (clinical procedure)	
	Consumables	
	Transport container, triple packing (for transport of infectious substances) class 6.2	10
	Tube, tight fitting screw-cap, sterile, 10–12 mL	24
	Appropriate transport media as required by the reference laboratory	
	Transfer pipettes, 3 mL, sterile	12

Module 5p: Meningococcal/bacterial meningitis – antigen detection testing – CSF

[I]	Description/instructions	50 tests	Once only
	In situ serological testing of CSF specimens for bacterial meningitis using a core laboratory		
[!]	**Cautions**		
	Meningitis outbreaks should be confirmed by a reference or higher laboratory Cryptococcus serology is not included in this module Some test kits may require additional items; check with manufacturer		
	Collection		
	None (clinical procedure)		
	Consumables		
	Meningitis serology tests, kit, commercial	60	
	Tube, tight fitting screw-cap, sterile, 10–12 mL	60	
	Transfer pipettes, 3 mL, sterile	120	
	Other: see cautions	As required	

Module 5p-SA: Meningococcal/bacterial meningitis – antigen detection testing – CSF – stand-alone

[I]	Description/instructions	50 tests	Once only
	In situ serological testing of CSF specimens for bacterial meningitis as a stand-alone		
	Refrigeration may be needed for the storage of the haemoglobin test strips; check the manufacturer's specifications; the choice of the refrigerator if required will depend on the power supply available. See Group 1 modules		
	Waste disposal An incinerator and a sharps pit do not need to be included if there is access to a general programme incinerator and sharps pit		
[!]	**Cautions**		
	For maximum sensitivity CSF samples may need to be heated at 100°C and centrifuged. A centrifuge is included in this module; check electric power supply. See Group 1 modules		
	Meningitis outbreaks should be confirmed by a reference or higher laboratory		
	Cryptococcus serology is not included in this module		
	Access to refrigeration, an incinerator and a sharps pit will be required		
	Some test kits may require additional items; check with manufacturer		
[R]	**Recommendations**		
	Centrifuge To minimize power consumption, select the smallest size centrifuge needed to accommodate the workload A swing-out rotor with buckets is preferred to a fixed-angle rotor Refrigerator To minimize power consumption, select the smallest size refrigerator according to the anticipated requirements of the laboratory. Generally a medium size (for example 140 L or thereabouts) is suitable		
	An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator		

Collection	
None (clinical procedure)	
Equipment and low-use consumables	
Centrifuge, electric, bench-top model *Recommended selection:* • swing-out rotor • select smallest centrifuge capable of accommodating above tube requirements • if selecting fixed-angle rotor, consider two smaller centrifuges *Minimum specifications:* • Robust construction • Power supply: 110/230 V AC • Brushless drive induction motor • Suction-cup feet • Minimum size able to accommodate 3–15 mL tubes • The lid should have a safe lid interlock and a mechanical lid release mechanism. • Supplied with sealable buckets or sealable fixed-angle rotor • Centrifugal force: adjustable from 500× g to 2000× g (note: this is *not* the rpm rating) • Timer and alarm • An imbalance detector • Electronic meter displaying rpm and g-force. • Operating manual • Full spare part list and manufacturer's maintenance manual One-year manufacturer's guarantee	1
Centrifuge, manufacturer's recommend spare parts	1 set
Centrifuge, rotors and buckets Recommended: swing-out rotor with bucket inserts suitable for 3–7 mL blood tubes *or* Equivalent fixed-angle rotor suitable for 3–7 mL tubes	1
Gas stove, small	1
Gas, cylinder, for gas stove	2
Metal container (saucepan or similar) with sufficient size to accommodate a metal test tube rack to accommodate 10–12 mL tubes	1
Rack, test tube, metal to accommodate 10 –12 mL tubes, small four-hole (to fit saucepan)	2

Rack, test tube, 10–12 mL tubes		2
Registration books for recording patient details and test results. Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed		Quantity to be determined according to the projected patient numbers
Receptacle, waste, with attached lid stainless steel, 12 L; foot operated		1
Ruler, 30 cm		1
Consumables		
Meningitis serology tests, kit, commercial	60	
Tube, tight fitting screw-cap, sterile, 10–12 mL	60	
Transfer pipettes, 3 mL, sterile	120	
Pen, ball-point, black	2	
Container, sharps, 5 L, cardboard for incineration	1	
Disinfectant solution, hand-washing, waterless cleaner	500 mL	
Gloves, examination, non-latex, disposable, large/medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	100 pairs	
Request forms	As required	
Bag for hazardous waste	1	
Test tube, conical end, 10–12 mL, non-sterile	10	
Gloves, thick, leather for thermal protection, pair	2	
Forceps, stainless steel, flattened bent and blunt end, 105 mm long	1	
Timer, mechanical, 1–60 minutes, with ringer (dedicated)	1	
Other: see cautions	As required	

Meningitis – general laboratory testing – CSF

Caution:
Laboratory analysis of CSF samples includes both:

- tests only used for CSF – glucose, protein and Indian ink and serology testing for cryptococcus
- tests also used for other purposes by the laboratory – leukocyte counting, leukocyte differential analysis and Gram staining.

To avoid duplication, items required for leukocyte counting, leukocyte differential analysis and Gram staining are identified in the modules, and these items may be omitted if the corresponding test has been selected elsewhere.

This module supports the following testing in CSF:
CSF glucose testing
CSF protein
CSF leukocyte count (WBC)
CSF differential count
CSF Indian ink test for cryptococcus
CSF Gram stain
+
A separate section, optional, is included for Cryptococcus serology if required. This can be omitted if not applicable.

Module 5q: Meningitis – general laboratory testing – CSF

	Description/instructions	50 tests	Once only
	General laboratory testing of CSF specimens using a core laboratory For accuracy the module uses spectrophotometry-based analysis of protein and glucose. Other methods of glucose testing are not included because of the difficulty of validation of such test methodologies across the range of available commercial products		
[R]	**Recommendations**		
	It is recommended to select a small kinetic stand-alone spectrophotometer These instruments are relatively inexpensive		
	Collection		
	None (clinical procedure)		

	Equipment and low-use consumables	
	Glucose and protein	
	Spectrophotometer, kinetic, bench-top	1
	Rack, for tubes 100–125 × 15–20 mm diameter	1
[!]	***Leukocyte (WBC) counting***[1]	
	Counting chamber, Neubauer, new improved bright line, double grid[2]	1
	Counting chamber, cover glass, planed, for counting chamber, 20 × 26 mm	10
	Hand-tally counter, mechanical hand counter, plastic- or metal-cased (dedicated)	1
[!]	***Differential count***[1]	
	Counter, mechanical differential, five keys with totalizer	1
	pH meter Recommended: portable *Minimum specifications*: • Measuring interval pH: 6–8, resolution: 0.02 pH • Temperature-compensated measurement • Calibratable • Rugged casing • Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low battery warning • Auto shut-off after 10 minutes of non-use • Ambient conditions: up to 90% humidity (non-condensing), 0 °C to 50 °C temperature • If detachable electrodes: spare electrode • Electrode cleaning solution • Operating manual	1
	pH meter calibration solution set, pH 4, 7, 10 (or + 0.01); 500 mL each	1 set
	Indian ink for cryptococcus	
	Indian ink suspension[3]	5 mL
[!]	***Gram stain***[1]	
	Bottle, swan-neck jet, plastic, 250 mL	4
	Box, slide, plastic, for 50 slides	1
	Reference books/guidelines	1
	Lamp, spirit, metal with wick	1
	Lamp spirit, wicks	10

	Consumables	
	General	
	Container, sharps, 5 L, cardboard for incineration	1
	Gloves, examination, non-latex, disposable, large/ medium/small	50
	Size requirements vary from country to country – select distribution of large, medium and small as appropriate	
	Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	
	Glucose and protein	
	Chemistry test, kit, Glucose	60
	Chemistry test, kit, Protein, CSF-range	60
	Test cuvettes compatible with the spectrophotometer	60
	Pipette, automatic 10–200 µl tip	200
	Pipette, automatic, 100 to 1,000 µl tip	100
[!]	***Differential count***[1]	
[A]	Leishman stain, high quality (or Wright or May–Grünwald/Giemsa stain)	250 mL
	Buffer tablets, pH 7.0	2 5
	Bottled water	2 L
	Slide, 76 × 26 mm, 1–1.2 mm thickness, frosted ends both sides	60
	Box, slide, plastic (for 50 slides)	1
	Indian ink for cryptococcus	
	Slide, 76 × 26 mm, 1–1.2 mm thickness, frosted ends both sides	60
[!]	***Gram stain***[1]	
	Commercial Gram stain kit (preferred)	Depends on volume of the commercial kit[5]
	Microscope slides, 76 × 26 mm, 1–1.2 mm thickness, frosted marking area on both sides of one end of slide	60
	Lamp fuel; denatured alcohol or equivalent	50 mL
[O]	***Cryptococcus serology***	
	Commercial cryptococcus antigen detection test, kit (serology)	60

	Quality/safety	
	Chemistry quality control reagents, assayed, lyophilized	Minimum two levels of analyte. Sufficient volume for period programme will operate[6]

[1] May be omitted if the same testing is already performed by the laboratory.
[2] Alternatively a Fuchs–Rosenthal counting chamber and cover-slips
[3] Test ampoules containing Indian ink (colloidal carbon) are available.
[4] Assumes 1 tablet prepares 1 L buffer solution
[5] Often sufficient for 200–250 stains
[6] Check with manufacturer. Generally one vial can be used over a period of one week. Assuming a minimum packaging size of 25 vials, one set would be sufficient for four months.

Module 5q-SA: Meningitis – general laboratory testing – CSF – stand-alone

[I]	Description/instructions	50 tests	Once only
	General laboratory testing of CSF specimens as a stand-alone laboratory For accuracy the module uses spectrophotometry-based analysis of protein and glucose. Other methods of glucose testing are not included as because of the difficulty of validation of such test methodologies across the range of available commercial products Refrigeration may be needed for the storage of the haemoglobin test strips – check the manufacturer's specifications; the choice of the refrigerator if required will be dependent on the power supply available. See Group 1 modules *Waste disposal* An incinerator and a sharps pit do not need to be included if there is access to a general programme incinerator and sharps pit		
[!]	**Cautions**		
	The laboratory will require access to a sharps pit and general waste management of stains		
[R]	**Recommendations**		
	It is recommended to select a small kinetic stand-alone spectrophotometer. These instruments are relatively inexpensive		

Refrigerator	
To minimize power consumption, select the smallest size refrigerator according to the anticipated requirements of the laboratory Generally a medium size (for example 140 L or thereabouts) is suitable	
An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator	
Centrifuge	
To minimize power consumption, select the smallest size centrifuge needed to accommodate the workload	
A swing-out rotor with buckets is preferred to a fixed-angle rotor	
Collection	
None (clinical procedure)	
Equipment and low-use consumables	
General, common use	
Basin, plastic, diameter 285–310 mm[s]	1
Beaker, glass, low form, spouted, 100 mL	1
Beaker, glass, low form, spouted, 500 mL	1
Beaker, plastic, low form, spouted, 1 000 mL	1
Bottle, high density polyethylene, brown, screw-cap, 500 mL[gs]	1
Broom	1
Brush, scrubbing brush	1
Bucket, metal (10–12 L)	1
Calculator	1
Calculator batteries, spare	2
Centrifuge, electric, bench-top model	1
Recommended selection: • swing-out rotor • select smallest centrifuge capable of accommodating above tube requirements • if selecting fixed-angle rotor, consider two smaller centrifuges *Minimum specifications:* • Robust construction • Power supply: 110/230 V AC	

	• Brushless drive induction motor • Suction-cup feet • Minimum size able to accommodate 3–15 mL tubes • The lid should have a safe lid interlock and a mechanical lid release mechanism • Supplied with sealable buckets or sealable fixed-angle rotor • Centrifugal force: adjustable from 500× g to 2000× g (note: this is *not* the rpm rating) • Timer and alarm • An imbalance detector • Electronic meter displaying rpm and g-force. • Operating manual • Full spare-part list and manufacturer's maintenance manual • One-year manufacturer's guarantee	1
	Centrifuge, manufacturer's recommend spare parts	1 set
[A]	Centrifuge, rotors and buckets Recommended: swing-out rotor with bucket inserts suitable for 3–7 mL blood tubes and 10–15 mL urine tubes[1] *or* Equivalent fixed-angle rotors suitable for 3–7 mL blood tubes and 10–15 mL urine tubes	1 for each size tube described
	Clock, wall-mounted	1
	Cold box, vaccine carrier, overall dimensions: 24 × 24 × 33 cm, internal dimensions: 15 × 15 × 19 cm, storage capacity 1.7 L, ice packs (two sets of ice packs per cold box)	1
	Cylinder, with clear graduations, polypropylene, spout, 10 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 50 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 100 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 1000 mL	1
	Forceps, stainless steel, blunt end, 105 mm long	1
	Funnels, polypropylene, 65 mm diameter	2
	Funnels, polypropylene, 90 mm diameter	2
	Glass bottle, approximately 500 mL	1
	Gloves, rubber, heavy duty (for cleaning)	2
	Mop	1
	Petri dish, approximately 120 mm diameter, with lids	2

	Pipette filler, with thumb-wheel lever, (Pi-pump) green 10 mL	1
	Receptacle, waste, with attached lid stainless steel, 12 L; foot operated	1
[A]	Refrigerator *Minimum specifications:* • Size: 140 L (size may vary based on the needs at the site) • Internal air temperature; 2 °C to 10 °C • One-year manufacturer's guarantee • Important: should have a separate freezer compartment, non-automatic defrost (not a freezer located inside the refrigerator cabinet) • Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered	1
	Rod, glass, 250 mm, diameter 6–7 mm	2
	Rods, stainless steel adjustable length rods (for slide staining) in holders with levelling screws, for fitting across sink, minimum length 290 mm[s]	1
	Ruler, 30 cm	2
	Scissors, 17 cm, blunt ends	2
	Slide holder, cardboard, flat, capable of holding 20 slides	5
	Thermometer, –10 °C to 110 °C, red spirit	2
	Timer, mechanical, 1–60 minutes, with ringer	2
	Tool kit (See Annex 6)	1
	Water purification, brush, stiff bristles (to clean filters)	1
	Water purification, gravity water filter, 10 L, fountain, four self-sterilizing ceramic elements (candle filter)	1
	Water purification, spare candle filter, 18 cm	2
	Water storage container, polyethylene, 20 L, with handle and removable tap	2
	Protection paper for bench, absorbent, 50 cm × 50 m	2
	Protective clothing, laboratory coats or gowns *Minimum two per staff member*	According to setting

[A]	Registration books: recording details of patients and test results. Standard registration books used in-country	1
	or	
	Exercise books, A4, ruled, preferably hard-backed	
	Stapler, paper, hand-held	1
	Staples, size compatible with stapler	1 000
	Glucose and protein	
	Spectrophotometer, kinetic, bench-top	1
	Rack, for tubes 100–125 × 15–20 mm diameter	1
	Pipette tips, yellow, box including tray for 100 tips (empty)	1
	Pipette, automatic, adjustable volume, 100–1000 µl,	1
	Pipette, automatic, adjustable volume, 20–200 µL,	1
[!]	***Leukocyte (WBC) counting***[2]	
	Counting chamber, Neubauer, new improved bright line, double grid[3]	1
	Counting chamber, cover glass, planed, for counting chamber, 20 × 26 mm	10
	Lunch box	1
	Binocular light microscope	
	Recommended minimum specifications:	
	• Strong construction, stable base	
	• Optics anti-fungus treated	
	• Binocular head inclined to approximately 30°, and rotatable for 360° and adjustable for inter-pupillary distance	
	• Condenser, Abbe type with iris and filter holder	
	• Centring screws or an alternative system provided by the manufacturer	
	• Blue filter	
	• 10× eyepieces widefield (FN 18) with tube caps	
	• Rubber eye shelters for both eye pieces	
	• 100× oil immersion (spring-loaded) objective, minimum NA 1.25	
	• Parfocal DIN infinity-corrected plan achromat, 10×, 40× (spring-loaded) objectives, minimum 10×/NA 0.25, 40×/NA 0.65, 100×/NA 1.25.	
	Power supply: supply voltage: 110/230 V AC; battery-powered: minimum three hours of operation at full intensity per battery charge; low battery warning	
	Accessories: 1 battery charger or mains adaptor 1 battery pack, rechargeable 1 connection lead with car adaptor 12 V DC/crocodile clamps and optionally operated on a solar panel	

	Illumination	
	• Illumination unit with graduated lamp brightness control, light source: halogen lamp (luminous flux: minimum 700 lm; 20 W) *or* white LED lamp (luminous flux: minimum 700 lm, service life: minimum 15 000 hours) *and* back-up (daylight) mirror unit, plane and concave, mounted for angling and rotating *and* spare bulbs: three spare bulbs (if halogen)	
	• Coaxial fine and coarse focus controls on both sides	
	• A built-in stage with a mechanism for mounting object slide. Fixed graduated mechanical and coaxial controls	
	• Supplied with non-drying immersion oil	
	• Dust cover	
	Microscope, immersion non-drying oil, high quality	500 mL
	Microscope, lens-cleaning paper, sheet	200
	Microscope, lens-cleaning solution	1 L
	Microscope, lint-free cleaning cloth	2
	Microscope, dropper bottle for immersion oil, 50 mL	2
	Microscope, fuses	4
	Microscope, halogen lamps as specified by the microscope manufacturer (not needed if LED microscope)	4
	Tally counter, hand, manual, plastic- or metal-cased	2
[!]	***Differential count***[2]	
	Counter, mechanical differential, five keys with totalizer	1
	pH meter	1
	Recommended: portable *Minimum specifications:* • Measuring interval pH: 6–8, resolution: 0.02 pH • Temperature-compensated measurement • Calibratable • Rugged casing • Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low battery warning • Auto shut-off after 10 minutes of non-use	

	• Ambient conditions: up to 90% humidity (non-condensing), 0 °C to 50 °C temperature • If detachable electrodes: spare electrode • Electrode cleaning solution • Operating manual		
	pH meter calibration solution set, pH 4, 7, 10 (or + 0.01); 500 mL each		1 set
	Rack, drying, plastic or wood (for slides)		1
	Hydrochloric acid, concentrated		500 mL
	Sodium hydroxide pellets		100 g
	Microscope assumed; included in leukocyte counting above		Included in leukocyte counting
	Indian ink for cryptococcus		
	Indian ink suspension[4]		5 mL
[!]	***Gram stain***[2]		
	Bottle, swan-neck jet, plastic, 250 mL		4
	Box, slide, plastic, for 50 slides		1
	Reference books/guidelines		1
	Lamp, spirit, metal with wick		1
	Lamp spirit, wicks		10
	Rack, drying, plastic or wood (for slides)		1
	Microscope assumed; included in leukocyte counting above		Included in leukocyte counting
	Consumables		
	General		
	Container, sharps, 5 L, cardboard for incineration	1	
	Gloves, examination, non-latex, disposable, large/medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate.* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	50	
	Applicator stick, wooden, box of 100	1	
	Bag for hazardous waste	10	
	Bag, autoclave, 20 L	10	
	Bleach (household 5%) or commercial. Refer to Chapter 5[d]	2 L	
	Disinfectant solution, hand-washing, waterless cleaner	500 mL	

	Disinfectant, commercial, directed against viruses[d]	500 mL
	Ethanol, 70% v/v[d]	1 L
	Film, sealing plastic (parafilm) roll, 10 cm × 38 m	1
	Filter paper, circles, 12:5 cm, general purpose	10
	Paperclips, package	1
	Pen, ball-point, black	2
	Pen, ball-point, red	1
	Pen, permanent marker, black	2
	Pen, permanent marker, red	2
	Pipettes, transfer, non-sterile, polyethylene, 3 mL, 0.5 mL graduation	120
	Request forms	As required
	Toilet paper, rolls	2
	Glucose and protein	
	Chemistry test, kit, glucose	60
	Chemistry test, kit, protein, CSF-range	60
	Test cuvettes compatible with the spectrophotometer	60
	Pipette, automatic 10–200 µl tip	200
	Pipette, automatic, 100–1000 µl tip	100
[!]	***Differential count***[2]	
[A]	Leishman stain, high quality (or Wright or May–Grünwald/Giemsa stain)	250 mL
	Buffer tablets, pH7.0	2[5]
	Bottled water	2 L
	Slide, 76 × 26 mm, 1–1.2 mm thickness, frosted ends both sides	60
	Box, slide, plastic (for 50 slides)	1
	Indian ink for cryptococcus	
	Slide, 76 × 26 mm, 1–1.2 mm thickness, frosted ends both sides	60
[!]	***Gram stain***[2]	
	Commercial Gram stain kit (preferred)	Depends on volume of the commercial kit[6]
	Microscope slides, 76 × 26 mm, 1–1.2 mm thickness, frosted ends	60
	Lamp fuel; denatured alcohol or equivalent	50 mL
[O]	***Cryptococcus serology***	
	Commercial cryptococcus antigen detection test, kit (serology)	60

	Quality/safety	
	Chemistry quality control reagents, assayed, lyophilized	Minimum two levels of analyte. Sufficient volume for period programme will operate[7]

[gs] General storage
[s] Staining
[d] For disinfection
[1] Preferably the buckets themselves should remain the same size and only the inserts changed for different uses.
[2] May be omitted if the same testing is already performed by the laboratory.
[3] Alternatively a Fuchs–Rosenthal counting chamber and cover-slips
[4] Test ampoules containing Indian ink (colloidal carbon) are available.
[5] Assumes 1 tablet prepares 1 L buffer solution
[6] Often sufficient for 200–250 stains
[7] Check with manufacturer. Generally one vial can be used over a period of one week. Assuming a minimum packaging size of 25 vials, one set would be sufficient for four months.

Module 5r: Gram stain

[I]	Description/instructions	100 tests	Once only
	Gram staining using a core laboratory		
[R]	**Recommendations**		
	For emergency responses it is recommended to use staining kits. Programmes that prefer to use individual stains should substitute the individual stains crystal violet, iodine and Safranin (or neutral red), plus the decolourizer of choice (acetone or ethanol 95% v/v)[1]		
	Collection		
	None (clinical procedure)		
	Equipment and low-use consumables		
	Bottle, swan-neck jet, plastic, 250 mL		4
	Box, slide, plastic, for 50 slides		2
	Reference books/guidelines		1
	Lamp, spirit, metal with wick		1
	Consumables		
	Commercial Gram stain kit (preferred)	Depends on volume of the commercial kit[2]	
	Microscope slides, 76 × 26 mm, 1–1.2 mm thickness, frosted ends	120	
	Sterile swabs	120	
	Lamp spirit, wicks	2	
	Lamp fuel; denatured alcohol or equivalent	250 mL	
	Sharps container, large	1	

[1] Acetone-alcohol is recommended. Some workers prefer to use acetone by itself, ethanol 95% v/v, or ethanol-iodine as the decolourizing solution.
[2] Often sufficient for 200–250 stains

Module 5s: Wet mount

[I]	Description/instructions	100 tests	Once only
	Wet mount examination using a core laboratory		
	Collection		
	None (clinical procedure)		
	Consumables		
	Microscope slides, 76 × 26 mm, 1–1.2 mm thickness, frosted ends	120	
	Cover glass, 22 × 22 mm	120	
	Sharps container, large	1	
	Physiological saline solution, sodium chloride, 0.9%, 1 L. Alternatively clinical infusion physiological saline packs	50 mL	

Module 5t: Stool examination for ova, cysts and parasites – microscopy

[I]	Description/instructions	100 tests	Once only
	Direct sample microscopy examination of stool samples for ova, cysts and parasites using a core laboratory		
	Collection		
	Containers (for stool), polypropylene, 60–120 mL capacity, wide-neck	120	
	Equipment and low-use consumables		
	Lugol's iodine (solution 0.3%), 1 L		1
[O]	Eosin powder (red), indicator grade, 25 g pack or solution		1
	Physiological saline solution, sodium chloride, 0.9%, 1 L. Alternatively clinical infusion physiological saline packs		2
	Reference books/guidelines		1
	Bottle, dropper, polypropylene, brown with lid, 60 mL		2
	Bottle, dropper, polypropylene, clear with lid, 60 mL		1
	Bin, waste, 10 L		1
	Consumables		
	Slides, 76 × 26 mm, 1–1.2 mm thickness, plain	240	
	Cover glass, 22 × 22 mm	240	
	Plastic bin liners, disposable, 10 L	5	
	Applicator sticks	200	
	Autoclave bags	5	

Module 5u: Prenatal testing

Test	Select Module(s)	
Haemoglobin	5c, 5d or 5e	
Urinalysis	5x or 5y	
Syphilis	5k or 5l	
Infectious diseases	5i or 5j	
Malaria	5m	Also 5n (microscopy) depending on national protocol

Module 5u-SA: Prenatal testing – stand-alone

Test	Select Module(s)	
Haemoglobin	5c-SA	
Urinalysis	5x	
Syphilis	5k-SA	
Infectious diseases	5i-SA	
Malaria	5m-SA	Also 5n-SA (microscopy) depending on national protocol

Module 5v: Trauma

[!]	Description/instructions	100 tests	Once only
	Laboratory testing for trauma using a core laboratory It is assumed that the laboratory testing performed by this module will be supported by skilled technical staff/advisers. This module is therefore intended to be modified according to the specific testing required by the setting, and according to the manufacturer's requirements for specific instrumentation This module requires blood transfusion and potentially donor blood collection		
[!]	**Cautions**		
	This module uses venous blood that may be acceptable; confirm with clinical staff. Alternatively the blood gas and pH testing can be performed on arterial blood; this would require the required consumables to be supplied by the clinical unit Some instrumentation may require an operating ambient temperature of < 30 °C		

	This module provides one instrument of each type. In some settings it may be more effective to provide additional instruments. Adjust accordingly		
[R]	**Recommendations**		
	It is strongly recommended to select Point of Care (POC) hand-held equipment, capable of performing the following tests simultaneously (<10 minutes) pH pressure of carbon dioxide (pCO2) pressure of oxygen (pO2) total carbon dioxide (tCO2) bicarbonate (HCO3) base excess (BE) arterial saturation of oxygen (sO2) sodium (Na) potassium (K) haemoglobin/haematocrit (Hgb/Hct)		
	Collection		
	Add Module 2c: Venepuncture blood sample collection and multiply the quantities by the expected total number of patients (if not supplied in the testing kit) and additionally include a 20% safety margin	120	
	Equipment and low-use consumables		
	Hand-held multipurpose analyser capable of performing the following: pH pressure of carbon dioxide (pCO_2) pressure of oxygen (pO_2) total carbon dioxide (tCO_2) bicarbonate (HCO3) base excess (BE) arterial saturation of oxygen (sO2) sodium (Na) potassium (K) haemoglobin/haematocrit (Hgb/Hct)		1
[A]	Hand-held rapid prothrombin time (INR) analyser reagent cartridge for prothrombin time (PT) *and/or* activated clotting time (ACT)		1

[O] **[A]**	Add Module 5c: Haemoglobin meter, portable, 5d: Haemoglobin spectrophotometer/colorimeter – laboratory instrument or 5e: Automated haematology instrument as required		1
	Instrument manuals		As required
	Consumables		
	Reagents/cartridges compatible with selected instruments	120	
	Pipettes, transfer, 3 mL	120	
	Additional consumables required by the instrument manufacturer	As required	
	Quality/safety		
	Quality control standards appropriate for the instrument	1 set	

Module 5w: Tuberculosis – direct sputum examination – acid fast bacilli

[I]	Description/instructions	100 tests	Once only
	Direct sputum smear examination for acid fast bacilli using a core laboratory		
	Important: this module is designed for 100 tests. Diagnostic and follow-up protocols may require two or three tests (sputum samples examined) per patient. Provision also needs to be made for the testing of additional sputum samples in cases where patients initially provide unsatisfactory samples (such as saliva). Because of these variables each programme should estimate the number of tests that need to be performed for the estimated number of patients to be screened and followed-up		
	Sputum concentration is not covered by this module		
[!]	**Cautions**		
	Supervising sputum collection and the preparation of sputum smears is hazardous. Expectorating sputum and the manipulation of wet sputum samples can create infectious aerosols that can infect clinical and laboratory staff with pulmonary tuberculosis. Staff exposed to sputum collection or preparation must wear specifically designed protective face masks at all times. It is also extremely important to ensure that other persons in the general vicinity are also not exposed to infectious aerosols		
[R]	**Recommendations**		
	Sputum collection and smear preparation should be performed outside in the open air and not inside a building. When it is not possible to prepare sputum smears in an out-of-doors location (such as in cold climates) then the laboratory must be equipped with a correctly constructed safety cabinet which expels infectious aerosols outside of the building		
	HEPA filtration is not generally recommended for sputum smear preparation. An exhaust extraction safety cabinet is recommended when required		
	Collection		
	Sterile sputum container, wide necked, leak-proof, 50 mL, with screw-cap, labelled "Sterile"	120	
	Equipment and low-use consumables		
[O]	Cold box, leak-proof (for storage and transport of samples to laboratory)		2

	Micro-loop, Pasteur, loop handle, nickel chromium (dedicated)		2
	Micro-loop, Pasteur, nickel/chromium		4
	Storage bottle, open neck, large opening (to contain coarse sand/phenol mix for loop cleaning)		2
	Pen, diamond tip, metal handle (avoid retractable-point pen)		2
	Bottle, swan-neck jet, plastic, 250 mL		6
	Forceps for slides; stainless steel, 150 mm, Kühne		2
	Funnel, plastic, 90 mm diameter, short end		2
	Lamp, spirit with wick		1
	Timer, mechanical, 1–60 minutes (dedicated)		2
	Rack for drying slides, vertical, plastic 10 slides		2
	Slide-holder, flat, capacity 20 slides		6
[O]	Safety cabinet, at a minimum fitted with effective extractor fan and exhaust system.		1
[O]	Plate cooking, metal, ribbed surface, with handle, shallow tray construction with shallow walls, minimum size 15 × 20 cm (used by some programmes for staining)		1
	Tally counter, hand, manual, plastic- or metal-cased		2
	Phenol		1 kg
	Protection paper for bench, non-absorbent/ polyethylene, 50 cm × 50 m (additional to general laboratory supplies)		4 metres/ day for each working day the programme will operate
	Waste receptacle, stainless steel, 12 L		1
	Consumables		
	Mask, microdroplet protection, meeting or exceeding the N95 standard respiratory mask	1 mask per day for staff preparing sputum smears + 1 mask per patient for staff supervising collection	
	Autoclave bags or non-leak bags suitable for incineration	5	

	Box, slide; plastic, for 50 slides	3	
[A]	Alternative sputum smear preparation methods:		
	Micro-loop, Pasteur, nickel/chromium	1	
	or		
	Disposable plastic loops	120	
	or		
	Depressor, tongue, wooden	60	
	or		
	Applicator sticks	500	
	Slide, 76 × 26 mm, 1–1.2 mm thickness, plain	120	
	Lamp, spirit, fuel (denatured alcohol) or ethanol, denaturated, 70%, (fuel for heating slides)	200 mL	
	Lamp, spirit, wick, spare	2	
	Carbol-fuchsin, Ziehl–Neelsen solution, commercial	400 mL	
	Methylene blue, Kinyoun stain, commercial	400 mL	
	Tuberculosis decolourizer, commercial[1]	1.5 L	
	Microscope, immersion oil, non-drying high quality	50 mL	
	Filter paper, sheet, large, general purpose	10	
	Toilet paper, roll	2	
	Quality/safety		
	Box, slide; plastic, for 50 slides		1 for each month the programme will operate

[1] Alternatively, a 1 L bottle of denaturated 95% ethnol and a 1 L bottle of 37% hydrochloric acid can be used to make the decolourizer. Acid-alcohol 3% v/v is used as a decolourizer. This is a 3% v/v hydrochloric acid solution in 70% v/v alcohol. Needed: ethonol or methanol, absolute 680 mL; distilled water 290 mL; hydrochloric acid, concentrated 30 mL. Prepare and place in a 1 L bottle.

Module 5w-SA: Tuberculosis – direct sputum examination – acid fast bacilli – stand-alone

[I]	Description/instructions	100 tests	Once only
	Direct sputum smear examination for acid fast bacilli as a stand-alone Important: this module is designed for 100 *tests*. Diagnostic and follow-up protocols may require two or three tests (sputum samples examined) per patient. Provision also needs to be made for the testing of additional sputum samples in cases where patients initially provide unsatisfactory samples (such as saliva). Because of these variables each programme should estimate the number of tests that need to be performed for the estimated number of patients to be screened and followed up Sputum concentration is not covered by this module Refrigeration may be required if samples are also to be referred to a reference laboratory. See Group 1 modules for energy requirements *Waste disposal* An incinerator does not need to be included in the laboratory module if the laboratory has access to a general programme incinerator. The requirement for an autoclave will depend on the national protocol for the disposal of infectious materials. There will also need to be provision for the waste disposal of stains		
[!]	**Cautions**		
	Supervising sputum collection and the preparation of sputum smears is hazardous. Expectorating sputum and the manipulation of wet sputum samples can create infectious aerosols that can infect clinical and laboratory staff with pulmonary tuberculosis. Staff exposed to sputum collection or preparation must wear specifically designed protective face masks at all times. It is also extremely important to ensure that other persons in the general vicinity are also not exposed to infectious aerosols		

[R]	**Recommendations**		
	Sputum collection and smear preparation should be performed outside in the open air and not inside a building. When it is not possible to prepare sputum smears in an out of doors location (such as in cold climates) then the laboratory must be equipped with a correctly constructed safety cabinet and with infectious aerosols expelled to the outside of the building.		
	HEPA filtration is not generally recommended for sputum smear preparation. An exhaust extraction safety cabinet is recommended when required		
	Microscope(s)		
	The efficiency of the laboratory will often be dependent on the number of available microscopes. Depending on the workload and setting it is recommended that one microscope be provided for each laboratory staff member who will perform microscopy		
	Refrigerator (if required)		
	To minimize power consumption, select the smallest size refrigerator according to the anticipated requirements of the laboratory Generally a medium size (for example 140 L or thereabouts) is suitable		
	An electric refrigerator should be selected whenever possible. If an electric refrigerator is not feasible then a gas-powered refrigerator is recommended in preference to a kerosene refrigerator		
	Collection		
	Containers, wide mouthed polypropylene (for sputum), screw-cap, leak-proof, 60 mL capacity, non-sterile	120	
	Equipment and low-use consumables		
[O]	Cold box, leak-proof (for storage and transport of samples to laboratory)		2
	Micro-loop, Pasteur, loop handle, nickel chromium (dedicated)		2
	Micro-loop, Pasteur, nickel/chromium		4

	Storage bottle, open neck, large opening (to contain coarse sand/phenol mix for loop cleaning)	2
	Pen, diamond, metal handle (avoid retractable point pen)	2
	Bottle, swan-neck jet, plastic, 250 mL	6
	Forceps for slides; stainless steel, 150 mm, Kühne	2
	Funnel, plastic, 90 mm diameter, short end	2
	Lamp, spirit with wick	1
	Timer, mechanical, 1–60 minutes, with ringer (dedicated)	2
	Rack for drying slides, vertical, plastic 10 slides	2
	Slide-holder, flat, capacity 20 slides	6
[O]	Safety cabinet, at a minimum fitted with effective extractor fan and exhaust system	1
[O]	Plate, cooking, metal, ribbed surface, with handle, shallow tray construction with shallow walls, minimum size 15 × 20 cm (used by some programmes for staining)	1
	Tally counter, hand, manual, plastic- or metal-cased	2
	Phenol	1 Kg
	Protection paper for bench, non-absorbent/ polyethylene, 50 cm × 50 m (additional to general laboratory supplies)	4 metres/day for each working day the programme will operate
	Basin, plastic, diameter 285–310 mm[s]	1
	Beaker, glass, low form, spouted, 100 mL	2
	Beaker, glass, low form, spouted, 500 mL	2
	Beaker, plastic, low form, spouted, 1000 mL	1
	Beaker, plastic, spouted, 50 mL	2
	Binocular light microscope *Recommended minimum specifications:* • Strong construction, stable base • Optics anti-fungus treated • Binocular head inclined to approximately 30°, and rotatable for 360° and adjustable for inter-pupillary distance • Condenser, Abbe type with iris and filter holder • Centring screws or an alternative system provided by the manufacturer	Dependent on workload. Recommended: 1 for each laboratory technical staff who will perform microscopy reading

- Blue filter
- 10× eyepieces widefield (FN 18) with tube caps
- Rubber eye shelters for both eye pieces
- 100× oil immersion (spring-loaded) objective, minimum NA 1.25
- Parfocal DIN infinity-corrected plan achromat, 10×, 40× (spring-loaded) objectives, minimum 10×/NA 0.25, 40×/NA 0.65, 100×/NA 1.25.

Power supply: supply voltage: 110/230 V AC; battery-powered: minimum three hours of operation at full intensity per battery charge; low battery warning

Accessories: 1 battery charger or mains adaptor
1 battery pack, rechargeable
1 connection lead with car adapter 12 V DC/crocodile clamps and optionally operated on a solar panel

Illumination

- Illumination unit with graduated lamp brightness control, light source: halogen lamp (luminous flux: minimum 700 lm; 20 W)
  or
  white LED lamp (luminous flux: minimum 700 lm, service life: minimum 15 000 hours)
  and
  back-up (daylight) mirror unit, plane and concave, mounted for angling and rotating
  and
  spare bulbs: three spare bulbs (if halogen)
- Coaxial fine and coarse focus controls on both sides
- A built-in stage with a mechanism for mounting object slide. Fixed graduated mechanical and coaxial controls
- Supplied with non-drying immersion oil
- Dust cover

Bottle, high density polyethylene, brown, screw-cap, 500 mL[gs]	4
Bowl, plastic	2
Broom	1
Brush – scrubbing brush	2
Bucket, metal, 10–12 L	2
Calculator	1
Calculator batteries, spare	4

	Clock, wall-mounted	1
	Cylinder, with clear graduations, polypropylene, spout, 10 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 50 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 100 mL	2
	Cylinder, with clear graduations, polypropylene, spout, 1 000 mL	1
	Eye-shield (goggles, clear shatter-resistant polycarbonate and fitted with side shields)	2
	Fire blanket	1
	Fire extinguishers, multipurpose dry chemical or carbon dioxide powder models	1
	First aid kit	1
	Funnels, polypropylene, 65 mm diameter	2
	Funnels, polypropylene, 90 mm diameter	2
	Gloves, rubber, heavy duty (for cleaning)	2
	Microscope, lens-cleaning paper, sheet	200
	Microscope, lens-cleaning solution	1 L
	Microscope, lint-free cleaning cloth	2
	Microscope, dropper bottle for immersion oil, 50 mL	2
	Microscope, fuses	4
	Microscope, halogen lamps as specified by the microscope manufacturer (not needed if LED microscope)	4
	Mop	1
	Pipette filler, with thumb-wheel lever, (Pi-pump) green 10 mL	1
	Pipettes, graduated, polypropylene, 1 mL	5
	Pipettes, graduated, polypropylene, 10 mL	5
	Pipettes, graduated, polypropylene, 5 mL	5
	Rack, drying, plastic or wood (for slides)	2
[O]	Refrigerator *Minimum specifications:* • Size: 140 L (size may vary based on the needs at the site) • Internal air temperature; 2 °C to 10 °C • One-year manufacturer's guarantee	1

• Important: should have a separate freezer compartment, non-automatic defrost (not a freezer located inside the refrigerator cabinet) • Electric, compression type, 110/230 V AC, standard electric *or* Electric, compression type, photovoltaic *or* Gas powered *or* Kerosene powered		
Rod, glass, 250 mm, diameter 6–7mm		2
Rods, stainless steel adjustable length rods (for slide staining) in holders with levelling screws, for fitting across sink, minimum length 290 mm[s]		1 set
Ruler, 30 cm		2
Slide holder, cardboard, flat, capable of holding 20 slides		10
Slide mailer, polyethylene or cardboard, with integral push-in lid		10
Spatulas, polypropylene, length 100 mm		2
Stapler, paper, hand-held		1
Tool kit consisting of screwdrivers (Phillips and standard), set of spanners (wrenches) 5–17 mm, pliers (needle nose and standard), jeweller's screwdriver set, hacksaw, adjustable spanner, hammer		1 set
Water purification, brush, stiff bristles (to clean filters)		1
Water purification, gravity water filter, 10 L fountain, four self-sterilizing ceramic elements (candle filter)		1
Water purification, spare candle filter, 18 cm		2
Water storage container, polyethylene, 20 L, with handle and removable tap		1
Waste receptacle, stainless steel, 12 L		1
Consumables		
Mask, microdroplet protection, meeting or exceeding the N95 standard respiratory mask	1 mask per day for staff preparing sputum smears + 1 mask per patient for staff supervising collection	

	Autoclave bags or non-leak bags suitable for incineration	5
	Box, slide; plastic, for 50 slides	3
[A]	Alternative sputum smear preparation methods:	
	Micro-loop, Pasteur, nickel/chromium	1
	or	
	Disposable plastic loops	120
	or	
	Depressor, tongue, wooden	60
	or	
	Applicator sticks	500
	Slide, 76 × 26 mm, 1–1.2 mm thickness, plain	120
	Lamp, spirit, fuel (denatured alcohol) or ethanol, denaturated, 70%, (fuel for heating slides)	200 mL
	Lamp, spirit, wick, spare	2
	Carbol-fuchsin, Ziehl–Neelsen solution, commercial	400 mL
	Methylene blue, Kinyoun stain, commercial	400 mL
	Tuberculosis decolourizer, commercial[l]	1.5 L
	Microscope, immersion oil, high quality	50 mL
	Filter paper, sheet, large, general purpose	10
	Bag for hazardous waste	5
	Bag, autoclave, 20 L	5
	Bags, plastic bags, self-sealing, medium size	10
	Bags, plastic, self-sealing, small	510
	Bleach (household 5%) or commercial. Refer to Chapter 5 and Annex 16[d]	1 L
	Disinfectant solution, hand-washing, waterless cleaner	1 L
	Ethanol, 70% v/v[d]	100 mL
	Eye wash, solution, 1 bottle + eye cup	2
	Film, sealing plastic (parafilm) roll, 10 cm × 38 m	2
	Filter paper, circles, 12:5 cm, general purpose	10
	Gloves, examination, non-latex, disposable, large/ medium/small *Size requirements vary from country to country – select distribution of large, medium and small as appropriate* Quantity: five pairs of gloves for each laboratory staff member per day. As a guideline, 12 boxes for two staff for three months	According to setting
	Paperclips, package	100
	Pen, ball-point, black	2

	Pen, ball-point, red	1
	Pen, permanent marker, black	1
	Pen, permanent marker, red	1
	Protective clothing, laboratory coats or gowns	According to setting
	Minimum two per staff member	
	Registration books for recording patient details and test results. Standard registration books used in-country *or* Exercise books, A4, ruled, preferably hard-backed	Quantity to be determined according to the projected patient numbers, and whether separate registration books are used for different tests
	Request forms	As required
	Staples, size compatible with stapler	100
	Steel wool pads, non-detergent[c]	10
	Toilet paper, roll	2
	Quality/safety	
	Box, slide; plastic, for 50 slides	1 for each month the programme will operate

[l] Alternatively: ethanol, denaturated, 95%, 1 L, bottle and hydrochloric acid, 37%, 1 L, bottle can be used to make the decolourizer.
[c] Cleaning
[d] For disinfection
[gs] General storage
[r] It is recommended that the temperature of the refrigerator should be monitored using a thermometer immersed in a container of glycerol. This provides a better measurement of the core temperature of the contents of the refrigerator rather than the air temperature.
[s] Staining

Note: a microscope with LED attachment, when available, would enable acid-fast bacilli (AFB) to be rapidly detected, using auramin phenol stained sputum smear.

Module 5x: Urinalysis – test strips only

[I]	Description/instructions	100 tests	Once only
	Urine analysis by test strips only, using a core laboratory or stand-alone This module uses extended testing urine test strips; adjust according to programme needs		
	Collection		
	Container (for urine), plastic, non-sterile, 20–60 mL capacity, a wide-neck universal is suitable	120	
	Equipment and low-use consumables		
[O]	Refractometer		1
	Waste bin		1
	Consumables		
	Urinalysis test strips for: pH, density (specific gravity), protein, glucose, ketones, blood, nitrite, leucocytes (one strip)[1]	120	
	Quality/safety		
	Reference chart and text, urine sediment		1
	Urinalysis quality control for test strips, two levels	1 set for the period of time specified by the manufacturer	

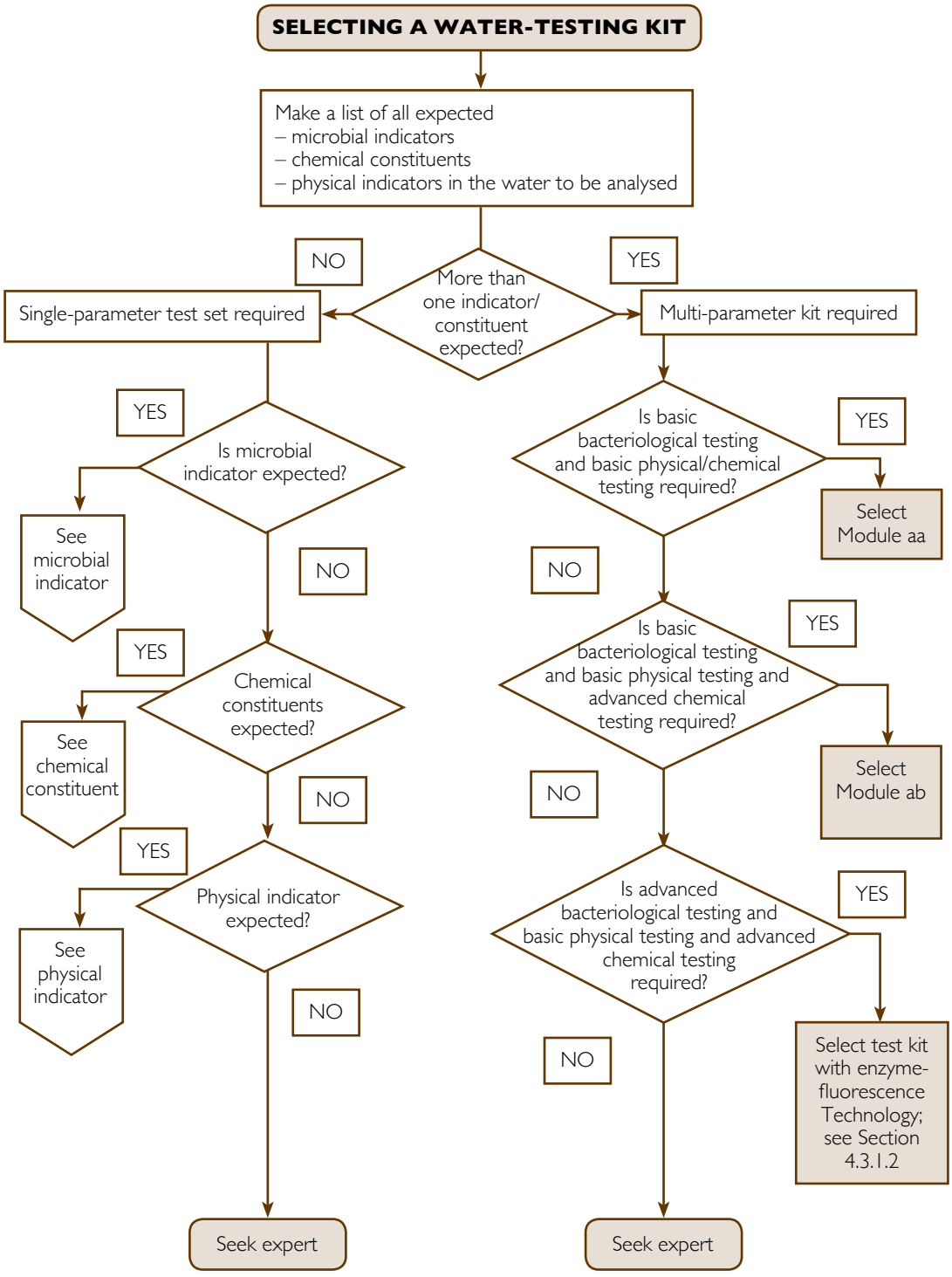
[1] Depending on the situation, a strip for only glucose, blood, protein and pH may be warranted.

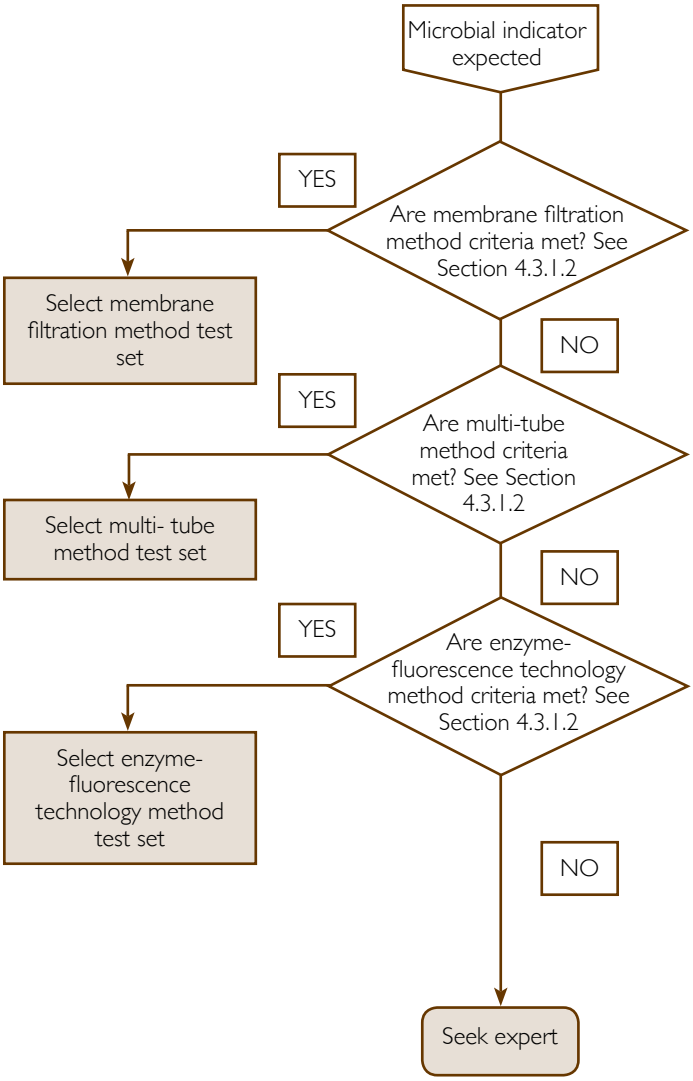
Module 5y: Urinalysis – by test strips and sediment

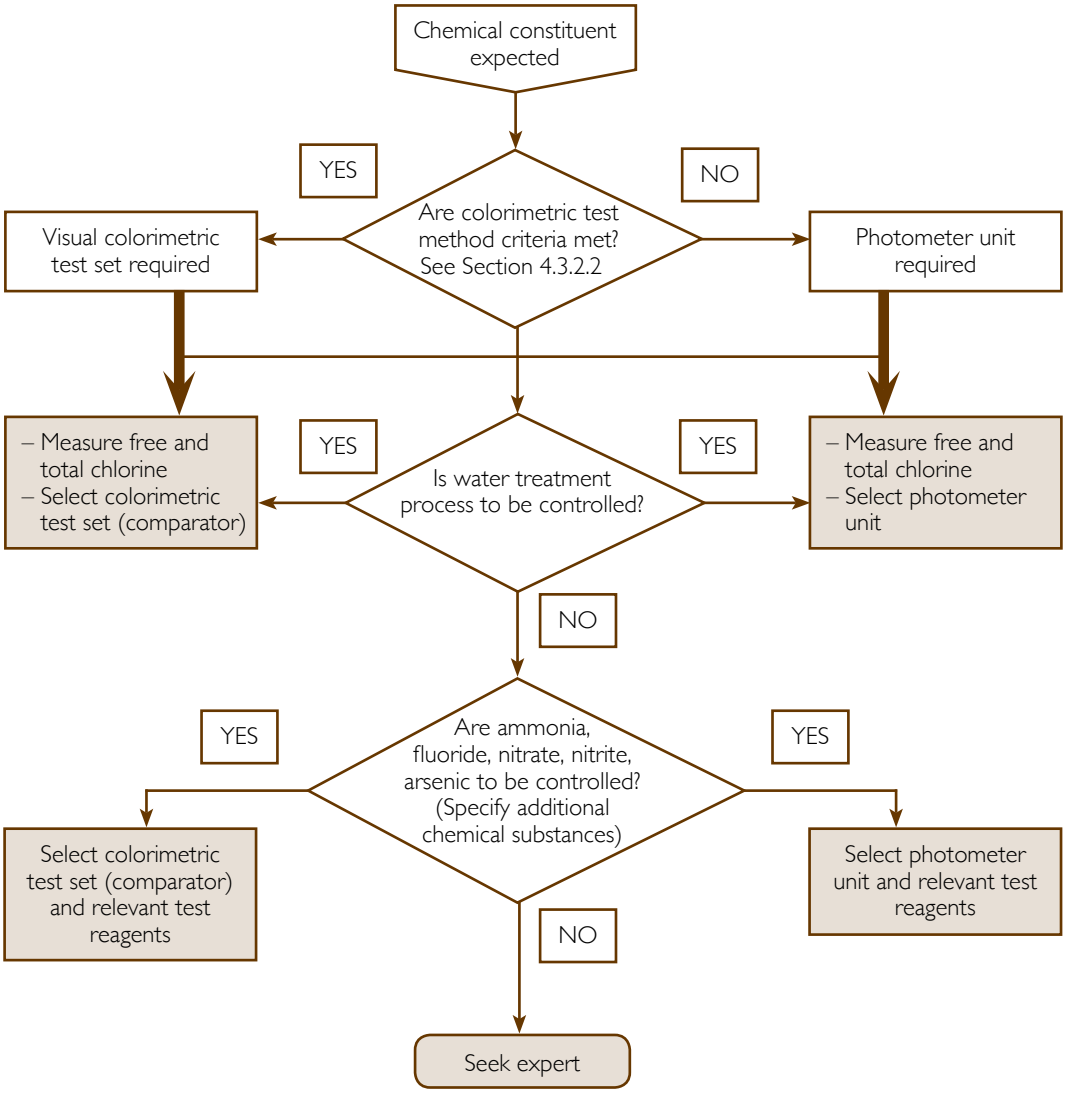
[I]	Description/instructions	100 tests	Once only
	Urine analysis by test strips and sediment using a core laboratory This module uses extended testing urine test strips; adjust according to programme needs		
	Collection		
	Container (for urine), plastic, non-sterile, 20–60 mL capacity, a wide-neck universal is suitable	120	
	Equipment and low-use consumables		
[O]	Refractometer		1
	Test tube rack, for 15 mL conical tubes, with caps	2	
	Transfer pipettes, nonsterile, polyethylene 3 mL	120	
	Tubes, 15 mL, conical bottom, with caps	50	
	Waste bin		1
	Consumables		
	Urinalysis test strips for: pH, density (specific gravity), protein, glucose, ketones, blood, nitrite, leucocytes (one strip)[1]	120	
	Slides, 76 × 26 mm, 1–1.2 mm thickness, plain, frosted ends	120	
	Cover glass, 22 × 22 mm	120	
	Sharps container, small	1	
	Quality/safety		
	Reference chart and text, urine sediment		1
	Urinalysis quality control for test strips, two levels	1 set for the period of time specified by the manufacturer	

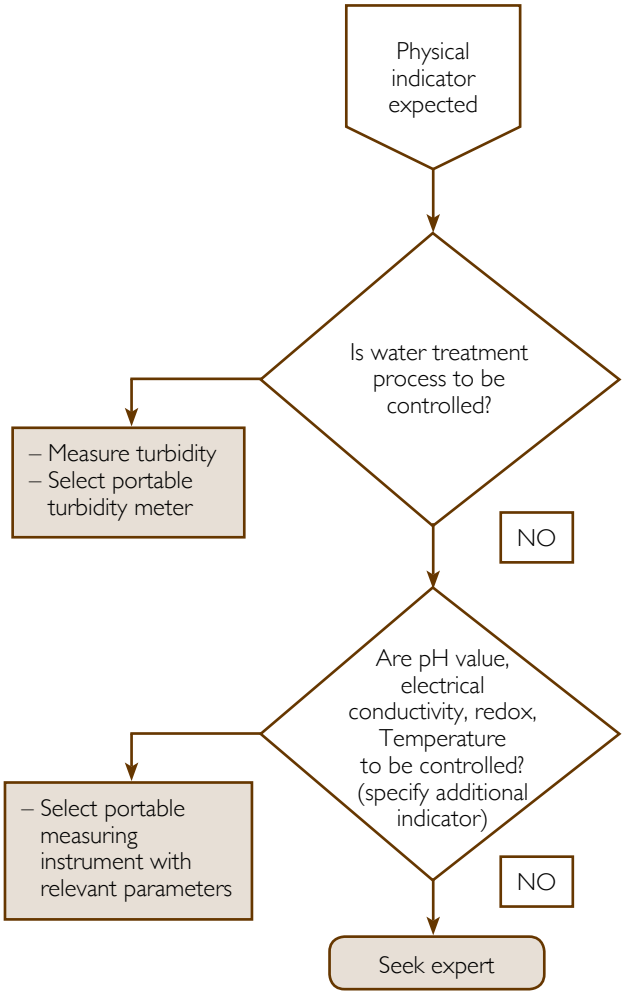
[1] Depending on the situation, a strip for only glucose, blood, protein and pH may be warranted.

Modules aa, ab, ac: water-testing




Microbial indicator expected
Are membrane filtration method criteria met? See Section 4.3.1.2
YES
Select membrane filtration method test set
NO
Are multi-tube method criteria met? See Section 4.3.1.2
YES
Select multi- tube method test set
NO
Are enzyme-fluorescence technology method criteria met? See Section 4.3.1.2
YES
Select enzyme-fluorescence technology method test set
NO
Seek expert


Chemical constituent expected
Are colorimetric test method criteria met? See Section 4.3.2.2
YES
NO
Visual colorimetric test set required
Photometer unit required
– Measure free and total chlorine
– Select colorimetric test set (comparator)
Is water treatment process to be controlled?
YES
YES
– Measure free and total chlorine
– Select photometer unit
NO
Are ammonia, fluoride, nitrate, nitrite, arsenic to be controlled? (Specify additional chemical substances)
YES
YES
Select colorimetric test set (comparator) and relevant test reagents
Select photometer unit and relevant test reagents
NO
Seek expert


Physical indicator expected
Is water treatment process to be controlled?
– Measure turbidity
– Select portable turbidity meter
NO
Are pH value, electrical conductivity, redox, Temperature to be controlled? (specify additional indicator)
– Select portable measuring instrument with relevant parameters
NO
Seek expert

Module aa: Water-testing – bacteriological testing and basic physical/chemical tests

Test volume: 200 microbiological tests and 250 tests for free and total chlorine

The kit should enable testing for:

- faecal indicator bacteria: thermotolerant (faecal) coliforms and total coliform bacteria (using membrane filtration technique)
- pH, turbidity, temperature
- chemical testing for free and total chlorine.

[I]	**Alternatives and variations**	
	The proposed kits are stand-alone kits to be used over an extended area. Should your organization want to keep the kit in one location and bring water samples back from the field for analysis you may order a model that operates directly from the electric mains supply The proposed basic kit performs at incubator setting of 44°C for testing of thermotolerant coliform bacteria Should it be necessary to additionally test for total coliform bacteria, select a combined incubator for 44°C and 37°C	
[R]	**Recommendations**	
	In many emergencies a water-testing kit (used to test for faecal indicator bacteria) will be needed urgently. Ask the supplier/manufacturer: – if the kit could be delivered immediately – how many kits are available in stock (additional kits may be needed)	
	Equipment and low-use consumables	**Quantity**
	Water-testing kit, with single incubator set at 44°C, for testing thermotolerant coliform bacteria, portable, battery-powered *Minimum specifications:* • Carry-case, plastic or aluminium • Battery charger/mains power unit, 110/230 V (state voltage needed) • Electric cable for operation of incubator via vehicle cigarette lighter • Filtration apparatus, complete kit including wire cable and clip supplied for fastening to the sampling cup • Petri dishes, aluminium, with strap/rack, sets (16 or 18 reusable) • Rack for Petri dishes • Temperature/incubator calibration kit including: spirit thermometer (–10°C to 50°C), lid for calibration, small • Screwdriver for trimming • Bottles, polypropylene, 100 mL (× 10) or 50 mL (× 4) set • Colour comparator, for measuring chlorine and pH (for digital pH meter: see Optional items) • Turbidity tubes (× 2) to measure 5 to 2000 NTU (or in some modules to 500)	1

- Hand lens
- Lubrication grease (silicone)
- Timer
- Tweezers/forceps (for holding membranes)
- Spares kit for filtration apparatus, including: sealing gaskets/silicone rings (pair), bronze disc, black rubber O-ring and silicone grease
- Operating manual
- Operating instructions for the colour comparator

Optional items

- Rucksack/carry sack
- Dispenser (for methanol)
- Deionizer pack, for field preparation of de-ionized water for chemical test dilutions
- Media measuring device (MMD), used to make up enough media for 10 tests at a time (× 5), one set
- pH/temperature meter (including pH buffers, 50 mL, for pH4 and pH7), digital pocket type, with operating instructions
- For quick preparation:
- pre-prepared media in sterile ampoules (2 mL of dissolved media)
- pre-prepared media in disks (with dehydrated membrane lauryl sulphate broth)
- Instructional CD ROM

Recommended items to include

- Measuring cylinder or beaker, 500 mL (separate purchase)
- Pasteur pipettes (× 5)
- Ball-point pen
- Cigarette lighter
- Pencil (wax) or permanent marker pen
- Electric cable with crocodile clips for operation of incubator via mobile battery
- Fuses for charger, set (× 2)
- Spare batteries for: pH meter (when included)

Consumables	
Membrane filters, individually sterile and wrapped, 200 a pack	1
Membrane pads, 100 a pack	2
Pad dispenser	1
Culture medium, membrane lauryl sulphate broth (MLSB), 38.1 g or 500 g container	1
DPD (N,N diethyl-p-phenylenediamine sulfate), no. 1 Tablets (× 250)	1
DPD, no. 3 tablets, packet of 250	1
Phenol red tablets (if the comparator also measures pH), packet of 250	1
Methanol, 1 L	1
Colour discs (for colour comparator system) and tablet reagents for the following test: chlorine (minimum 250 tests), set	1

Module ab: Water-testing – bacteriological testing and basic physical/ advanced chemical tests

Test volume: 200 micro-biological tests and 250 tests each for free and total chlorine, arsenic, ammonia, fluoride, nitrate and nitrite

The kit should enable testing for:

- faecal indicator bacteria: thermotolerant (faecal) coliforms and total coliform bacteria (using membrane filtration technique)
- pH, turbidity, temperature, conductivity
- chemical testing for: free and total chlorine, arsenic, ammonia, fluoride, nitrate, nitrite.

[I]	**Alternatives and variations**	
	The proposed kits are stand-alone kits to be used over an extended area. Should your organization want to keep the kit in one location and bring water samples back from the field for analysis you may order a model that operates directly from the electric mains supply The proposed basic kit performs at incubator setting of 44 °C for testing of thermotolerant coliform bacteria Should it be necessary to additionally test for total coliform bacteria, select a combined incubator for 44 °C and 37 °C Additional chemical tests are available with the comparator system. A comparator is able to determine the levels of free chlorine residual as well as total chlorine residual. A number of key parameters can be measured in water using test strips; the resulting colour is compared to a chart to determine the chemical levels. Multiparameter test strips are commercially available. Although they are good for screening purposes, test strips are usually not as accurate as liquid reagent testing.	
[R]	**Recommendations**	
	In many emergencies a water-testing kit (used to test for faecal indicator bacteria) will be needed urgently. Ask the supplier/manufacturer: • if the kit could be delivered immediately • how many kits are available in stock (additional kits may be needed)	
	Equipment and low-use consumables	**Quantity**
	Water-testing kit, with single incubator set at 44 °C, for testing thermotolerant coliform bacteria, portable, battery-powered	1

Minimum specifications:

- Carry-case, plastic or aluminium
- Battery charger/mains power unit, 110/230 V (state voltage needed)
- Electric cable for operation of incubator via vehicle cigarette lighter
- Filtration apparatus, complete kit including wire cable and clip supplied for fastening to the sampling cup
- Petri-dishes, aluminium, with strap/rack, sets (16 or 18 re-useable)
- Rack for Petri dishes
- Temperature/incubator calibration kit including spirit thermometer (–10 °C to 50 °C), lid for calibration, small screwdriver for trimming
- Bottles, polypropylene, 100 mL (× 10) or 50 mL (× 4) set
- Colour comparator, for measuring chlorine and pH (for digital pH meter: see Optional items)
- Turbidity tubes (× 2) to measure 5 to 2000 NTU (or in some modules to 500)
- Hand lens: folding pocket magnifyer x8 or x10
- Lubrication grease (silicone)
- Timer
- Tweezers/forceps (for holding membranes)
- Spares kit for filtration apparatus, including sealing gaskets/silicone rings (pair), bronze disc, black rubber O-ring and silicone grease
- Operating manual
- Operating instructions for colour comparator

Optional items

- Rucksack/carry sack
- Dispenser (for methanol)
- Deionizer pack, for field preparation of deionized water for chemical test dilutions
- Media measuring device (MMD), used to make up enough media for 10 tests at a time (× 5), one set
- pH/temperature meter, (including pH buffers, 50 mL, for pH4 and pH7), digital pocket type, with operating instructions
- For quick preparation:
- pre-prepared media in sterile ampoules (2 mL of dissolved media)
- pre-prepared media in disks (with dehydrated membrane lauryl sulphate broth media)
- Instructional CD ROM

Recommended items to include • Measuring cylinder or beaker, 500 mL (separate purchase) • Pasteur pipettes (× 5) • Ball-point pen • Diamond head pen to mark glass slides • Cigarette lighter • Pencil (wax) or permanent marker pen • Electric cable with crocodile clips for operation of incubator via mobile battery • Fuses for charger, set (× 2) • Spare batteries for pH meter (when included)	
Consumables	
Membrane filters, individually sterile and wrapped, 200 a pack	1
Membrane pads, 100 a pack	2
Pad dispenser	1
Culture medium, membrane lauryl sulphate broth (MLSB), 38.1 g or 500 g container	1
DPD (N,N diethyl-p-phenylenediamine sulfate), No. 1 tablets, packet of 250	1
DPD No. 3 tablets, packet of 250	1
Phenol red tablets (if the comparator also measures pH), packet of 250	1
Methanol, 1 L	1
Colour discs (for colour comparator system) and tablet reagents for the following tests: chlorine, arsenic, ammonia, fluoride, nitrate and nitrite (minimum 250 tests for each parameter), set	1
Conductivity, standard solution	1

Module ac: Water-testing – portable meters for basic physical tests

Individual portable meters for the following physical indicators:

- pH-value
- turbidity
- electrical conductivity
- temperature measurement is usually integrated in the above meters
- arsenic testing device, hand-held, digital type with operating instructions
- photometer, portable, digital type, direct reading (for testing many chemical parameters).

[I]	**Alternatives and variations**	
	The proposed meters are hand-held portable measuring devices for individual parameter testing, battery operated. Some manufacturers offer portable meters with more than one parameter	
	Equipment and low-use consumables	**Quantity**
	Portable pH meter Minimum measuring interval: 4–10 pH, resolution: 0.02 pH Temperature compensated measurement Calibratable Large-format digital display Rugged casing Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low battery warning Auto shut-off after 10 minutes of non-use Ambient conditions: up to 90% humidity (non condensing), 0 °C to 50 °C temperature Operating manual 2 pH electrodes (1 spare, if detachable) Electrode cleaning solution Calibration solutions (pH calibration buffer pouch kit, pH range 4.00, 7.00, 10.00), 500 mL each *Consumables for pH meter* 1 spare pH-electrode (if detachable) 1 electrode cleaning solution Calibration solutions (buffer solutions 1, 2 and 3) 500 mL each	1
	Portable turbidity meter Measuring interval: 0–50 NTU (or higher) Resolution: 0.01 NTU Auto-ranging feature if different intervals for the measurements are available Calibration: 3 points Large-format digital display Rugged casing Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low-battery warning Auto shut-off after 10 minutes of non-use Ambient conditions: up to 90% humidity (non condensing), 0 °C to 50 °C temperature operating manual	1

Consumables for turbidity meter
5 sample cuvettes and caps
1 cuvette cleaning solution
1 bottle calibration solution, 500 mL

Portable conductivity meter — 1
Measuring range: 0–3 000 µS/cm
Resolution: 1 µS/cm
Temperature compensated measurement
Calibratable
Large-format digital display
Rugged casing
Battery type: standard size; operating hours per battery set: minimum 25 hours of continuous use or minimum 500 measurements; low-battery warning
Auto shut-off after 10 minutes of non-use
Ambient conditions: up to 90% humidity (non condensing), 0 °C to 50 °C temperature
Operating manual

Consumables for conductivity meter
1 spare electrical conductivity (EC) probe (if detachable)
1 probe cleaning solution
calibration solution, appropriate for chosen measuring interval, 250 mL

Arsenic testing device — 1
Hand-held, digital type with operating instructions

Photometer — 1
Portable, digital type, direct reading (for testing many chemical parameters)

7. Energy supply

7.1 General

Health laboratories in emergencies often face problems in the supply of the energy for their installations such as lighting, cooling and/or heating and for key items of laboratory equipment. Lack of fuel, erratic mains power supply and increasing complexity of the required equipment may lead to equipment failure. Frequently stand-by generators are used to solve these problems. However, results are often disappointing, because switching problems occur. The need for correct sizing, installation and regular maintenance of energy supply is often ignored. In remote areas with stand-alone power systems the supply voltage is often unstable. Earthing and lightning protection are mostly ignored under adverse emergency conditions.

This chapter will provide information to:

- identify potential sources of power problems
- foresee potential hazards and risks due to power problems
- select suitable equipment and protection methods.

See also the WHO Regional Publications, Eastern Mediterranean Series publication *Selection of basic laboratory equipment for laboratories with limited resources (14)*.

7.2 Use of laboratory equipment and its related energy demand

For the selection of appropriate laboratory equipment and their related energy sources it proves to be most useful to analyse the demand of energy under operating conditions of the equipment by means of a daily energy profile. Through careful planning the most economic combination of power supply system and laboratory equipment may be chosen. Table 7.1 provides a tool for a functional grouping of the equipment according to its use, the required level of availability and its daily period of operation. Locally obtainable energy sources can be allocated to each device. In conjunction with the rated power consumption of the equipment, the daily (electric) energy demand can be determined (see Section 7.4). From this analysis the output of a diesel generating set, the size of a photovoltaic system, the quantity of bottled gas, the capacity of a battery and many other technical parameters can be specified. Table 7.1 shows a completed daily energy profile sample form for a health laboratory in an emergency, with the allocation of the rated power of each device and by subsequent

calculation of the daily energy demand (see Section 7.4). The figures for power of the individual devices have been calculated based on a situation whereby not all electric power consumers are connected simultaneously. In addition, the daily consumption of energy has been calculated (for details see Section 7.5.3).

Table 7.1 A completed daily energy profile sample form

Equipment group/ equipment	Availability	Daily period of use (≥ total operating time/day) (sample)						Possible energy sources (sample)	Electric power × operating time/day (sample)	Electric energy per day (sample)
		2400–0600	0600–1000	1000–1400	1400–1800	1800–2200	2200–2400			
Equipment in core modules										
Microscope	A							Mains electricity	20 W × 10 h	200 Wh
Centrifuge	A							Mains electricity	500VA × 1.5 (hardstart)[a] × 3h	2250[W3] VAh
Balance	A							Battery	N/A	N/A
Haemoglobino-meter	A							Battery	2W × 3h	6Wh
Glucometer	A							Battery, rechargeable	N/A	N/A
Refrigerator, general use	A							Gas	N/A	N/A
Advanced laboratory equipment *optional*										
Spectrophoto-meter	A							Mains electricity	150W	300 Wh
pH meter	A							Battery, rechargeable	5W	Battery, rechargeable
Water bath	B							Mains electricity	1000 W × 2 h	2000 Wh
Water still	B							Mains electricity	1000 W × 2 h	2000 Wh
Water-testing kit	B							Battery, rechargeable	500 W × 4h	2000 Wh
Refrigerator, blood bank	A							Gas	N/A	N/A

Table 7.1 A completed daily energy profile sample form (*concluded*)

Equipment group/ equipment	Availability	Daily period of use (≥ total operating time/day) (sample) 2400–0600	0600–1000	1000–1400	1400–1800	1800–2200	2200–2400	Possible energy sources (sample)	Electric power × operating time/day (sample)	Electric energy per day (sample)
Additional *optional*										
Lighting, emergency	A	■				■	■	Mains electricity	200 W × 2 h	400 Wh
Heating, water	C		■	■	■	■		Mains electricity	1000 W × 2 h	2000 Wh
Water pumping	B		■		■	■	■	Mains electricity	1000 W × 2 h	2000 Wh
Communication data processing (telephone, computer, printer)	C		■	■	■	■		Mains electricity	250 W × 2 h	500 Wh
Transportation	C		■	■	■	■		Diesel Petrol	N/A	N/A
Daily total electric power and energy demand									**4000 W[2]**	**13 656 Wh**

[a] Hard start: the extra voltage required to get the centrifuge going

7.3 Availability of energy sources in emergencies

The most common primary energy sources are compiled in Table 7.1. The availability of individual forms of energy may vary (depending on which tests are being done and the associated equipment in use) during the emergency phase.

The main energy source for laboratories is electricity. Electricity is assumed to be a universal and easily convertible form of energy. However, the availability and reliability of mains electricity can vary greatly from country to country. In some areas, mains electricity is not universal. The following sections focus on the selection of appropriate laboratory equipment, the planning of power supplies and power conditioning gear, taking into consideration mains electricity, generators and fuel, and batteries.

7.4 Selection criteria for electrical laboratory equipment

When selecting laboratory equipment for a particular purpose the following electric and protective features must be taken into consideration.

- **The supply voltage** (volts; V) falls into two main categories, indicating the wave form, applicable to both AC and DC, of of the voltage and thus the related current: AC (alternating current) and DC (direct current). AC supply systems are designed as single-phase systems (for household consumers; ordinary laboratory equipment) and as three-phase systems for heavy-duty consumers (autoclaves, medium- and high-power electric motors). Equipment using DC power is usually preferred for a mobile laboratory.
- **The frequency** (hertz; Hz) of the supply voltage goes together with AC voltages only and must be considered for the selection of equipment with electric motors (for example, refrigerators, air-conditioners, centrifuges, water pumps).
- **The electric current** is a flow of electric charge. Amperes (A) are used to express flow rate of electric charge. The milliampere (mA) is a value which describes various ampere levels and is useful when specifying installation materials such as cables, switch gear, and fuses/circuit breakers. Together with the supply voltage, the ampere level is an indication of the total power consumption of a piece of equipment.
- **The electric power** is the rate at which a device converts electrical energy into another useful form such as light, heat, or motion, or the other way round – the rate at which a generator or photovoltaic array generates electricity. It helps determine the energy profile of the laboratory according to Table 7.1.

Two categories of power are of critical importance:

- The active power (watts; W (occasionally kilowatts; kW)), which is relevant to AC and DC voltages, is relevant for all power calculations in DC systems and for AC systems without apparent power indication
- The apparent power (volt-ampere; VA (occasionally kilovolt-ampere; kVA)), which is relevant to AC voltages only, is used for power calculations in AC systems.
- **The storage capacity of batteries** (ampere-hours; Ah (occasionally milliampere-hours; mAh)) is an indication of the stored electric energy and is normally determined at a current discharge rate that fully depletes the battery cell in a defined period of time (for example, five hours).

- The **operating time** (hours; h) of the device during one working day or any other appropriate period of time is an indication of the use rate of the equipment and helps determine the energy profile of the laboratory according to Table 7.1.
- The **protective design** of enclosures, casings, guards, probes, electric leads and connectors to withstand impairing external influences, such as atmospheric conditions including daily and seasonal alterations (ambient temperature, humidity, solar radiation, lightning, insects, fungus, dust) and technical influences (shock, vibration, magnetic fields).

7.5 Selection criteria for electric power supply systems

7.5.1 Overview of relevant electric power supply systems

Table 7.2 gives a technical overview of relevant electric power supply systems, applicable in emergencies.

Table 7.2 A technical overview of relevant electric power supply systems

Electric power supply system	Typical (nominal) voltage interval	Typical frequency	Typical power interval, active and apparent	
AC systems				
National/regional electric grid types	220–240 V	50 Hz	up to 15 kW	
	single phase 380–400 V three phase	50 Hz	up to 100 kW	
	100–115 V single phase US standard	60 Hz US standard [JS8] [W9]	up to 10 kW	
Diesel/petrol generating sets	240/400 V	50 Hz		0.5 kVA up to 250 kVA
Medium-size wind generators	240 V	50 Hz		up to 10 kVA
Hydro generators for institutional use	240/400 V	50 Hz		0.5 kVA up to 100 kVA
Large solar (photovoltaic) systems via DC–AC inverters	240 V	50 Hz		up to 5 kVA
DC–systems				
Small wind generators	12 V 24 V		2500 W	
Electric systems in vehicles and boats	12 V 24 V		200 W 400 W	

Table 7.2 A technical overview of relevant electric power supply systems (*concluded*)

Electric power supply system	Typical (nominal) voltage interval	Typical frequency	Typical power interval, active and apparent
Small and medium-size solar (photovoltaic) systems	12 V 24 V stationary systems		up to 750 W
	portable charging kit for standard-size rechargeable batteries		up to 4 W
Batteries			**Storage capacity**
Primary cells (non-rechargeable batteries) (all dry cell batteries)	1.5 V 6 V 9 V all standard sizes		800–10 000 mAh
Secondary cells (rechargeable batteries) dry cell batteries for 1.2–6 V	1.5–3 V button cells of various sizes		30–600 mAh
	1.2 V 6 V 9 V all standard sizes, and individual sizes for portable equipment		800–10 000 mAh
Lead–acid/gel cell batteries for 12–24 V	12 V 24 V variable sizes: car or truck batteries, solar systems		40–225 Ah

7.5.2 Quality of electric power supply systems

Indicators of poor quality of electric power supply include unexpected interruptions (power cuts) and voltage fluctuations, spikes and surges as well as frequency fluctuations. In a laboratory a wide range of equipment is in use. Some equipment, such as heating devices and light bulbs, may be able to bear a relative large deviation of the nominal voltage and may absorb quite high energy surges and spikes. They can operate on a power supply of a poorer quality. The relatively low price of the items does not justify installing expensive equipment for improving the quality of the electricity supply. However, expensive laboratory equipment, telecommunications

and data-processing equipment and other devices with electronic control circuits require a high-quality supply.

A high-quality electricity supply system can be made possible by:

- power conditioning, which ensures that the power provided to the equipment is of a quality that is demanded by the equipment
- related components and equipment: voltage stabilizers, transformers, surge/spike suppressors, filters, charge controllers
- power back-up, which ensures that power is available for all critical services at any time; related components and equipment: uninterruptible power supplies (UPS), small/medium-size generators or solar systems.

An assessment of the quality of the power supply system shows the following.

- National/regional electric grid voltage fluctuations and power cuts may occur, particularly in emergencies; spikes and surges caused by thunderstorms or switching are quite common. Therefore electric power back-up and power conditioning in the laboratory is necessary.
- Diesel/petrol generating sets depend on the reliability of fuel supply and effectiveness of maintenance. Voltage fluctuations can be minimized, and unforeseen power cuts avoided. Continuous operation of the plant is usually not expected. All activities requiring electric power must therefore be carried out during the operation period, and electric power conditioning in the laboratory is necessary.
- Wind and hydro generators depend on seasonal and climatic conditions and the effectiveness of maintenance. Voltage fluctuations can be minimized, and unforeseen power cuts avoided. Continuous operation of wind generators is usually not possible; the energy generated must therefore be stored in batteries (or in water tanks in case of drinking-water lifting), and electric power conditioning in the laboratory is necessary.
- Electric systems in vehicles and boats are suitable for short-term and low-power laboratory applications. Precautions must be taken to avoid overloading the electric system or deep discharge of the battery, resulting in a disabled vehicle or boat. Electric power conditioning in the vehicle or boat is necessary.
- Solar (photovoltaic) systems depend on seasonal and climatic conditions and the effectiveness of maintenance; unforeseen power cuts can be avoided. Continuous generation of electricity is not possible; the energy must be therefore stored in batteries. Deep discharge of batteries should be avoided (see Section 7.5.4.2). Electric power conditioning in the laboratory is therefore necessary.

- Batteries: a relatively high grade of power quality can be ascertained by using batteries for the energy supply of devices. This method is appropriate for portable laboratory equipment and emergency lighting. Power conditioning is not necessary, and unforeseeable power cuts can be avoided if a sufficient number of batteries of appropriate sizes is kept in stock (in case of primary cells), or if rechargeable batteries are charged in time. A continuous supply of batteries (primary cells) must therefore be ensured, or rechargeable batteries must be charged regularly by:
  - a battery charger if power is supplied by a national grid or generators
  - a charge regulator when using a solar system.

7.5.3 Determining the power rating of generating sets and power conditioning equipment

This section specifies the electric power requirements of a health laboratory. Quoting well-founded technical details ensures the effective selection and purchasing of:

- a properly dimensioned electric house service connection
- power back-up equipment, such as
  - diesel/petrol generating sets
  - wind/hydro generators
  - solar (photovoltaic) systems
  - uninterruptible power supplies (UPS)
  - electric systems in vehicles and boats
- power conditioning equipment, such as
  - voltage stabilizers
  - surge/spike suppressors, filters
  - transformers
  - DC–AC inverters
  - DC–DC converters
  - charge regulators.

The power rating of power units can be determined using the chart in Fig. 7.1.

Determine the total electric power of the equipment to be connected to the power unit

- Compile **all electric details** according to Section 7.4, which can be found in the documentation or on the rating plate of the devices.
- Add the **power rating** of all devices to be connected to the unit together. Use either only VA values (for AC systems) or only W values. Determine equipment requiring hard starting, that is, a high start-up current to get them operating (for example, centrifuges), and multiply nominal power by a factor of 1.5. Use Table 7.1 for compilation

↓

Consider future equipment which you may want to connect to the unit

- Add the rating of this equipment to total load to be connected

↓

Determine the supply voltage of the power unit

- Select a nominal supply voltage for the power unit which satisfies the **high power** consuming instruments
- Make a list of accessory power conditioning equipment, for example, transformers, charge regulators, inverters, to match those devices with variable supply voltage and frequency

↓

Consider which equipment is used concurrently and which not

- All power consumers are usually not connected simultaneously. Determine periods with critical maximum load. Design a daily energy profile according to Table 7.1
- Carefully check the list of equipment to be connected to the power unit. Leave out non-critical equipment, resulting in a smaller size and thus cheaper power unit

↓

Determine the rating of the power unit (electric power supply system)

- Select a power unit from the documentation or quotation of a possible manufacturer, considering all technical details according to Section 7.4, particularly supply voltage and electric power
- Consider potential system energy losses caused by the wiring system and de-rating factors due to prevailing environmental conditions (ambient temperature, altitude and maximum continuous operation time)
- The selected unit should have at least the same or next higher **power rating**
- Select accessory power conditioning equipment from the documentation or quotation of a possible manufacturer, considering all technical details according to Section 7.4

Fig. 7.1 Power unit power rating determination

Box 7.1 shows the specification of a sample generating set for the energy supply of an essential health laboratory.

Box 7.1 Sample specification of a generating set (see Module 1.d.2)

Equipment connected to the system of this sample essential health laboratory includes:

- five tube lamps (10 W each, 2 h/day)
- one microscope (20 W, 8 h/day)
- centrifuge (100 VA, 2 h/day; hard starting should be taken into account by multiplying this voltage by a factor of 1.5: 150 VA).

All equipment is operated with a supply voltage of 230 V AC and frequency 50 Hz and all equipment is to be operated simultaneously.

Determination of specific data for the generating set of this sample laboratory:

- Total electric power, calculated according to Sections 7.2 and 7.5.3 and considering periods with critical maximum load (concurrently used appliances) = 100 W + 160 W + 150 VA (see Section 7.4); since tube lamps and centrifuge are being used in a AC system active power has to considered and converted into apparent power (1 VA = 0.8 W)
- Therefore total apparent power = 435 VA
- Supply voltage and frequency, determined according to Section 7.5.3 = 230 V AC, 50 HzSupply voltage and frequency, determined according to Section 7.5.3 = 230 V AC, 50 Hz
- Generating set specification de-rating factors for altitude (5%), ambient temperature (2%), maximum operating time (20%) means adding 27% on total apparent power = 552 VA therefore power rating, selected from manufacturer's catalogue: at 230 V AC, 50 Hz = 750 VA
- Therefore power rating, selected from manufacturer's catalogue: at 230 V AC, 50 Hz = 750 VAA

A detailed selection guide can be found in WHO/UNICEF Product Information Sheets, 2000: "Standby generator buyer's guide" www.who.int/immunization_standards/vaccine_quality/PQS_2000_corrected.pdf

7.5.4 Determining the type and capacity of batteries

This section specifies the type and capacity of batteries for portable laboratory equipment and stationary power back-up systems (solar systems and uninterruptible power supplies) of a health laboratory. Quoting well-founded technical details ensures the effective selection and purchasing of:

- non-rechargeable batteries (primary cells), standard size for portable measuring and diagnostic instruments
- rechargeable batteries (secondary cells), standard size for portable measuring and diagnostic instruments, individual sizes for uninterruptible power supplies (UPS) and solar (photovoltaic) systems.

Typical (nominal) voltages, storage capacities and size indications of batteries are quoted in Table 7.2.

7.5.4.1 Primary cells

Primary cells are supplied as:

- zinc carbon batteries
- zinc chloride batteries
- alkaline batteries and button cells
- silver oxide button cells
- lithium–manganese dioxide batteries (not to be confused with rechargeable lithium ion battery)
- zinc air batteries.

Alkaline batteries are good all-round batteries and are recommended for most laboratory equipment. However, all primary cells must be discarded after discharge. Thus they are environmentally incompatible.

7.5.4.2 Secondary cells

Secondary cells are supplied as:

- nickel–cadmium batteries (NiCd)
- nickel–metal hydride batteries (NiMH)
- lithium ion batteries (Li ion), (not to be confused with non-rechargeable lithium–manganese dioxide battery)
- lead–acid batteries, supplied as liquid electrolyte or as gel (non–liquid electrolyte) type.

Nickel–metal hydride batteries (NiMH) are an appropriate and economical option to replace non-rechargeable standard-size batteries. Lithium ion batteries (Li ion) are increasingly used in a wide range of equipment due to their advantages, such as high specific storage capacity and long shelf-life. Nickel–cadmium batteries (NiCd) are no longer recommended and are being gradually taken off the market due to their environmental incompatibility.

Certain devices which were designed to operate using primary carbon zinc or alkaline cells may not function if NiMH (or NiCd) batteries are used as substitutes. The reason is the lower voltage of NiMH (or NiCd) cells (1.2 V instead of 1.5 V).

Lead–acid batteries are the recommended type for large energy storage demand. If properly handled they last three to five years. The rated mAh or Ah value of this type of battery is a nominal figure: they should not be discharged below 80% charge for shallow cycle batteries (for example, car batteries) or 40% charge for deep cycle batteries (for example, solar batteries). In order to determine the appropriate nominal storage capacity of a battery system, the equipment or system energy requirement

must be multiplied by a depth of discharge factor, namely 3.5 for shallow cycle batteries and 1.7 for deep cycle batteries.

7.5.4.3 Battery chargers

Battery chargers are essential to optimize the performance of expensive rechargeable batteries. Batteries have to be charged with the correct voltage and the correct amount of current over a defined period of time. If the voltage or the electric current is too high or too low, the batteries can be damaged. The charging current (mA or A) should be 10% of the capacity value of the battery (mAh or Ah). Equipment powered by rechargeable batteries will often have a customised battery pack with an integrated charger. Standard-size batteries, however, often have to be charged with multipurpose chargers, with some models even fabricated to charge different battery types. Simple chargers require the user to keep a note of the time of charging and learn from experience how long an effective charge takes. For a fully discharged NiMH battery, an appropriate charge time can be calculated using the following formula:

Battery mAh capacity (indicated on the battery label) x 120% ÷ mA charge rate (indicated on the charger datasheet) = hours of charge[16]

The appropriate charge time can be also calculated using many online calculators.

The charging current of the charger can be found on its rating plate or in the product data sheet.

More advanced battery chargers are equipped with a timer, which will stop the main charge at a predetermined time. Some chargers follow the main charge with a float voltage to maintain their full charge. Timer-controlled chargers are constricted in cases with unreliable power supply. A power cut may reset the timer and repeat the full charging cycle, thus impairing the battery. Fully sophisticated chargers automatically monitor the battery voltage characteristics to determine when it is fully charged. Some models, in addition, monitor the battery temperature to avoid battery overcharging and overheating.

Batteries must be replaced immediately after they are discharged. Many battery types can leak if left in the equipment for a long time and cause irreparable damage to the equipment.

[16] NiMH Battery Chargers Handbook and Application Manual. Energizer Charger Handbook Version: Chg1.4, 2008. Available at http://data.energizer.com/PDFs/charger_appman.pdf

It is recommended that the emergency relief team carry solar phone chargers or compact solar charging kits (for charging phones, GPS, POV cameras and other small USB devices). Multiple compact solar charging kits, mid-size solar charging kits and heavy-duty solar charging kits are commercially available.

7.5.4.4 Battery arrangement and storage capacity

Diagnostic laboratory equipment that uses batteries, uninterruptible power supplies or solar (photovoltaic) systems, requires more than just one cell at a time. Batteries are normally grouped together in battery packs, serially to form higher voltages, or in parallel to form higher currents. In a serial arrangement, the voltages add up while the system current remains the nominal current (and thus the storage capacity [Ah]) of the single battery. In a parallel arrangement, the currents add up (and thus the storage capacity [Ah]) while the system voltage remains the nominal voltage of the single battery. In a parallel arrangement it is strongly recommended to use one and the same type and age of batteries for the whole pack. In case of replacement, all single batteries should be replaced at once. Figure 7.2 shows these two arrangements. If a battery fails in series, the whole circuit fails, whereas in parallel it does not.

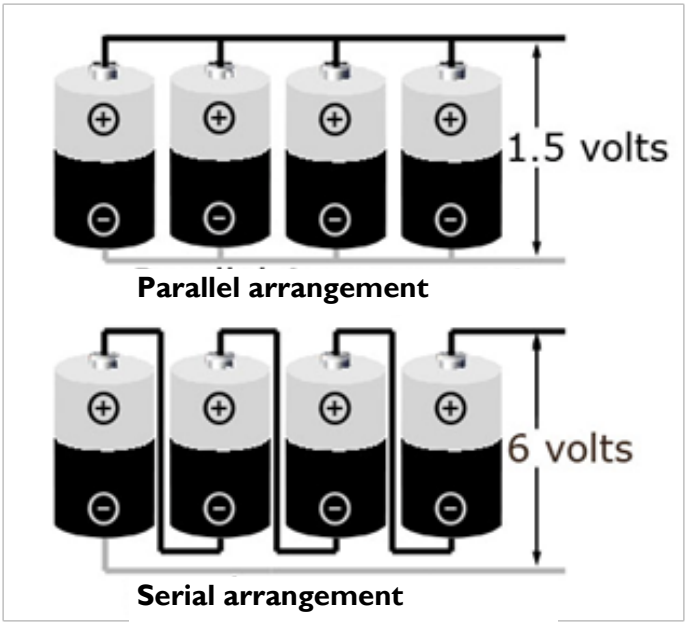


Fig. 7.2 Battery arrangement

A battery system can be specified using the chart in Figure 7.3.

Determine the total electric power input of the equipment to be connected to the battery system

- Compile all electric details of equipment to be supplied by the provided battery based back-up system according to Section 7.4. Details can be found in the documentation or on the rating plate of the devices.
- Add the power rating of all devices to be connected to the system together. Convert all power-values of AC equipment which is stated in VA into watts:
  - if the battery system replaces the AC power adaptor of electronic devices (for example, computers, lab diagnostic instruments), use 1 VA = 0.8 W
  - if the consumer equipment is to be supplied via power plugs, inverters, converters, use VA = W
- The power rating of **high power** consumers determines the nominal supply voltage of the battery system according to Section 7.4 and Table 7.2

↓

Consider future equipment which you want to connect to the system

- Add the rating of this equipment to total load to be connected

↓

Estimate the amount of time per day that each appliance is in operation

- Use Table 7.1 for the calculation
- For economic reasons try to keep operating periods as short as possible

↓

Calculate the daily energy requirement for each device

- Use Table 7.1 for this calculation:
- Operating time per day (h) × power of device (W) = energy per day (Wh)

↓

Calculate the total energy demand per day to be covered by the battery system

- Use Table 7.1 for this calculation:
- Sum of energy per day (Wh) of all consumers = total consumer energy per day (Wh)
- Estimate system energy losses:
  - if system components are new and properly sized, estimate energy losses to be 15% of total consumer energy per day (Wh)
  - if there are a number of long wire runs (> 10 metres), and the equipment is new, estimate energy losses to be 20% of total consumer energy per day (Wh)
  - if the battery available is second hand, estimate energy losses to be at least 25% of total consumer energy per day (Wh)
  - if the system uses power conditioning units, estimate system losses to be 30% of total consumer energy per day (Wh)
- Calculate daily system energy requirement: total consumer energy per day (Wh) + estimated system energy losses (Wh) = daily system energy requirement (Wh)

↓

(continued overleaf)

(continued)

Determine the rating of the battery system: nominal supply voltage, battery capacity

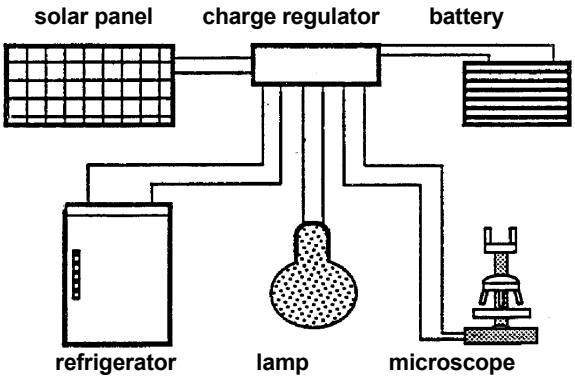
- Select a nominal DC supply voltage for the power unit (see Section 7.4 and Table 7.2) which fits for the **high power** consumers provided
- Calculate the respective energy storage demand: daily system energy requirement (Wh) ÷ DC supply voltage (V) = energy storage demand (Ah)
- Decide about the autonomy time of the battery system (in days): what is the minimum period of time that you want to run stand-alone on the batteries?
- Calculate the storage capacity of the battery: energy storage demand (Ah) × autonomy time [days] × discharge factor [1.7 for deep cycle batteries; 3.5 for shallow cycle batteries] = storage capacity of battery (Ah)
- Select quantity and capacity of batteries from the documentation or quotation of a possible manufacturer. Depending on the selected DC supply voltage and the demanded storage capacity a single battery or a battery pack may be required (see Figure 7.2).
- The selected battery or battery pack should have at least the same or next higher power rating

Fig. 7.3 Battery system specification

7.5.5 Specification of a solar energy supply system

7.5.5.1 General information

A solar system is a self-sufficient energy system varying in size and capacity (for manufactures of photovoltaic equipment see Annex 8). In its basic form it consists of a solar panel array, a charge regulator, a battery and the consumer equipment, as shown in Figure 7.4.



Source: *(35)*

Fig. 7.4 Basic photovoltaic system

Provided that the system is properly designed and installed, the subsequent maintenance activities are technically fairly simple and require limited technical expertise. However, user training and user awareness are essential prerequisites for managing performance of any solar photovoltaic system satisfactorily.

Photovoltaic systems can be individually sized due to the modular construction of solar panels and batteries. Caution must be applied to individual solutions, which can result in application problems caused by non-matching system components. The market still offers a number of substandard components, which are often responsible for breakdown or poor performance of the system. Typical power intervals of solar systems are shown in Table 7.2.

The following factors must be considered when planning the installation of a solar photovoltaic system:

- reliable national grid is not available as economical option
- diesel/petrol generators involve high operating costs or fuel supply is not assured
- everyday use of solar energy and photovoltaic electricity is guaranteed
- the average annual solar irradiance exceeds the up-to-date guideline value for the economic use of photovoltaic systems (at present 4 kWh/m²/day). The decision is made after consulting solar radiation (insolation) maps, according to the time of year, number of daylight hours, etc.
- the photovoltaic system is supposed to supply only essential equipment
- only instruments consuming electricity with high efficiency are selected as part of the system
- funds are available to allow reinvestments for batteries (see Section 7.5.4)
- a maintenance system for solar technology is in place and funds are available.

Local climatic data determine the system design. Solar radiation can vary even within the same geographic region, depending on climatic conditions, altitude, vegetation and ambient temperature around the solar panels. A particular energy demand in one location may require double the size of solar panels and extended battery capacities in another location in the same region. A reliable design for a solar photovoltaic system always requires individual data.

A continuous electricity supply throughout the period of an emergency requires sufficient battery storage capacity to buffer short-term changes in solar irradiation. A photovoltaic system is reasonably reliable if the batteries are not discharged below 50% state of charge after a period of three days without being charged by sunlight (see also Section 7.5.4 for depth of discharge of batteries).

The power rating of the solar system may be reduced if high efficiency electric instruments are chosen. The technical specifications of electric consumer equipment should be clearly outlined and specified.

The daily energy profile according to Table 7.1 and Section 7.5.3 determines the daily energy demand and the power rating of the solar system. If the demand exceeds a certain power level or if particular equipment exclusively powered by AC needs to be used, the solar system must be supplemented by a DC–AC converter. This power conditioning device converts low voltage DC electricity from the batteries into mains voltage AC power.

The tender should outline all technical specifications. Training components should be considered for technical staff and users. Handbooks for users and comprehensive technical documents for skilled technicians should be available. It may be necessary to outline basic guidelines for equipment handling.

No matter whether the technical installations are carried out by agents or local technicians, quality control of the installation is important. Trained personnel should supervise the installation and perform the commissioning.

During the operation of the photovoltaic system the energy consumption should be monitored continuously to maintain the energy balance, thus ensuring economical use of the entire plant.

In the following sections the specification requirements of solar panels and charge regulators are described in more detail.

7.5.5.2 Solar panels

There are three different kinds of solar panel commercially available:

- wafer-based crystalline silicon cells
- thin-film cells, based on cadmium telluride or amorphous silicon, which come as rigid or flexible modules
- advanced thin-film cells, based on nanotechnology.

The panels differ in their physical properties and cost. The reader is advised to carry out a web search to find out about recent developments in panel technology with regard to high efficiency (or best value for money) and low cost per watt of electricity generated.

The electrical rating of solar panels includes:

- nominal power P_{max} [W_p or kW_p]
- open-circuit voltage V_{oc} [V]

- maximum-power voltage V_{mpp} [V]
- short-circuit current I_{sc} [A]
- maximum-power current I_{mpp} [A]
- panel efficiency [%].

Rating details refer to standard test conditions, such as:

- irradiance of 1000 W/m²
- module temperature at 25 °C
- The distribution of electromagnetic radiation (solar spectrum) of 1.5 air mass (solar energy).

7.5.5.3 Charge regulator

A charge regulator forms the central unit of the system and supplies, manages and protects the batteries and the consumer equipment. The charge regulator protects the battery from overcharging and discharging and supplies the consumer equipment with a constant voltage. A quality charge regulator adapts the maximum voltage of the battery according to changes in temperature in the battery environment. The adaptation prevents loss of water in a lead-acid or vented nickel-cadmium battery through evaporation. Attention must be paid to the stability of the charge regulator under tropical climate conditions. It is advisable to choose a charge regulator with an integrated digital display indicating the battery voltage.

Box 7.2 shows the components of a sample medium-size solar energy supply system for an essential health laboratory.

Box 7.2 Sample specification of a solar (photovoltaic) system (see Module 1.d.2)

Equipment connected to the system of this sample essential health laboratory includes:

- three tube lamps (10 W each, 2 h/day)
- one microscope (10 W, 8 h/day)
- one refrigerator (compressor type, 40 W, 24 h/day).

All equipment is operated with a supply voltage of 12 V DC, thus no DC–AC inverter is required for this application.

Determination of specific data for the solar energy supply system of this sample laboratory:

- total consumer energy per day, calculated according to Section 7.2 (Table 7.1) = 1 100 Wh/day
- supply voltage = system voltage, determined according to Section 7.5.3 = 12 V DC
- battery specification, according to Section 7.5.4.4
  system losses (new equipment, long wire runs): 20% of total consumer energy = 260 Wh/day
  so daily system energy requirement = 1 320 Wh/day
  so energy storage demand = 110 Ah
  desired autonomy time of system: 2 days
  discharge factor of deep cycle battery: 1.7
  so storage capacity of battery pack = 374 Ah
  power rating of battery, selected from manufacturer's catalogue: 12 V DC, 130 Ah
  so number of batteries = 3 cells
- solar panel specification, according to Section 7.5.5.2
  meteorological data at laboratory location: lowest solar insulation : 4.8 kWh/m²/day
  load = energy storage demand: 110 Ah
  safety factor (recommended): 1.2
  so system current to be provided by solar panels = (110 Ah × 1.2) ÷ 4.8 kWh/m²/day = 27.5 A
  power rating of solar panels selected from manufacturer's catalogue: 12 V DC, 40 Wp, maximum-power current = 2.3 A
  so number of solar panels = 12 pieces
- charge regulator specification, according to Section 7.5.5.3
  so power rating of charge controller, selected from manufacturer's catalogue: 12 V DC, 360 W, nominal current = 30 A

7.6 Electric installation requirements and maintenance

7.6.1 Protection of the user and the equipment

When carelessness and ignorance become part of electrical work, people may be injured or killed by electric shock and property may be destroyed by fire. Wiring faults and faulty electric appliances or carelessness in the use of such equipment are the most frequent causes of electrical hazard.

Safety regulations and standards are made to protect the user of electric installations. If an installation is well designed, the risk of fire and shock is reduced. Safety standards also apply to the installation of an electric system and equipment and to the maintenance of the system at regular intervals.

User protective systems can be subdivided as follows.

- **Protection against electric shock**
  - Protection against electric shock under normal operating conditions (applies to AC systems mentioned in Table 7.2).
  - Protection against any direct contact by means of insulation, barriers or enclosures (for example, cable insulation, switch gear cabinets, junction boxes). Additional protection can be achieved by residual-current protective devices.
  - Protection against electric shock in case of a fault – protection against earth-leakage currents (applies to AC systems mentioned in Table 7.2).
  - Protection against any indirect contact with exposed parts, which have become live under fault conditions. All electric installations shall be protected by a measure for automatic disconnection of supply (for example, fuses, circuit-breakers, insulation monitoring devices, protective conductors, earthing, equipotential bonding).
  - Protection against electric shock through extra-low voltage (does not exceed 50 V for AC or 120 V for DC) under specific installation conditions). This kind of protection is achieved through the use of DC systems.
- **Protection against over-currents**

Over-current can generate excessive heating of cables and electric components in devices thus causing the risk of fire. Over-current includes both overload currents and short-circuit currents. Overload currents occur in circuits which are electrically sound but are carrying excessive current due to overloaded machines or careless diversification of equipment and the distribution system. Short-circuits are due to

faulty conductors or electrical components. Such hazards can happen in any of the AC or DC systems.

Protective devices (for example, fuses, circuit-breakers, residual-current protective devices) break any overload and short-circuit current flowing in the installation. The device protecting a wiring system is to be placed at the point where the current-carrying capacity of the installation changes (for example, change of cross-sectional area (wire gauge) of cables, change of installation system).

Protection of conductors (cables, rails) against over-current does not necessarily protect the equipment connected to the conductors.

- **Earthing and equipotential bonding**

The principle of earthing considers the general mass of the earth as a conductor. Thus, everything connected to it by means of *effective* earth electrodes will be electrically interconnected. As a result, any conductive body directly connected to earth does not admit a dangerous voltage. Therefore, earthing for safety or protective purposes is earthing to protect persons and equipment against the occurrence of an inadmissible touch voltage.

Equipotential bonding is an electrical connection intended to prevent the occurrence of dangerous touch voltages between simultaneously accessible conductive parts. Such parts may be exposed conductive bodies like metal parts of equipment, metal casings, metal construction components of buildings and metal pipes of service systems. For safety and protective purposes the equipotential bonding system has to be connected to the earthing system of an electrical installation. In each building a main equipotential bonding conductor interconnects the following conductive parts at the entrance point of the power supply:

- protective conductor (PE)
- main earthing conductor
- neutral conductor (N) (in some earthing systems)
- metal pipe-work
- metallic parts of building structures
- generators for power back-up
- solar (photovoltaic) systems
- air-conditioning systems.

Protective measures may be applied to an entire installation, to part of it or to a single device.

The following deficiencies are frequently causes of hazards which the users of electric appliances should look for:

- too many fuses
- flexible cables not secure at plugs
- frayed cables
- bell or loudspeaker wire used to carry mains voltages
- cables and devices without appropriate mechanical protection
- unprotected or unearthed power outlets
- equipment with earthing requirements being supplied from two-pin plugs
- use of unearthed metalwork
- poor or broken earth connections; especially signs of corrosion
- broken connectors, such as plugs and power outlets
- signs of heating at power-outlet contacts.

7.6.2 Maintenance requirements for electric power supply systems

7.6.2.1 Maintenance of diesel/petrol generators

Generating sets are mechanical and electric devices of high complexity. They require regular and qualified maintenance.

Check daily:

- oil level
- fuel supply
- cooling water level (if applicable).

Check weekly:

- for fuel and oil leaks
- for water leakages
- liquid level of battery (if applicable).

Maintenance intervals every 250 running hours:

- Change oil.
- Change oil filter element.
- Check fan belt tension (if applicable).
- Clean engine and generator housing.
- Check output voltage of generator.
- Check load of generator.
- Check engine speed.

Maintenance intervals every 500 running hours:

- Change fuel filter element.
- Clean air cleaner.

Maintenance intervals every 1500 running hours:

- Clean fuel tank
- Change fuel filter
- Change air filter (if applicable)
- Check/clean radiator (if applicable).

Every 3 000 running hours:

- decarbonization of the engine and change of bearings of generator by specialized technician.

Precautions against theft of a generator: a large generator should be housed in its own shed with strong mesh steel walls and a locked door. A small portable generator should be firmly attached to a large steel chain secured to a heavy object. Where possible at night a small generator should be stored in a lock-up shed or taken to the home of the person responsible for its daily use.

7.6.2.2 Maintenance of wiring and control gear

It is useful to check the wiring of a system (compound, building, plant) regularly, at least once a year, according to changing environmental conditions.

- Check installation in places where it might be affected by rodents, tampered with or accidentally pulled.
- Check the tightness of screws on all connector strips, switches and lamps; make sure that no bare wire is visible.
- Inspect system wire runs for breaks or cracks in the insulation.
- Inspect junction boxes to make sure they are not affected by insects and are still watertight.
- Check switches to make sure they are operating properly.
- Check fuses to find if any has blown; if so, find the cause, repair it and replace the fuse with a new one of the same size.
- Check grounding wires to make sure they are still intact.

7.6.2.3 Maintenance of consumer equipment

On a daily basis it is advisable to operate the devices as efficiently as possible. Maintenance of equipment includes turning lights and appliances OFF when not in use.

- Clean lamps, reflectors and fixtures in regular intervals; dust and dirt will make lamps appear less bright.
- Replace blackened or blinking tubes and starters in fluorescent fixtures.
- Keep vent holes in any electric equipment clean to allow for proper cooling.

7.6.2.4 Maintenance of batteries

Batteries require careful maintenance. For long life, they should be cleaned regularly, depending on the mode of use in portable or stationary equipment. They should always be kept in a high state of charge. When handling and cleaning do not short the terminals.

Cleaning of lead–acid batteries (for vehicles and solar systems) should be carried out as follows.

- First switch OFF the charger/charge controller.
- Disconnect the battery from the leads and remove the terminals from the post.
- Clean the top and outside of the battery with a rag, do not allow dirt or water to enter the cells.
- Clean the terminals and posts until they are shiny.
- Replace the clean terminals and tighten bolts, apply petroleum jelly or grease to connected terminals to prevent from further corrosion.

Check and top up electrolyte level of lead–acid batteries once a month.

- Remove the caps of each cell one at a time and check the level of the electrolyte; acid should touch the gauge.
- Make sure the acid is well above the level of the plates.
- If electrolyte level is down, add deionized or distilled water up to the gauge.
- Rainwater collected in glass or plastic (not metal) containers can also be used to replace distilled water.

Check state of charge once a month.

- If the battery is in a low state of charge reduce load, allow the battery to be charged up by the charger or solar system or have it charged at a petrol station.

- With large systems, keep records of battery state of charge, age and performance. This allows users to judge more easily whether a battery needs replacement and to budget for new batteries.

7.6.2.5 Maintenance of solar panel arrays

The maximum power of the photovoltaic system is generated when the glass surface of the panels are kept clean. Prevent plants and trees from growing up around the modules. Check occasionally for loose connections in the mounting hardware.

Remove dust and clean the panels once a month or as required.

- Check for dust by running a finger along the top.
- Clean panels with water and, if necessary, with mild soap.
- Wipe the glass with a sponge or a soft cloth (hard cloth may scratch the glass, thus reducing the output of the panel).

Check connections once a year.

- Inspect the junction box on the back of each panel to make sure that the wiring is tight.
- Make sure that the wiring is not affected by rodents and that there are no insects living in the junction boxes.

8. Laboratory equipment

8.1 General

Laboratory equipment used in an emergency may be affected after a few months by high temperature, humidity and dust. It may be necessary to check the manufacture's recommended operating temperature for the equipment. Find out the manufacturer's limits of relative humidity for reliable operation. Equipment used in an area where there is high humidity should have the electronics protected against high humidity. The use of a can of circuit-board lacquer will give a flexible coating to protect printed circuit boards from humidity. Equipment also needs to be protected from insect and rodent damage.

Laboratory equipment should be evaluated by the following criteria:

- suitability for the emergency/disaster
- affordability
- energy efficiency
- durability and robustness
- user-friendliness
- safe operation
- reliability
- supportable; to include availability of spare parts and a warranty
- suitable for a range of climates (if applicable, tropical)
- must be appropriate to the available electrical supply.

In this chapter the following laboratory equipment is discussed:

- microscope
- centrifuge
- photometer and haemoglobinometer
- refrigerator
- water purification systems
- balance
- pH meter
- EIA equipment
- Water bath, 37 °C to 56 °C.

8.2 Microscopes

In many emergencies the microscope is the instrument that is used most in the laboratory. The procurement of a microscope is a long-term investment. Therefore, price should not be the primary consideration. Reliable microscopes are available at medium cost (for manufactures of microscopes see Annex 9). When purchasing a microscope, attention should be paid not only to the magnification but also to the resolution and curvature of the field, which are important criteria. These are not satisfactory in less expensive microscopes, which may also have mechanical problems.

Recommended minimum specifications for a brightfield light microscope:

- Strong construction, stable base
- Optics anti-fungus treated
- Binocular head inclined to approximately 30°, and rotatable for 360° and adjustable for inter-pupillary distance
- Condenser, Abbe type with iris and filter holder
- Centring screws or an alternative system provided by the manufacturer
- Blue filter
- 10× eyepieces widefield (FN 18) with tube caps
- Rubber eye shelters for both eye pieces
- 100× oil immersion (spring-loaded) objective, minimum NA 1.25
- Parfocal DIN infinity-corrected plan achromat, 10×, 40× (spring-loaded) objectives, minimum 10×/NA 0.25, 40×/NA 0.65, 100×/NA 1.25.
- Power supply: supply voltage: 110/230 V AC; battery-powered: minimum three hours of operation at full intensity per battery charge; low battery warning.

Note: there are alternative power supplies ranging from mains and battery to solar-power; microscopes should be supplied with a socket in the base where a plug from a battery can be connected. The socket connections should not be interchangeable. The light source of the microscope should be connected to a battery that can be charged by a solar panel or local mains AC power supply.

- Illumination
  - Illumination unit with graduated lamp brightness control, light source: halogen lamp (luminous flux: minimum 700 lm; 20 W)

  or

  - white LED lamp (luminous flux: minimum 700 lm, service life: minimum 15 000 hours)

and

- back-up (daylight) mirror unit, plane and concave, mounted for angling and rotating
- spare bulbs: three spare bulbs (if halogen)
- Coaxial fine and coarse focus controls on both sides
- A built-in stage with a mechanism for mounting object slide. Fixed graduated mechanical and coaxial controls
- Supplied with non-drying immersion oil (not cedar wood oil)
- Dust cover
- Silica gel, self-indicating, 100 g
- Robust case (with handle) for transport and storage
- Operating manual
- A manufacturer's guarantee.

- **Optional accessories**
  - Graticle eyepiece (a stage micrometer would need to be purchased for use with the eyepiece)
  - 1 battery charger or mains adaptor
  - 1 battery pack, rechargeable, battery-powered: minimum three hours of operation at full intensity per battery charge; low battery warning
  - Include lead with car adaptor for 12 V DC/crocodile clamps and also for a cigarette lighter.

Routine maintenance is important.

The selected microscope should produce illumination of at least 700 lm. A halogen bulb of 20 W is sufficient for routine work (including work at 100×). LED bulbs have a luminous efficacy of approximately 35 lm/W resulting in 700 lm.

8.3 Centrifuge

Recommended minimum specifications:

Centrifuge, electric, bench-top model.

Recommended selection:

- Swing-out rotor
- Select smallest centrifuge capable of accommodating above tube requirements
- If selecting fixed-angle rotor, consider two smaller centrifuges.

Minimum specifications:

- Robust construction
- Power supply: 110/230 V AC
- Brushless drive induction motor
- Suction-cup feet
- Minimum size able to accommodate 3–15 mL tubes
- The lid should have a safe lid interlock and a mechanical lid release mechanism.
- Supplied with sealable buckets or sealable fixed-angle rotor
- Centrifugal force: adjustable from 500× g to 2000× g (note: this is not the rpm rating)
- Timer and alarm
- An imbalance detector
- Electronic meter displaying rpm and g-force
- Operating manual
- Full spare part list and manufacturer's maintenance manual
- One-year manufacturer's guarantee.

8.4 Instruments for haemoglobin measurement

Accurate haemoglobin measurement is imperative; therefore, colour card and other visual comparator methods are inappropriate because of their inaccuracy. Hand-held haemoglobinometers are practical and have a place in an emergency laboratory.

Oxyhaemoglobin method is recommended over cyanmethaemoglobin due to the difficulties inherent in the cyanmethaemoglobin method. The limitation of the oxyhaemoglobin method is that it requires an external standard from an outside source.

Some hand-held haemoglobinometers cannot be used in certain high-temperature tropical regions due to instability of the reagents used in the system. Therefore, if working in ambient temperatures above 30 °C, check with the manufacturer for use parameters. In addition, some are also susceptible to high relative humidity. Some manufacturers provide consumables in tropical packaging. Annex 10 lists some haemoglobinometers that are available commercially.

8.5 Refrigerators

8.5.1 General

Electric refrigerators have high energy consumption levels. This point should be taken into consideration when planning a solar energy supply system (powered by batteries and using a photovoltaic array) for a laboratory. Daily energy demand on the laboratory energy system may be reduced if a separate solar refrigerator is installed. Annex 11 lists some of the manufacturers of photovoltaic refrigerators.

Issues

Refrigerators are a large component of the energy module demands. Refrigerators powered by gas or kerosene (also called absorption refrigerators) have been considered an option in areas without a reliable power supply. Gas refrigerators are preferable to those powered by kerosene, as gas refrigerators are low maintenance and because they are fitted with a thermostat for temperature control. Refer to Table 8.1. However, both gas and kerosene refrigerators have a significant number of disadvantages, and it is preferable to use "direct-drive solar refrigerators", which are wired directly to photovoltaic generators. As of May 2013, five companies have direct-drive solar vaccine refrigerators recommended by WHO. The 10-year life cycle cost of solar direct drive systems is estimated to be equal to or lower than gas-powered refrigeration systems in settings where bottled gas is readily available and its supply is reliable.

Vaccine refrigerators have icepack walls that pose the danger of freezing the contents of containers.

The following website provides useful information about choosing refrigerators, freezers and cold boxes:

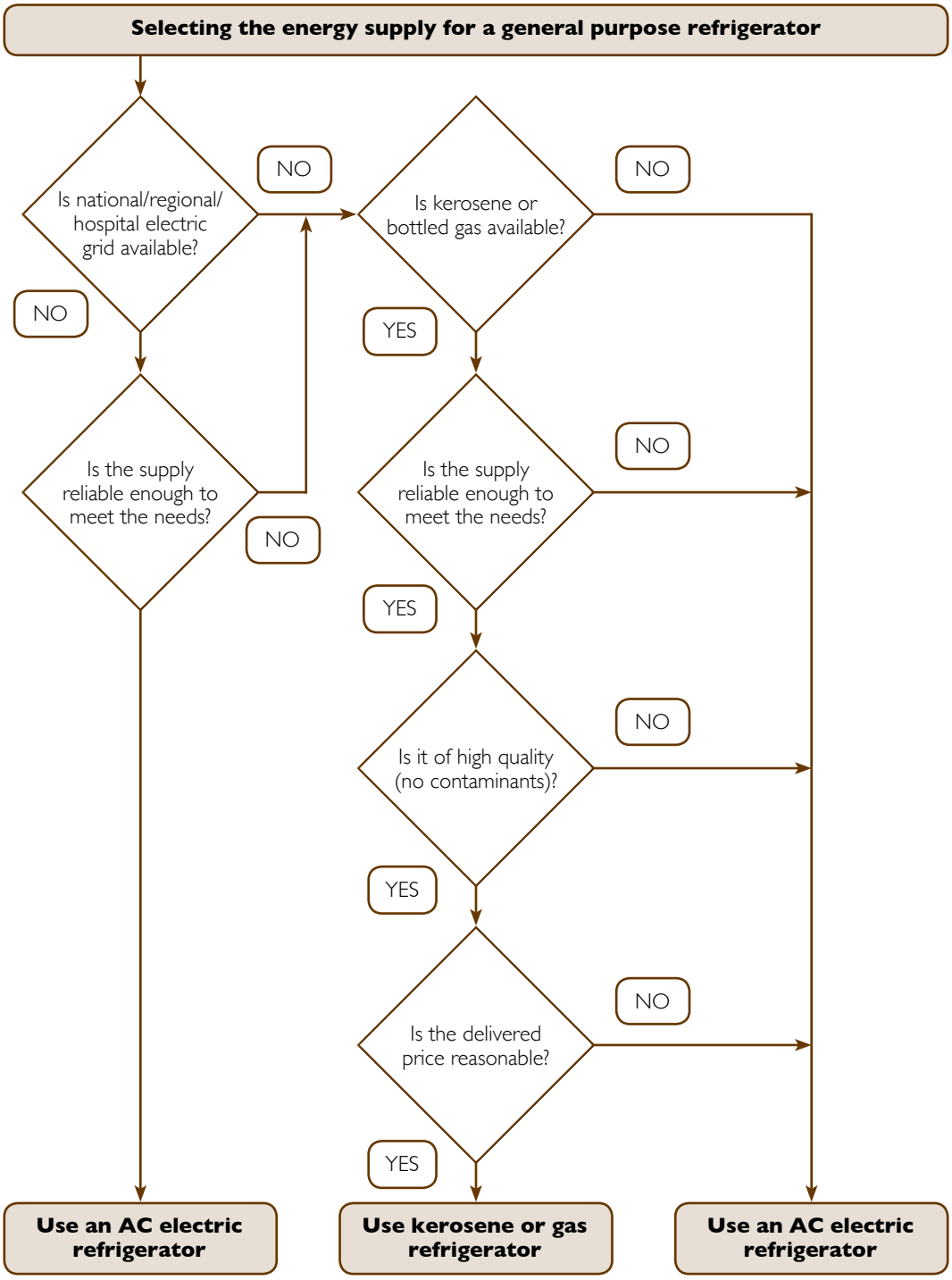
http://www.paho.org/hq/index.php?option=com_docman&task=doc_view&Itemid=270&gid=32008&lang=en

Selection recommendation:

- To minimize power consumption, always select the smallest volume size to meet required needs.

Minimum specifications:

- Electric (compression type) 110/230 V AC (standard electric, photovoltaic (compression refrigerator); kerosene (absorption refrigerator) or gas); internal


Selecting the energy supply for a general purpose refrigerator
Is national/regional/ hospital electric grid available?
NO
NO
Is kerosene or bottled gas available?
NO
YES
Is the supply reliable enough to meet the needs?
NO
NO
Is the supply reliable enough to meet the needs?
NO
YES
Is it of high quality (no contaminants)?
NO
YES
Is the delivered price reasonable?
NO
YES
Use an AC electric refrigerator
Use kerosene or gas refrigerator
Use an AC electric refrigerator

Source: *(37)*

air temperature of between 2 °C and 10 °C; volume: 140 L (volume may vary based on the location).

- A one-year manufacturer's guarantee.

Reasons for recommending a separate freezer:

Refrigerators with freezers should have a separate freezer compartment, that is, each compartment should have a separate external door – the freezer should not be located inside the refrigerator cabinet. The unit should also have non-automatic defrost. Refrigerators that combine refrigeration storage with a freezer within the same insulated chamber do not control temperature or freeze as well as models that have separate freezing and refrigeration storage areas.

Separate systems consisting of a refrigerator and a freezer use more fuel. They do, however provide more reliable refrigerator temperature control.

If blood transfusion services are provided, a separate dedicated refrigerator should be procured.

Additional considerations for blood bank refrigerators:

- better insulation to withstand fluctuations in power
- built-in temperature monitoring and alarm system
- transparent door to view the contents.

Gas- or kerosene-powered refrigerators cannot meet the requirement for a temperature monitor and alarm, but unless there is access to reliable power this may be the only alternative; choose gas over kerosene.

An ice-walled vaccine box should not be used for the storage of blood bags.

A blood bank refrigerator (compression type) with a built-in temperature monitor and a temperature alarm system and transparent display doors should always be preferred: electric (compression type) 110/230 V AC (standard electric, [compression type]; kerosene or gas), able to provide an internal air temperature of between 1 ° and 6 °C. The refrigerator must not have a freezer located within the refrigeration cabinet.

Refrigerators are affected by fluctuating electricity supply. If the mains power supply is liable to high voltage or low voltage and if the area is known for lightning strikes, the refrigerator should be fitted with a voltage stabilizer (voltage regulator monitor trip switch) for protection.

Should it not be possible to use an electricity-powered refrigerator, refer to Table 8.1 when choosing a model powered by gas, kerosene or solar energy (photovoltaic).

Table 8.1 Comments on various fuel sources[1]

Energy source	Temperature control	Routine maintenance	Other remarks
Electricity (absorption or compression models)	Thermostatic control: good	Little required	Requires frequent replacement of heating element when voltage varies widely
Liquefied petroleum (LP) gas (absorption or compression models)	Thermostatic control: partial	Little required	Pilot flame can cause excessive cooling in low ambient temperatures In regions where bottled gas is readily available at reasonable prices, gas-powered refrigerators provide a dependable alternative to kerosene because of the higher quality fuel
Kerosene (absorption model)	No thermostat Wick must be manually adjusted day and night to control internal temperature when external temperatures vary	Frequent cleaning and adjustment of wick and flue are necessary	Kerosene needs to be filtered before use The reliability of a kerosene refrigerator is strongly affected by the availability and quality of fuel and by how the refrigerator is used.
Photovoltaic (compression models)	Thermostatic control: good	Require little preventive maintenance Repair technicians with electrical and electronic skills may not be available in most rural areas of developing countries	The capital cost of solar refrigerators is high High initial cost, which is often more of a consideration than the extremely low operating cost.

[1] Sources: Polar Power Inc., manufacturers of solar-powered refrigerators; Vaccine Solar Refrigerators: Lessons Learnt from Large Scale Programme Surveys; various contributors, compiled by M. Zaffran, WHO/EPI, August 1991, unpublished data; and Module 2: The vaccine cold chain. In: Immunization in practice. A practical guide for health staff – 2015 update. Geneva: World Health Organization; 2015. Available at http://www.who.int/immunization/documents/IIP2015_Module2.pdf

Safety

A domestic refrigerator used in a laboratory may create hazards by providing ignition sources (thermostats, light switches, heater strips, etc.) that can ignite vapours from stored flammable solvents. These hazards may be eliminated or reduced by placing a warning sign on the refrigerator reading "Do not store flammable solvents in this refrigerator", by relocating the manual temperature controls to the exterior of the cabinet and by sealing all points where wires pass from the refrigerator compartment.

However, remember that self-defrosting refrigerators cannot be modified this way. A spark-free model can be ordered.

A suitable refrigerator for a field laboratory has a cooling chamber of 140 L or less. The size of the refrigerator should not be larger than necessary, because the dead volume in the cooling chamber must also be kept at low temperature, which requires additional energy. If blood for transfusion is to be stored in the refrigerator, it must maintain a temperature interval of between 2 °C and 8 °C and have a temperature monitoring system.

Refrigerators are monitored with the following two thermometer systems: integrated digital thermometers and stem thermometers. Solar direct-drive refrigerators typically have an integrated digital thermometer powered by an integrated photovoltaic cell; these do not work at night or in dim light. Stem thermometers only provide an instantaneous temperature reading. For this reason, WHO no longer recommends them as the main monitoring device in vaccine refrigerators. However, they remain an essential back-up device because they do not require a battery or other power source.[17]

A maximum–minimum thermometer with the bulb immersed in 250–500 mL of glycerol (water may be substituted but glycerol is preferred) as this will more accurately monitor the core temperature of the contents of the refrigerator. A maximum–minimum thermometer lying on a shelf or wall-mounted will only measure the air temperature, which will fluctuate with the opening and closing of the door and may give a falsely high reading compared with the actual temperature of the contents.

8.5.2 Installation and use

The correct installation and use of a refrigerator can reduce energy consumption considerably. When installing a refrigerator, it should be placed in a position that allows maximum air circulation at the condenser. It should be placed at least 10 cm away from the wall behind it and should not be covered. The air convection behind the refrigerator can be improved by providing a suitable small ventilator fan. If possible, place the refrigerator on a small timber platform (pallet). This improves cooling. Make sure the refrigerator is levelled by placing a ball on top of it and adjusting the refrigerator until the ball stops rolling. If the refrigerator is to be moved, it should not be tilted excessively and must never be laid on its side. To discourage people from disconnecting the refrigerator from its power outlet, it is advisable to fix a length of tape over the plug.

[17] http://www.who.int/immunization/documents/IIP2015_Module2.pdf

The energy consumption of a refrigerator depends on its design and frequency of use. The degree of heat exchange is proportional to the number of times the door is opened and for how long. These facts are important to remember in daily use, particularly if the refrigerator runs on photovoltaic energy.

8.6 Laboratory water purification systems

Pure water is needed to prepare stains and other reagents. Good sources of clean water are springs or rain, collected from a clean roof (if the salt concentration of the available water is high, it is preferable to use rainwater). The container used for collection and storage of water should be protected by a cover or lid at all times. A list of manufacturers of water purification systems is given in Annex 12.

It is important to determine water needs based on general cleaning and water needed for actual laboratory use. Water needs for laboratory use are typically lower.

There are two types of water used for laboratory purposes; water for general cleaning, which must simply be clean (that is, transparent, free from particulate matter), and water for reagents, which needs to have a low mineral content, be free from heavy metal cations, solids of any kind, have a pH of 6.5 to 8.5 and be free of microorganisms. Potential problems with water are reactions with phosphates, interference in Coomb's testing and with lyophilized reagents. For these reasons, it is strongly recommend that distilled or reagent-grade water be purchased if local water does not meet these requirements.

Local water can be purified by processing through a ceramic element. This may require pretreatment with the following procedure.

A number of simple methods can be used to treat water for laboratory use.

Removal of suspended solids

- Place the water in a container such as a tank or bucket, and leave it to stand overnight. Slowly pour off the clearer supernatant water, and discard the precipitate at the bottom. Add aluminium sulfate (alum cake) to the supernatant water at a rate of 5 g to 1 bucket (10 L) of water. Leave it to stand for 20 minutes, and then carefully pour off the clear supernatant water.
- Pour water with a low content of suspended solids through a filter with pore size 1 to 0.2 µm, depending on the use of the filtered water.

Distillation

Distillation is a good way to produce quality water for a laboratory, but this process has a high power and large water (for cooling) requirement. This is likely to make this

process unsuitable for many settings. However, if power and water requirements are met, then this is a very good alternative method of producing reagent-quality water.

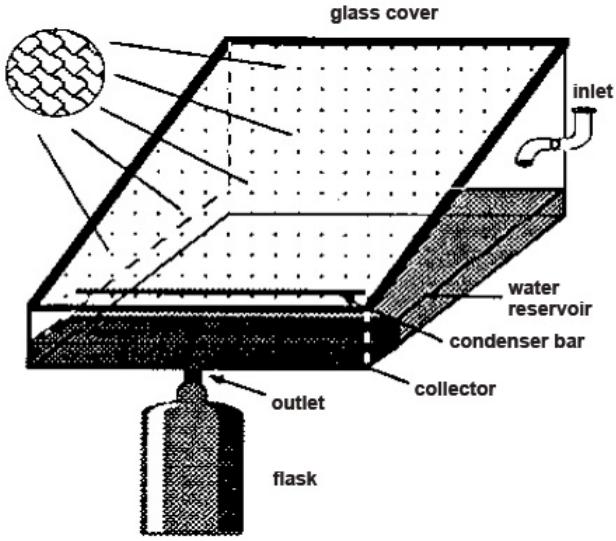
In water stills, impure water is boiled and the steam produced is condensed on a cold surface to give pure distilled water.

Water stills remove non-volatile organic and all inorganic material. Stills with a water flask and heating device are costly to maintain. They require a source of cool running water and a reliable energy source. Water with a high salt content should be demineralized prior to distillation (see below).

A simple solar-powered water still can be built using local materials to overcome pure water supply problems in sunny remote areas (Figure 8.1). A glass sheet covers a clean plastic container with a large surface area (1 m x 1 m) at an angle of about 30°. Water in the container is evaporated by the sun, condenses on the glass cover, and drops into a water collector placed at the lower end. From there the distilled water drops into a flask. In hot climates, 2–7 L of distilled water with a conductivity of 30–60 µS/cm[18] can be produced daily from a solar still with a surface area of 1 m^2.

Deionization

The easiest way to produce water for the preparation of diagnostic reagents and for washing equipment is by deionization. Deionizers contain ion-absorbing resins, which



Source: *(35)*

Fig. 8.1 Solar still

[18] Distilled water is used in laboratory testing. Electrical conductivity estimates the amount of total dissolved salts, or the total amount of dissolved ions in the water. Distilled or deionized water has very few dissolved ions and so there is almost no current flow. Good distilled water has a range of conductivity from 0.5 to 2 uS/cm. A conductivity of 30–60 µS/cm, under the circumstances, is good enough for many laboratory procedures.

remove inorganic and organic ions from water. Deionizers operate without an energy input, but they do not produce sterile water and do not remove all organic impurities. They may be subject to bacterial contamination, particularly in a warm environment. Impure water should be filtered before being deionized to prevent the resin from becoming exhausted too rapidly. Their capacity for demineralization of water is limited, and they require routine control and maintenance. Portable deionizers are commercially available.

Good quality water can also be obtained by means of carbon filters and reverse osmosis. Carbon filters have a limited capacity and the filters, resins or membranes have to be replaced.

Note: ceramic element filters are self-sterilizing and last for 6 to 12 months. They require weekly cleaning with a stiff-bristled brush and clear water (with no detergent).

8.8 Balance

A balance having sensitivity (readability) of 0.01 g (10 mg) will be adequate in most situations. There are two types that are suitable:

- a mechanical model with built in weights
- an electronic lightweight model operating on mains or battery power. A model with a flat top pan is easier to clean.. Electronic balances should have been adjusted at the factory for the particular location of their use (influence due to gravitational forces). When ordering the balance, specify the geographical location where it will be used. If the balance is to be used in an area of high relative humidity, ask the supplier if the balance has been protected from the effects of high humidity, for example, by conformal coating.[19]

8.9 pH meter

There is typically a choice between a bench-top and hand-held meter. In most instances, the hand-held type is more suitable, with the primary advantage of being battery operated. It is important that the pH meter selected reads to at least two decimal places. Select the meter best suited for the material/application being tested. A pH meter must also have the ability to be calibrated and be supplied with at least 500 mL of calibration solutions of pH 4, 7 and 10 as specified by the manufacturer.

[19] Conformal coating material is a thin polymeric film (transparent) which "conforms" to the contours of a printed circuit board to protect the board's components. In regions where high relative humidity is likely to occur, this protection should be applied by manufacturers of the equipment listed on pages 242 and 243.

8.10 Haematology analyser

Haematology analysers have the value of obtaining timely results for a complete blood count, differential leukocyte count and a wide range of other parameters. They are especially useful where a high workload is anticipated.

Automated haematology analysers are on the market in the form of affordable, compact and easy-to-use models (that provide open or closed vial sampling and analysis modes) which make them ideal for a laboratory in emergencies and disasters. They also cover the need for calculating red blood cell indices.

8.11 Blood gas analyser

Blood gas analysis is an important diagnostic tool and an essential part of managing a patient's oxygenation status and acid-base balance. Hand-held multipurpose analysers are available on the market (Some instrumentation may require an operating ambient temperature of < 30 °C). They can measure pH, pressure of carbon dioxide (PCO2), pressure of oxygen (PO2), total carbon dioxide (TCO2), bicarbonate (HCO3), base excess (BE), arterial saturation of oxygen (SO2), sodium (Na), potassium (K) and haemoglobin/haematocrit (Hgb/Hct). The blood gas and pH testing can be performed on arterial blood, which would need the sample to be supplied by the clinical unit. Alternatively, the use of hand-held multipurpose analysers using venous blood may be acceptable.

8.12 Serofuge and cell washer

The serology centrifuge (serofuge) is used for the easy, quick and thorough washing of red cells during red cell serology testing. It is designed for blood grouping, typing and crossmatching, particularly for the Coombs test, and other cell washing procedures.

The standard rotor holds up to 12 standard serology tubes, size 10 mm × 75 mm or 12 mm × 65 mm. A six-place aluminium head will accommodate 16 tubes of 100 mm length, 12 vacutainer blood collecting tubes or 12 tubes of 10 mL capacity.

8.13 Enzyme immunoassay equipment

Low-cost enzyme immunoassay (EIA) readers in a robust portable format and powered by an internal rechargeable battery or from mains electricity are available on the market. They are suited to laboratory or field test operations. They are important pieces of equipment, especially for screening blood donors and blood donations for markers of transfusion transmissible infections.

9. Supply of blood for transfusion in emergencies

This chapter is intended to facilitate coordination in a disaster between responders, aid agencies, local facilities, blood organizations, local hospitals and local government officials to:

- determine the medical need for blood
- facilitate transportation of blood from one facility to another
- communicate a common message to the public about the status of the blood supply in the disaster-affected area and the nation.

The best preparation is anticipation and planning. It is not a matter of if, but rather when the next disaster (man-made or natural) will occur. Certain events will have a greater impact on blood supplies and blood need. It is important to consider the impact that hazards will have on local blood supplies and need. Table 9.1 presents brief considerations and estimates regarding the need for blood supplies/requirements during emergencies.

Table 9.1 Considerations regarding blood supply/need during emergencies

Hazard	Impact on blood supply/need
Hurricane/cyclones	Depending on the projected path and force of the storm, local efforts to prepare may have a negative effect on blood collections in the days before and right after the storm. Blood need is typically low due to advance notice. Supply is often disrupted due to storm preparations and recovery efforts
Severe windstorm (tornado)	Tornadoes and severe windstorms pose a direct threat to blood facilities and to other medical structures in their path. Blood may be needed to treat casualties, which may number from a few to scores
Storms	Depending on the duration of the storm, local efforts to prepare may have a negative effect on blood collection in the days before and after the storm. Blood need would be considered low and manageable
Earthquake	Generally, blood use may not be initially significant, but the event could significantly hamper collection activities if a large area is deemed uninhabitable. In some situations, such as the Haiti and Pakistan earthquakes, immediate deployment of blood transfusion services is required from the start

Table 9.1 Considerations regarding blood supply/need during emergencies (*concluded*)

Hazard	Impact on blood supply/need
Floods	Impact on supplies and transportation can be significant, but demand should remain low and manageable
Tsunami	Given the unexpected nature and potential damage from a tsunami, the impact on the blood supply is similar to that of an earthquake and hurricane combined. Traumatic injuries may occur in coastal areas, resulting in an acute need for trauma-related transfusions with limited supplies
Industrial accident (fire, building collapse, hazardous material spill)	Hard to predict as it depends on the event, but they may or may not require blood support, depending on the nature and number of injuries. Historically, this type of disaster generally requires 300 units or fewer of blood products
Explosive event	Immediate mortality may be high, and some survivors would require resuscitation and surgery with associated transfusion support
Conflict emergencies	Mortality may be high, and numbers of injured will vary, but would require resuscitation and surgery with associated transfusion support
Epidemics	As in malaria and kala-azar epidemics. In malaria epidemic areas, many children are infected with the malaria parasite, and the severe anaemia which can result frequently causes death. Blood transfusions could be life saving for severely sick children. In kala-azar epidemics, anaemia should be corrected and blood transfusion is indicated in extremely anaemic patients

9.1 General

The greatest risk in blood transfusion during an emergency is the disruption of the blood distribution system. General assumptions are as follows.

- All disasters are inherently local.
- Immediate shipment of required blood products will be from blood collector(s) with access to the most rapid means of transportation to the affected area.

The first decision to be made in any emergency is whether a patient requires blood transfusion. This will depend upon factors such as:

- clinical situation of a patient
- availability and accessibility of blood from existing blood transfusion services or blood collection centres, availability of plasma substitutes or volume

expanders, such as crystalloid or colloid solutions. Intravenous fluid resuscitation is routinely prescribed for injury victims to expand intravascular volume and sustain adequate tissue perfusion and vital organ function.

Responses to disasters occur in phases. The following is the optimal response to a given phase of disaster:

- plasma volume expanders: crystalloids/colloids
- first 24 hours: Type O red blood cells (RBCs)
- 1–10 days: RBCs (all ABO/Rh types) and platelets (PLTs), fresh frozen plasma (FFP)
- 1–30 days: RBCs, PLTs, FFP, cryoprecipitate (PLTs, Cryo and FFP are sourced externally).

9.2. Equipment and consumables for blood transfusion in emergencies

For details of equipment and consumables for blood transfusion needed in emergencies, see Module 4a and Module 4b: Blood transfusion (Chapter 6).

Crystalloids and colloids (crystalloid solutions: lactated Ringer's solution, 0.9% sodium chloride solution; non-protein colloid solutions: dextran, hetastarch (hydroxyethyl starch); and other synthetic colloidal products) must always be available in situations involving patients with acute blood loss. The provision of such supplies should be based on the preliminary assessment, and they should be included in emergency surgery/pharmaceutical kits. The administration of plasma volume expanders will not normally involve the laboratory service. Guidelines on the indications for use of crystalloids and colloids and on the management of acute haemorrhage can be found in *Plasma and plasma substitutes in developing countries (3)*. Basic information is provided in the following sections to give an understanding of the process in order to better advise first responders on requirements and resources.

9.3 Transfusion therapy

The management of patients with acute blood loss may involve any or a combination of the following:

- crystalloid or colloid solutions
- blood supplied from transfusion services or blood collection centres
- emergency whole blood collected from selected donors on site.

After acute blood loss and haemorrhage control, the most important immediate therapeutic goal is to restore the blood volume. The infusion of crystalloid or colloid solutions must always be the first choice for early volume replacement therapy in patients with acute hypovolaemia due to haemorrhage.

Crystalloid infusions should be given as first-line therapy when acute blood loss exceeds 10% of blood volume. The treatment can be considered effective when vital signs have normalized. Red blood cell transfusions are helpful if blood loss exceeds 15% to 30% of blood volume. In addition to increasing red cell mass and oxygen delivery capacity, red blood cell transfusions also increase plasma volume by recruiting plasma proteins and extracellular fluid into the vascular compartment. In most cases crystalloids and red blood cell transfusions are sufficient to correct all adverse effects of the blood loss. Fresh frozen plasma transfusion may be useful if coagulation abnormalities exist.

Blood supply from existing transfusion services

If crystalloid or colloid solutions are not available or have been used and blood is still required, the patient must be transferred to a health facility where safe blood is available. Alternatively, blood can be transported to the site of the patient. In most emergencies involving large numbers of patients, blood should be transported from existing transfusion services or blood collection centres if the following prerequisites are met:

- an adequate supply of blood
- adequate communications
- adequate transport facilities for transport and storage of blood
- power supply for storage of materials for rapid blood typing.

9.4 Emergency whole blood collection from selected donors on site

In emergencies where blood cannot be provided from transfusion services or blood collection facilities, it may be necessary to collect blood from selected donors (that is, walking donors) on site. This should not be done without the necessary materials to collect, test and transfuse blood safely (see equipment and consumables of Module 4a and Module 4b: Blood transfusion). Donors should be selected to comply with standard blood donor selection criteria (see Section 9.5).

Collected blood donations must be correctly labelled, grouped/antigen-typed for ABO and RhD and should be screened for markers of the following transfusion-transmissible infections (TTIs): HIV, hepatitis B (HBV), hepatitis C (HCV) and syphilis

as well as other prevalent transfusion-transmissible illnesses in certain locations, such as malaria, sleeping sickness and Chagas disease. Screening of donations for other infective agents, such as those causing malaria or Chagas disease, should be based on local epidemiological conditions. Testing blood donations for HIV, HBsAg and HCV should be carried out using highly sensitive and specific immunoassays: HIV antibody (or combination HIV antigen–antibody), HBsAg assay and HCV antibody (or a combination HCV antigen–antibody) assay. Testing for syphilis should also be performed using a highly sensitive and specific Treponema pallidum antibody assay. In populations with a high prevalence of syphilis, screening could be performed using Venereal Disease Research Laboratory (VDRL) tests or rapid plasma reagin (RPR) tests. Both sensitivity and specificity of assays used for blood screening should be the highest possible, having a sensitivity and specificity that approach 100% (preferably, of minimum evaluated sensitivity of 99.9% and minimum specificity of 99.5%). WHO recommends that the minimum evaluated sensitivity and specificity levels of all assays used for blood screening should be as high as possible and preferably not less than 99.5%; see reference *(29)*.

Highly sensitive and specific immunoassays are the tests of choice for blood banks. Rapid or simple tests are not suitable for screening large numbers of blood donations for clinical use. If emergency screening using rapid or simple assays was performed in order to enable urgent and immediate release of blood for clinical use, it is recommended that samples be sent to the nearest referral laboratory for follow-up EIA testing. The ordering doctor should be informed of the type of test used and the results. While there are reasonably sensitive and specific HIV-1 + HIV-2 antibody rapid assays for use in emergencies, this is not the case with the majority of the currently available HBsAg and anti-HCV rapid assays. When the situation dictates use of rapid tests for blood screening for HIV, HBV and HCV, it is necessary to use highly sensitive and specific HIV-1 + HIV-2 antibody rapid assays, highly sensitive and specific HBsAg rapid/particle agglutination assays and highly sensitive and specific HCV antibody rapid assays, respectively.

Equally important is good documentation. Ensure adequate records are kept that indicate the ABO blood group and RhD type of the donor, TTI test results, the recipient and which emergency whole blood units were transfused to which patients. This is very important in the event of a retrospective testing indicating a positive TTI test, which will ensure that the patient and the donor get the necessary follow-up.

9.5 Emergency whole blood collection

9.5.1 Selection of donors

International criteria (for example, those of WHO or AABB) should be applied:

- weight — minimum 50 kg (or local standard)
- haemoglobin (Hb) — ≥ 12.5g/dl (or based on local standards)
- temperature — < 37.5 °C (99.5 °F)
- volume — limit of 10.5 mL per kilogram
- health status — donor should be interviewed; assessed to be in good health and free of major organ disease (see Annex 13).

9.5.2 Labelling of blood units in emergency collection

If a blood unit label printer is available, one system is to assign unit numbers starting with year followed by assigned blood unit numbers, for example, for 2009, start with 091001 followed by 091002, 091003, etc.

If a printer is not available, use a waterproof marker to write the assigned number.

Write the assigned blood unit number on the donor health questionnaire and donor's blood specimen for testing. The FDA-approved Full-Length Donor History Questionnaire: Version 1.1 June 2005, developed by AABB, could be used as a model to develop questionnaires appropriate to the geographical location and the situation. AABB has developed a newer version of the questionnaire (Version 2, May 2016, shown in Annex 13).

9.5.3 Blood collection volume

The accepted maximum for collections is 10.5 mL per kg of body weight (that is, 50 kg donor = 525 mL whole blood donated) based on a minimum haemoglobin of ≥ 12.5g/dl. In some developing countries, the blood volume collected is limited to 350 mL.

9.5.4 Blood storage with no power supply

In situations where electricity supply is limited, store collected blood units in expanded polystyrene foam boxes or cold-boxes packed with plastic bags containing ice cubes or ice packs. Separate the blood units from the icepacks/ice cubes with plastic or card board. Place a thermometer inside the expanded polystyrene foam box to monitor the storage temperature. This is purely for short-term storage requirements.

9.5.5 Testing blood donors

Ideally, blood donors are tested for ABO group by both forward (cell) grouping and reverse (serum/plasma) grouping. In some field settings where reverse grouping is not possible, it may be necessary to only perform forward grouping, in which case, blood grouping should be performed with a control provided by the manufacturer. If adequately equipped, RhD typing should include weak D typing when the direct RhD is tested as negative. Weak D positive blood units are labelled as RhD positive.

Quarantine and discard system should be documented. TTI reactive blood donations should be clearly marked and placed in a separate box for discard.

9.5.6 Labelling of blood samples for compatibility testing of unidentified patients, including patient's wristband and blood transfusion request form

Assign identification numbers starting with 1001 for the first unidentified patient, followed by 1002, 1003 etc.; include the sex of the patient. Put this number on an adhesive tape or even a bandage and put it on the wrist or forehead of the unidentified patient and the patient's blood transfusion request form. The labels are applied to the specimen tubes before leaving the bedside to avoid labelling the wrong tube.

9.5.7 Testing recipient (unidentified patient)

Pre-transfusion testing of the recipient shall include at a minimum ABO group by both forward (cell) grouping and reverse (serum/plasma) grouping to confirm the ABO blood group and RhD type (weak D testing is not needed). Ideally, antibody screening should be performed.

9.5.8 Compatibility testing (crossmatching)

At a minimum, a saline room temperature immediate spin method should be done, followed by an anti-human globulin test. The negative antiglobulin test should be validated with Coombs-checked cells. If crossmatching is not possible the blood group should be checked at the bedside by direct slide agglutination before a transfusion is given. The issued blood units should be labelled with the unidentified patient's ID, for example, 1001, or an available patient name and ID, ABO blood group and RhD type and result of compatibility testing.

9.5.9 Decision to transfuse group O RhD positive blood to RhD negative patient when RhD negative blood is not available

The clinician will make the above decision based on the risk factor relating to the patient's clinical condition. Some donors in developing countries can have very high isoagglutin titres that could result in passive antibody-induced transfusion reactions. Even red cell concentrates could have sufficient residual plasma in these circumstances. Nevertheless, the risk of this fact must be weighed against the need for transfusion.

It is recommended that pregnant women and those of childbearing age be transfused with RhD negative blood to prevent development of anti-D and potential haemolytic disease of the newborn.

9.5.10 Blood administration

Proper administration of blood is essential for patient safety. Issuance of blood, blood components and derivatives ordered by a physician should be of the same ABO group of the recipients or compatible red blood cells. All units of whole blood, red blood cells, plasma or other blood components and derivatives should be inspected visually right away prior to issuance for any abnormal physical appearance and to make sure that the correct issuance labels are attached.

The final clerical check is performed at the patient's bedside when the nurse/doctor double checks that the unit is designated to the correct recipient. All blood must be filtered (170 µm/180 µm filter) using the appropriate blood administration set. A patient with difficult veins should have the intravenous infusion device in place before the blood is administered. Blood and blood components are infused slowly for the first 10 to 15 minutes. The patient's vital signs should be monitored before starting the transfusion and periodically during the transfusion to detect early signs of a transfusion reaction.

9.5.11 Investigation of adverse events post transfusion

It is recommended to have basic protocols for nurses and doctors to recognize a transfusion reaction and to collect blood and urine samples for further investigation. In general, consider any adverse signs or symptoms at the time of the transfusion to be a transfusion reaction until proven otherwise. Listed below are the signs and symptoms that are typically associated with acute transfusion reactions:

- fever with or without chills (increase of 1 °C or 2 °F)
- shaking chills with or without fever
- pain at the infusion site, chest or abdomen

- blood pressure changes (acute)
- respiratory distress, including dyspnoea, tachypnoea, wheezing, etc.
- skin changes, including urticaria, pruritis (itching), flushing or local oedema
- darkened urine or jaundice
- bleeding or other sign of consumptive coagulopathy.

In the laboratory, perform the following three steps.

- Check for clerical errors.
- Perform a visual check for haemolysis on a post-transfusion venous-collected blood sample.
- Reconfirm donor and recipient ABO/Rh group.
- Perform a serological check for blood group incompatibility repeating the crossmatch and perform a direct antiglobulin test (DAT), also known as a direct Coombs test.

9.6 Summary

The first choice of therapy for volume replacement in emergencies must always be colloid or crystalloid solutions and, if necessary, blood from existing blood collection centres or transfusion services. Blood transfusion should always be the therapy of last resort, never the first.

Among the important factors contributing to safe transfusion to patients are proper identification and labelling of patients' blood samples, correct testing of ABO and RhD blood groups, compatibility testing, and issuing and administering the correct blood to a patient. In addition, the role of obtaining a donor's health questionnaire, aseptic arm preparation, blood collection, ABO and RhD grouping and TTI testing play a crucial role in the patient's therapeutic benefit of safe blood transfusion starting from donor's vein to patient's vein.

For further information and details regarding blood transfusion and blood safety, the reader is encouraged to refer to WHO publications, documents and recommendations, many of which are available on WHO's website: www.who.int

10. Collection, storage and transport of specimens

10.1 General

While many medical diagnostic laboratory tests can be done near to the patient, in small clinics, or in the field, there may be occasions that require more elaborate or extensive tests. This potential need can be met in several ways. The patient can be transported to a central medical facility, or specimens obtained from the patient can be sent to a laboratory for analysis. The latter is usually more convenient and cost--effective. Standard precautions should be considered when acquiring and handling specimens for outbreak investigations. Gloves should be worn, and special care should be taken when centrifuging blood and transferring the plasma/serum to a second container. Blood from suspected viral haemorrhagic fever patients should not be manipulated post-collection.

For specimens to be stored and transported it is essential that:

- the appropriate specimen is taken and correctly labelled
- a suitable container, with transport medium where necessary, is used
- appropriate storage temperatures are used
- an effective system of transport from the field is established
- appropriate safety precautions are taken
- specimens to be transported to another country are packed correctly, according to current IATA regulations.

Depending on the investigation required, samples may be sent in the following containers:

- transport of liquid specimens on filter paper (commonly incorporated into a form of card specifically constructed for sample collection; most often used for the collection and transport of dried blood samples. See Annex 14).
- clean screw-cap container
- sterile screw-cap container
- transport media for bacteria (Clary–Blair)
- transport media for viruses (universal transport medium)
- transport media for tissue (10% formalin).

Information regarding the transport of various specimens is given in Table 10.1. To preserve integrity and pathogen viability for culture or inoculation, specimens should be kept in appropriate media and stored at recommended temperatures. These conditions will differ depending on the specimen's sensitivity. Discuss specimen suitability, storage and transport with the receiving laboratory. Long storage time and long transportation times should be avoided. In any outbreak investigation, consultation with the receiving laboratory is recommended.

Table 10.1 Specimen transport: purposes, methods, and conditions

Specimen	Purpose	Container/ preservative	Specimen amount	Holding temperature	Storage time
CSF	Serology	Tube/sterile	1–2 mL	4 °C to 8 °C or frozen[a]	1–2 days 4 °C to 8 °C Specimens may be stored indefinitely at –70 °C[d]
	Bacteria	Sterile bottle/ tube/ appropriate transport media	1–2 mL	Ambient temperature, not exceeding 37 °C. Protect from sunlight[b]	Within 24 hours
	Virus	Tube/sterile	1–2 mL	4 °C to 8 °C or frozen[c]	1–2 days (4 °C to 8 °C) Specimens may be stored indefinitely at –70 °C[d]
Vaginal, urethral secretion	Bacteria,	Sterile bottle/ tube/appropriate transport media	Swab		Within 24 hours
Faeces	Bacteria	Sterile bottle/ tube/appropriate transport media	Swab		1–2 days
	Virus	Sterile tube	1–2 g	Fresh stool 4 °C to 8 °C	1–2 days
	Parasites	Tube with preservative	5 mL	Mix fresh bulk-stool specimens thoroughly with preservative. If no preservative is available, refrigerate the untreated stool specimen at 4 °C to 8 °C (do not freeze) for up to 48 hours. A preserved, specimen can be stored and transported at ambient temperature or refrigerated. Do not freeze	Indefinite

Table 10.1 Specimen transport: purposes, methods, and conditions *(continued)*

Specimen	Purpose	Container/ preservative	Specimen amount	Holding temperature	Storage time
Hair, nails, skin scraping	Fungus	Envelope or screw-cap tube/ none	Several pieces	25 °C (room temperature not to exceed 37 °C)	1 week
Pus	Bacteria	Bottle/tube/ appropriate transport media	1 mL	4 °C to 25 °C (room temperature not to exceed 37 °C)	Within 24 hours
Blood/ serum	Serology	Sterile tube	5–7 mL	4 °C to 8 °C or frozen[a]	1–2 days (4 °C to 8 °C) Serum may be frozen at –20 °C for weeks or indefinitely at –70 °C. Avoid freezing whole blood. (Whole blood should not be frozen for transport to the receiving laboratory)[d]
	Bacteria	Bottle/culture bottle	5–7 mL	37 °C	As soon as possible
	Virus	Sterile tube, (serum)	1 mL	4 °C to 8 °C or frozen	4 °C to 8 °C (1day) May be stored indefinitely at –70 °C
Sputum	Bacteria	Wide necked, screw-capped, leak-proof, 50 mL sputum containers labelled "Sterile", with appropriate transport media	5–10 mL	25 °C to 37 °C	Within 24 hours
Sputum	For *M. tuberculosis*[e]	Sterile sputum container, wide necked, leak-proof, 50 mL, with screw-cap, labelled "Sterile"	3–5 mL	4 °C to 8 °C	1–2 days
Throat	Bacteria	Sterile bottle/ tube/appropriate transport media	Swab	25 °C to 37 °C	Within 24 hours
	Virus	Sterile tube/ appropriate transport media		4 °C to 8 °C	1–2 days

Table 10.1 Specimen transport: purposes, methods, and conditions *(concluded)*

Specimen	Purpose	Container/ preservative	Specimen amount	Holding temperature	Storage time
Naso-pharyngeal swab, nasal aspirate	Virus	Sterile bijou bottle containing 1–3 mL of viral transport medium	Swab; with a synthetic tip	4 °C to 8 °C	1–2 days
	Bacteria	Sterile bottle/ tube/appropriate transport media		4 °C to 8 °C	1–2 days
Urine	Bacteria	Sterile bottle or sterile tube	10 mL	4 °C to 25 °C	Within 2 hours
	Bacteria	Sterile universal container with boric acid 1%	10 mL	4 °C to 8 °C	Within 24 hours
	Parasites	Tube, with bleach, 0.2 mL (4 drops); hydrochloric acid, 0.1 mL (2 drops)	10 mL	25 °C to 37 °C	Indefinite

[a] Specimens for antigen or antibody detection may be stored between 4 °C and 8 °C for 24–48 hours, or at –20°C for longer periods. Some specimens may require special handling, for example freezing, so specific instructions should always be sought prior to collection. Sera for antibody detection may be stored between 4 °C and 8 °C for up to 10 days. It is important to avoid unnecessary freeze–thaw cycles, so do not freeze sera unless the facilities are available to keep them frozen until delivery. Although not ideal, sera stored at room temperature may still be useful for antibody testing even after prolonged periods (weeks) if the sample is collected in a sterile container and is not contaminated. Therefore, do not discard sera which have been collected simply because there are no refrigeration facilities available. Valuable information can sometimes be obtained from samples which have not been handled optimally because of resource or logistic limitations, but for the correct laboratory handling and interpretation of results the samples must be labelled and accompanied by a history of the storage and transport conditions.

[b] With the exceptions of urine and sputum, most specimens may be kept at ambient temperature, 25 °C (not to exceed 37 °C), if the specimen will be processed within 24 hours. For longer periods, storage between 4 °C and 8 °C would be advisable, with the exception of particularly cold-sensitive organisms, such as shigella, meningococcus and pneumococcus. Longer delays are not advisable as the yield of bacteria may fall significantly.

[c] Many specimens taken for viral isolation are acceptable for culture after two days if maintained in type-specific media between 4 °C and 8 °C. For longer periods, freeze these specimens as directed by expert advice, as infectivity may be altered. For prolonged storage periods, preservation at –70 °C may be indicated.

[d] Discuss specimen storage time and transport with the receiving laboratory.

[e] Warning: there are a number of risks to laboratory staff when carrying out tuberculosis work. The authors recommend reading the following publication: Lumb R, Van Deun A, Bastian I, Fitz-Gerald M, editors. Laboratory Diagnosis of Tuberculosis by Sputum Microscopy. Adelaide: SA Pathology; 2013 (http://www.stoptb.org/wg/gli/assets/documents/tb%20microscopy%20handbook_final.pdf).

Refer also to: WHO/CDS/CSR/EDC/2000.4 Guidelines for the collection of clinical specimens during field investigation of outbreaks (Geneva: World Health Organization, 2000. Available at www.who.int/csr/resources/publications/surveillance/whocdscsredc2004.pdf).

10.2 Collection and storage

10.2.1 Microorganisms

Various transportation systems and preservatives are used to maintain the viability of microorganisms while suppressing their growth in specimens. Certain preservatives will also suppress the growth of contaminating organisms in the specimen while keeping the pathogenic bacteria alive. Any clinical specimen should be transported to the reference laboratory as soon as possible. The fresher the specimen, the greater the likelihood of a successful laboratory analysis.

These specimens should be sealed in containers with tightly fitting lids or in sealed double plastic bags.

10.3 Shipment of samples

Under certain provisions, infectious substances may be sent by air. The shipment of infectious agents or diagnostic specimens by air must comply with local, national and international regulations. International air transport regulations are found in the International Air Transport Association (IATA) publication "Dangerous Goods Regulations".

It is of paramount importance to emphasize that personnel involved in the transport of infectious material must have received adequate training (including exposure to courses, consultation and guiding documents) in the appropriate procedures for the handling and shipping of infectious substances.

The United Nations Committee of Experts on the Transport of Dangerous Goods, a committee of the United Nations Economic and Social Council, is continually developing recommendations for the safe transport of dangerous goods by any mode of transport (by air, rail, road, sea or post). The International Civil Aviation Organization (ICAO) has used these recommendations as the basis for developing regulations for the safe transportation of dangerous goods by air. The IATA regulations include all requirements of the ICAO Technical Instructions for the Safe Transport of Dangerous Goods. However, IATA has included additional, more restrictive requirements than those of ICAO. Dangerous goods are classified into nine hazard classes. Infectious substances fall under Class 6, Division 6.2; (solid carbon dioxide, also called dry ice, falls under Class 9, Miscellaneous (must be assigned UN 1845). When preparing a specimen for shipping, one must know the hazard class in order to correctly complete the packaging and documentation.

Pathogens are no longer assigned according to their risk group. According to the new UN classification for transport purposes pathogens are divided into two categories: Category A (infectious substances affecting humans UN 2814 and infectious substances affecting animals UN 2900) and Category B (biological substances, UN 3373).[20]

A Category A infectious substance is a substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability to or life-threatening or fatal disease in healthy humans or animals. Category A infectious substances includes the higher risk infectious pathogens.

Indicative examples of infectious substances included in Category A, defined as infectious substances affecting humans (must be assigned UN 2814) or animals (must be assigned UN 2900), are shown in Table 10.2. All specimens of infectious substances listed in Category A as "cultures only" (for example, *Bacillus anthracis, Brucella abortus, Pseudomonas mallei, Mycobacterium tuberculosis,* poliovirus, rabies virus, clostridium botulinum, dengue virus, etc.) need to be sent as Category A, while clinical samples of these same Category A substances which are not in the form of culture may be sent as Category B substances. For those infectious substances listed in Category A which are not defined as "cultures only", all specimens and their cultures must be sent as Category A.

Table 10.2 Examples of infectious substances in Category A

UN 2814. Infectious substances affecting humans (and animals)	
Bacillus anthracis (cultures only)	Human immunodeficiency virus (cultures only)
Brucella abortus (cultures only)	Japanese Encephalitis virus (cultures only)
Brucella melitensis (cultures only)	Junin virus
Brucella suis (cultures only)	Kyasanur forest disease virus
Burkholderia mallei – Pseudomonas mallei-glanders (cultures only)	Lassa virus
Burkholderia pseudomallei – Pseudomonas pseudomallei (cultures only)	Machupo virus
Chlamydia psittaci – avian strains (cultures only)	Marburg virus
Clostridium botulinum (cultures only)	Monkeypox virus
Coccidioides immitis (cultures only)	*Mycobacterium tuberculosis* (cultures only)
Coxiella burnetti (cultures only)	Nipah virus
Crimean–Congo haemorrhagic fever virus	Omsk hemorrhagic fever virus
Dengue virus (cultures only)	Poliovirus (cultures only)
Eastern equine encephalitis virus (cultures only)	Rabies (cultures only)

[20] For regulations for UN3373, see: http://www.un3373.com/info/regulations/; for regulations for shipping a biological substance, Category B using IATA packing instruction 6502, see: https://www.iata.org/whatwedo/cargo/dgr/Documents/packing-instruction-650-DGR56-en.pdf, and http://www.ehs.washington.edu/epo-shiphazmat/09_PI650_inst.pdf

Table 10.2 Examples of infectious substances in Category A *(concluded)*

UN 2814. Infectious substances affecting humans (and animals)	
Ebola virus	*Rickettsia prowazekii* (cultures only)
Escherichia coli, verotoxigenic (cultures only): serotype O157:H7 and other serotypes associated with the production of verotoxin	Rift Valley fever virus (cultures only)
Flexal virus	Russian spring – summer encephalitis virus (cultures only) Sabia virus
Francisella tularensis (cultures only)	*Shigella dysenteriae* type 1 (cultures only)
Guanarito virus	Tick-borne encephalitis virus (cultures only)
Hantaan virus	Variola virus
Hantaviruses causing hemorrhagic fever with renal syndrome	Venezuelan equine encephalitis virus (cultures only)
Hendra virus	Vesicular stomatitis virus (cultures only)
Herpes B virus (cultures only)	West Nile virus (cultures only)
Highly pathogenic avian influenza virus (cultures only)	Yellow fever virus (cultures only) *Yersinia pestis* (cultures only)
UN 2900. Infectious substances affecting animals only	
African swine fever virus (cultures only)	Mycoplasma mycoides – contagious bovine pleuropneumonia (cultures only)
Avian paramyxovirus type 1 – velogenic Newcastle disease virus (cultures only)	Peste des petits ruminants virus (cultures only)
Classical swine fever virus (cultures only)	Rinderpest virus (cultures only)
Foot and mouth disease virus (cultures only)	Sheep-pox virus (cultures only)
Goatpox virus (cultures only)	Swine vesicular disease virus (cultures only)
Lumpy skin disease virus (cultures only)	Vesicular stomatitis virus (cultures only)

Infectious substances, including those containing new or emerging pathogens, which do not appear in the Category A indicative list but which meet the same criteria as Category A, must be transported as Category A infectious substances. If there is any doubt about whether or not a pathogen falls under Category A, it must be transported as a Category A infectious substance.

Infectious substances considered to be of less risk include infectious substances not generally capable of causing permanent disability or life-threatening or fatal disease in otherwise healthy humans or animals after exposure to them, are assigned to Category B. Category B infectious substances also include clinical samples from a patient such as, but not limited to, excreta, secreta, and blood and its components, as well as tissue, tissue fluids and body parts being transported for purposes such as research, diagnosis and investigation. Category B biological substances must be assigned UN 3373.

Rules for packaging and shipping are determined according to the classification of a substance. The packaging requirements are defined by the UN and are contained in IACO and IATA regulations as Packaging Instructions 620 (for the transport of infectious substances in Category A assigned UN 2814 or UN 2900 as appropriate) and 650 (for the transport of infectious substances in Category B assigned UN 3373).[21] It should be noted that the requirements are subject to change by these organizations.

All packaging is based on a "triple" receptacle shipper. The packaging system used must be UN certified. UN approved packaging systems are available commercially. The UN certification number must be printed on the outermost container. UN certified packaging must be used as a complete shipping package as received from the manufacturer.

Every package containing potentially infectious material must have its contents durably and legibly marked on the outside of the primary container as well as on the secondary and outer containers. Packaging must be in three layers as detailed below.

Primary container (for example, tube, vial, bottle)

The primary container contains the specimen. The primary container must be watertight and leak-proof; it should be securely sealed with a screw-cap (no snap-caps). Never use mechanical devices to tighten the cap. Make sure that the specimen is correctly labelled. Screw-top tubes must have a piece of waterproof tape around the top to prevent the cover from coming loose during transit. The primary container must be protected to reduce shock; prevent breakage by surrounding it with sufficient absorbent material (for example, absorptive paper, cotton or cloth, but this should be non-particulate – not sawdust, vermiculite, etc.) to absorb all fluid in the primary container, should it be accidentally broken. The primary container must be packed in the secondary container in such a way that it will not break.

Secondary container (into which a primary container and the absorbent and cushioning material are placed)

The secondary packaging must be a durable watertight, leak-proof and securely sealed container made of metal or polycarbonate plastic with a screw-cap. It must be large enough to hold the primary container and the absorbent and cushioning material. Several primary containers can be enclosed in the secondary container, provided that the primary containers are individually wrapped or, in case of infectious substances

[21] UN3373 is a dangerous goods (DG) shipment classification under IATA Dangerous Goods Regulations (DGR) Division 6.2: Infectious Substances. See: https://www.iata.org/whatwedo/cargo/dgr/Documents/infectious-substance-classification-DGR56-en.pdf

transported in liquid nitrogen, separated and supported to prevent contact between them.

The following conditions must be met.

- The total volume in the primary containers should not exceed 50 mL.
- Each primary container must be individually protected as outlined above.
- Enough space must be left between the inner side of the secondary container and the primary containers for sufficient absorbent material to absorb the entire fluid from all the containers in case of accidental leakage or breakage.
- The smallest overall external dimension must be 10 × 10 cm.
- Tape one copy of the specimen data form and information about the specimen on the outside of each secondary container.
- Petri dishes must not be used for shipment.
- The maximum quantity per shipment is 50 mL or 50 g on passenger aircraft and 4 L or 4 kg for cargo aircraft. For surface transport there is no maximum quantity per package.

The secondary container must be placed in the outer container in such as way that it does not move.

An itemized list of contents is required and must be placed outside the secondary container (do not place documents inside the secondary container).The laboratory test requisition form may serve this purpose. The form should also be placed outside the secondary container. When packing specimen volumes of 50 mL or more, a shock-absorbent material should be added (a volume equal to the sample volume) between the outer sides of the secondary container and the outer shipping container. Do not overpack the secondary container, as this may cause breakage of the primary containers.

If dry ice is used for shipping frozen and refrigerated specimens the following should be remembered.

- Dry ice must be placed between the secondary container and the outer shipping container (dry ice must not be placed inside the primary or secondary receptacle because of the risk of explosions).
- Shock-absorbent material should be placed so as not to permit the secondary container to become loose inside the outer container, as dry ice sublimates and disappears.
- The outer container must permit the diffusion of carbon dioxide gas in order to avoid the built-up of pressure leading to rupture of the container.

If the infectious substance is shipped in liquid nitrogen, special arrangements must be made in advance with the carrier. Primary containers must be capable of withstanding extremely low temperatures, and secondary packaging must also withstand very low temperatures. Other appropriate packaging requirements of the carrier must be observed, in particular, the outermost packaging must carry a "non-flammable gas" label for liquid nitrogen, and UN Packing Instruction 202 must be observed. The primary container and the secondary packaging must maintain their integrity at the temperature of the liquid nitrogen as well as the temperatures and pressures of transport by aircraft to which they could be subjected if refrigeration were lost. Refrigerated liquid nitrogen packaging must be metal vacuum insulated vessels or flasks (also called "dry shippers"), vented to the atmosphere to prevent any increase in pressure within the packaging. The use of safety relief valves, check valves, frangible discs, or similar devices in the vent lines is prohibited. Fill and discharge openings must be protected. The packaging must be designed to prevent the release of any refrigerated liquid nitrogen irrespective of the packaging orientation.

Outer (tertiary) container (into which the secondary packaging with cushioning materials is placed)

The outer packaging (the outer shipping container) must be rigid and strong enough to withstand the weight and shock commonly associated with handling and shipment. It must be certified with a UN certification mark. The outer packaging must bear all required markings durably and legibly written on the outside of the outermost packaging, as follows.

- An infectious substances label must be attached.
- An address label must be attached, indicating the full name and address of the shipper (consigner) and the consignee as well as the name and telephone number of the person who is knowledgeable about the contents of the shipment.
- A Shipper's Declaration for Dangerous Goods must be attached to the top of the outer packaging.
- For Category A infectious substances, a Class 6.2 Infectious Substance label must be on the outer packaging.
- For all outer packaging containing receptacles with a capacity of more than 50 mL, arrows indicating the 'up' direction must be placed on two opposite sides of the outer packaging in such as way that the closures are upwards.
- For shipping infectious substances, the UN number followed by the shipping name must be indicated on the outside packaging (that is, UN 2814 for infectious substances affecting humans or UN 2900 for infectious substances affecting animals). The name of the organism is no longer required on the outside packaging.

- If dry ice is used, additional labelling is required, with the name of the refrigerant and the United Nations identification number UN 1845 for dry ice; the net quantity packed including the amount of dry ice added to the package in kilograms must be shown on the label. Dry ice must also be listed on the Shipper's Declaration for Dangerous Goods and the outer packaging must carry the hazard label for dry ice.
- If liquid nitrogen is used, the outer packaging must carry the hazard label for liquid nitrogen. Advance arrangements must be made with the carrier.

An example of the arrangement of a shipping container to transport dangerous or potentially dangerous specimens (Category A substances) is shown in Figure 10.3, while an example of the arrangement of a shipping container to transport specimens considered to be of less risk to health (Category B substances) is shown in Figure 10.4.

An import and/or export permit and/or declaration should be obtained if required. The shipper is responsible for the completion and signature of two copies of the Shipper's Declaration for Dangerous Goods. The declaration must be completed in the English language. If required by the country of origin and/or destination, the wording in English may be accompanied by an accurate translation in another language. The forwarding agent may assist and provide guidance to the shipper but is not entitled to complete the declaration. The forwarding agent may only enter the airway bill (AWB) number and the airports of departure and destination on the declaration. The shipper must enter all other items. Any correction must be countersigned by the same signatory.

A packing list (pro forma invoice) is required for nearly all categories of consignment and must include the consignee's address, number of containers, detail of contents, gross weight (optional) and value (for customs), together with a short statement indicating that the items are supplied free of charge. Even for medical samples a symbolic value must be entered.

The forwarding agent or an airline representative usually completes the airway bill. The airway bill is the airfreight document made out by or on behalf of the shipper, which determines the contract for carriage of goods over routes of the carrier(s).

The shipper should complete an export declaration. However, the export declaration may be prepared by the agent or airline representative who then presents it for signature.

It is recommended that an advisory fax/email/telex be sent to the consignee at least 48 hours before the arrival of the shipment. The fax/email/telex should include the following information: place of departure, place of arrival, number of containers,

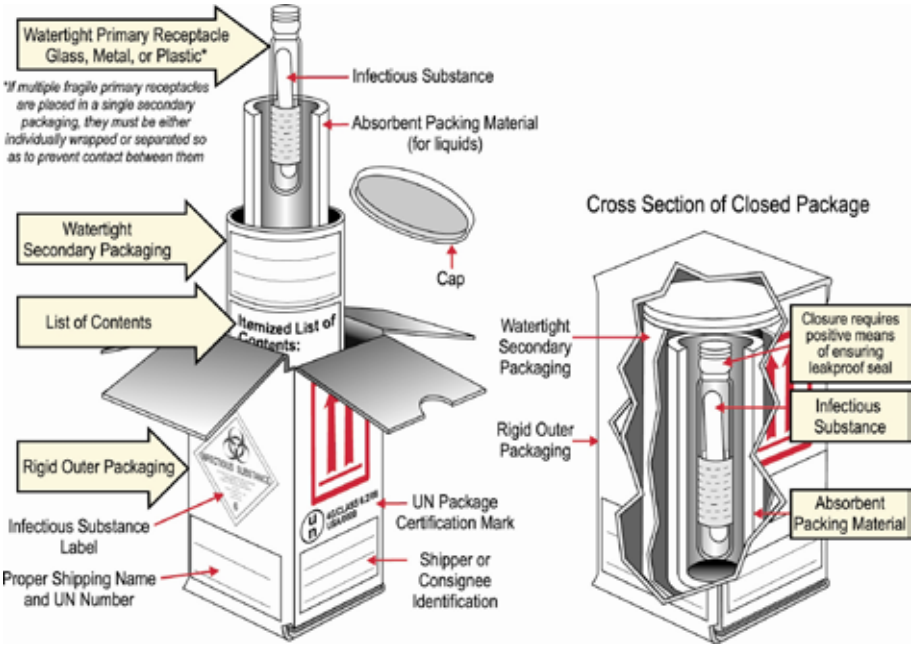


Fig. 10.3 Arrangement of a shipping container to transport dangerous or potentially dangerous specimens (Category A infectious substances): schematic Class 6 Division 6.2 Category A packaging

Source: reproduced with kind permission of the US Department of Transportation, USDOT/PHMSA.

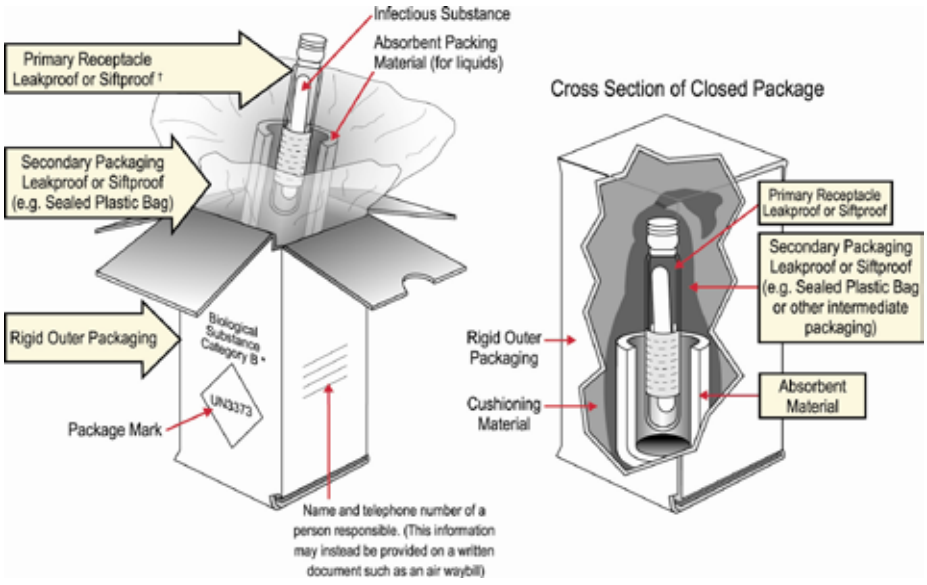


Fig. 10.4 Arrangement of a shipping container to transport Category B infectious substances: schematic Class 6 Division 6.2 Category B packaging

Source: reproduced with kind permission of the US Department of Transportation, USDOT/PHMSA.

flight arrival details (avoid, if possible, the arrival of the consignment over the weekend), airway bill number and recommended storage temperature.

In emergencies, all specimens should be considered potentially dangerous. Diagnostic specimen shipments do not require an infectious substance label, a Shipper's Declaration for Dangerous Goods or emergency response information.

11. Field laboratory record-keeping and reports

Field laboratory record-keeping may be different from the record-keeping in a modern laboratory with barcode labelled specimens and request forms, but some of the principles are the same. Proper recording and reporting in areas where people cannot read or write and the birthdate is not known might be quite a challenge, but the system must be good enough to ensure identity, reliability and confidentiality (the right person/requester must get the right result for the right patient). In settings where naming is difficult, the laboratory should use a numbering system to identify patient and samples. The system of slide labelling should enable the tracing of a specimen back to the patient and the day of testing.

Data collected by the laboratory is an important component of disease surveillance and diagnosis. Systematic reporting, daily, weekly and monthly, contributes to the assessment of the health status of the affected population, a disease notification system and early detection of disease outbreaks.

The following are points to consider when developing a laboratory record-keeping systems.

- Names may only be phonetic; one cannot assume a name can be spelled.
- Age is not important in some regions; people may not know their date of birth (child or adult).
- Similar names/same names may be prevalent.

Each programme is going to have to work out a recording system according to the local setting. In settings where naming is difficult, the laboratory should use a numbering system to identify patients and samples. It is essential that all laboratory results be recorded in permanent ink (not pencil). Certain results need to be reported to national authorities.

The work of the field laboratory worker should be recorded in a personal notebook, which can be used for future reference. All information should be recorded in a clear and understandable way. The daily records of the personal notebook should be written in such a way that any co-worker familiar with the type of work done would be able to understand it. Information on keeping a notebook and contacting a reference laboratory is given in Annex 17.

Annexes

Annex 1. Agencies providing health relief

UNITED NATIONS AGENCIES

United Nations High Commissioner for Refugees (UNHCR)

Case Postale 2500
CH-1211 Genève 2 Dépôt
Switzerland
Tel: +41 22 739 8111
Fax: +41 22 739 7377
Email: On website, go to 'Contact Us' to: use the online contact form to contact UNHCR Headquarters; search for information about a UNHCR field office
Website: www.unhcr.org

UNICEF'S Office of Emergency Programmes (EMOPS)

UNICEF House
3 United Nations Plaza
New York, New York 10017
U.S.A.
Tel: 1 - 212 – 326 7000
Fax 1 – 212 - 887 7465
Email: On website, go to 'Contact us', then 'email us'.
Website: www.unicef.org
Operating 24 hours, 7 days a week, the centre is a crucial communication hub between the UNICEF headquarters, the UNICEF supply warehouse in Copenhagen, and over 157 country offices. EMOPS coordinates headquarters support to country and regional offices dealing with emergencies. In addition, UNICEF's Operations Centre (OPSCEN) monitors emergency situations, as well as many ongoing crises. It provides UNICEF policy-makers with in depth analysis, while also keeping staff members in dangerous situations apprised of their own safety. The UNICEF Supply contact details are to be found in: Annex 15. Non-profit-making suppliers for tropical laboratories.

UNICEF Supply Warehouse

Denmark
The UNICEF catalogue includes laboratory equipment and reagents. Use the website below and click on Supply Catalogue.
Web site for supplies: www.unicef.org/supply/

World Food Programme (WFP)

Via Cesare Giulio Viola 68
Parco dei Medici
00148 Rome
Italy
Tel: +39 06 65131
Fax: +39 06 6590632
Email: use online Contact form
Website: wfp.org

Food and Agriculture Organization of the United Nations (FAO)
FAO Headquarters

Viale delle Terme di Caracalla
00153 Rome
Italy
Tel: +39 06 57051
Fax: +39 06 57051
Email: FAO-HQ@fao.org
Website: http://www.fao.org

WORLD HEALTH ORGANIZATION (WHO)

WHO headquarters

World Health Organization
Avenue Appia 20
1211 Geneva 27
Switzerland
Tel: +41 22 791 21 11
Fax: +41 22 791 31 11
Email: Use Request general information form: on website, go to 'Contacts', then 'other questions'.
Website: http://www.who.int/en/

WHO Regional Office for Africa

Regional Office for Africa
Cite du Djoue, P.O. Box 06
Brazzaville
Republic of the Congo
Tel: +242 770 02 02 or (47 241) 39100
Fax: +242 47 241 39503

Email: afrorgocommunications@who.int
Website: www.afro.who.int/

Regional Office for the Americas/Pan-American Health Organization

Emergency Programmes
Department of Emergency Preparedness and Disaster Relief
525, Twenty-third Street, N.W.
Washington, D.C. 20037, USA
Tel: +1 202 974 3399
Fax: +1 202 775 4578
Email: disaster@paho.org
Website: www.who/int

WHO Regional Office for the Eastern Mediterranean

Abdel Razak Al Sanhouri Street
P.O. Box 7608, Nasr City
Cairo 11371, Egypt
Tel: +20 2 2276 50 00
Fax: +20 2 2670 24 92 or +20 2670 24 94
Email: postmaster@emro.who.int
Website: www.emro.who.int/entity/information-resources/index.html

Regional Office for Europe

UN City, Marmorvej 51
DK-2100, Copenhagen 0
Denmark
Tel: +45 45 33 70 00
Fax: +45 45 33 70 01
Email: on website go to 'Contact us' to send an email
Website: www.euro.who.int/

Regional Office for South-East Asia

World Health House
Indraprastha Estate
Mahatama Gandhi Marg
New Delhi 110 002, India
Tel: +91-11-2337 0804
Fax: +91-11-2337 0197
Email: sereg@who.int
Website: www.searo.who.int

Regional Office for the Western Pacific

P.O. Box 2932
1000 Manila
Philippines
Tel: +63 2 528 8001
Fax: +63 2 521 1036
Email: postmaster@wpro.who.int
Website: www.wpro.who.int/

NONGOVERNMENTAL ORGANIZATIONS

Action Against Hunger | ACF-USA

One Whitehall Street
2nd Floor
New York, NY 10004
USA
Tel: +1 212 967 7800
Fax: Not given
Email: on web site use Contact for sending an email
Website: www.actionagainsthunger.org/

International Federation of Red Cross and Red Crescent Societies

P.O. Box 303
CH-1211 Geneva 19
Switzerland
Tel: +41 22 730 42 22
Fax: +41 22 733 03 95
Email: on website go to 'Contact us' to send an email
Website: www.ifrc.org/
Laboratory reagents and Laboratory supplies can be found at the website below:
http://procurement.ifrc.org/catalogue/overview.aspx?volume=2&groupcode=205&*familycode=205004*

International Committee of the Red Cross (ICRC)

19 Avenue de la Paix
CH 1202 Geneva
Switzerland
Tel: +41 22 734 60 01
Fax: +41 22 733 20 57

Email: on website go to 'Contact' to send an email
Website: http://www.icrc.org/

International Medical Relief

1151 Eagle Drive Suite 457
Loveland, CO. 80537
Tel: +1 970-635-0110
Fax: +1 970-635-0440
Email: on website go to 'Contact' to send an email
Website: http://www.internationalmedicalrelief.org/

CARE (Cooperative for American Relief Everywhere)

CARE USA
151 Ellis Street, NE
Atlanta GA 30303, USA
Tel: +1 404 681 2552
Fax: +1 404 577 5977
Email:info@care.org
Website: www.care.org

CARE International

Chemin de Balexert 7-9
1219 Chatelaine, Geneva
Switzerland
Tel: +41 22 795 10 20
Fax: +41 22 795 10 29
Email: cisecretariat@careinternational.org
Website: www.care-international.org/

Caritas Internationalis

Palazzo San Calisto
Vatican City State
V-00120
Tel: +379 06 698 797 99
Fax: +379 06 698 872 37
Email: caritas.internationalis@caritas.va
Website: www.caritas.org/

Catholic Relief Services (CRS)

228 W. Lexington St.
Baltimore,
Maryland 21201-3443, USA
Tel: +1 888 277 7575
Email: Use Contact form on website
Fax: Not given
Website: www. info@crs.org

InterAction

1400 16th Street, N.W.
Suite 210
Washington, D.C. 20036, USA
Tel: +1 202 667 8227
Fax: Not given
Email: ia@interaction.org
Website: www.interaction.org

International Rescue Committee (IRC)

122 East 42nd Street
New York 10168-1289
USA
Tel: +1 212 551 3000
Fax: +1 212 551 3179
Email: on website, go to: 'Contact'
Website: www.rescue.org/

International Federation of Biomedical Laboratory Science (IFBLS)

33 Wellington Street North
Hamilton, Ontario
L8R 1M7, Canada
Tel: +1 905 667 8695
Fax: +1 905 528 4968
Email: communications@ifbls
Website: www.ifbls.org/
IFBLS is an independent nongovernmental association of national societies in many countries. A list of IFBLS member countries can be found on the website under the heading 'Members'. This website gives educational links, for example: WHO:Summary of the new products available for the Zika and Yellow fever emergencies.

Lutheran World Relief (LWR)

700 Light Street
Baltimore, MD 21230
USA
Tel: +1 800 597 5972
Fax: +1 410 230 2882
Email: lwr@lwr.org
Website: www.lwr.org

World Council of Churches

150 Route de Ferney
1211 Geneva 2
CP 2100, 1211 Geneva 2, Switzerland
Tel.: +41 22 791 6111
Fax: +41 22 791 0361
Email: Not given
Website: http: www.oikoumene.org/

Medical Mission Institute Würzburg (MMI)

Salvatorstr. 7
D-97074 Würzburg
Germany
Tel.: +49 (0) 931 791 2803
Fax: +49 (0) 931 791 2801
Email: gf@medmisso.de
Website: http://www.medmissio.de

International Council of Voluntary Agencies

26-28 avenue Giuseppe Motta
1202 Geneva, Switzerland
Tel: +41 (0)22 950 9600
Fax: +41 (0)22 950 9609
Email: secretariat@icvanetwork.org
Website: http://www.icvanetwork.org

United States Agency for International Development (USAID) Information Center

Information Center
U.S. Agency for International Development
Ronald Reagan Building

Washington, D.C. 20523-1000, USA
Tel:+1 202 712 1000
Fax: Not given
Email: open@usaid.gov
Website: www. usaid.gov

EUROPEAN AGENCIES IN DISASTER RELIEF

Oxfam Health Unit

Oxfam House,
John Smith Drive,
Oxford OX4 2JY
United Kingdom
Tel: +44 (0) 1865 47 3727
Fax: Not given
Email: enquiries@oxfam.org.uk, or email: policyandpractice@oxfam.uk
Website: www.oxfam.org.uk/
Use the website for: Oxfam Supply Centre, Equipment Catalogue. See Water testing: Modules aa, ab, and ac; and Annexes 6 and 7.

Save the Children Fund

1 St John's Lane
London EC1M 4AR
United Kingdom
Tel: +44 020 7012 6400
Fax: +44 020 7012 6963
Email: supporter.care@savethechildren.org.uk
Website: www.savethechildren.org.uk

Disasters Emergency Committee

DEC Secretariat
Ground Floor, 43 Chalton Street,
London NW1 1DU
United Kingdom
Tel: +44 0207 387 0200
Fax: Not given
Email: info@dec.org.uk
Website: www.dec.org.uk

Liverpool School of Tropical Medicine

Pembroke Place
Liverpool L3 5QA
United Kingdom
Tel: +44 (0) 151 705 3100
Fax: +44 (0) 151 705 3370
Email: info@lstmed.ac.uk
Website: www.lstmed.ac.uk
The Parasitology laboratory offers a referral service for the identification of a wide range of human parasites from clinical specimens.

London School of Hygiene and Tropical Medicine

Keppel Street
London WC1E 7HT
United Kingdom
Tel: +44 (0) 20 7636 8636
Fax: +44 (0)20 7436 5389
Email: postmaster@lshtm.ac.uk
Website: www.lshtm.ac.uk

Royal Tropical Institute (KIT)

P.O. Box 95001
1090 HA Amsterdam
Netherlands
Tel: +31 (0) 20 568 8711
Fax: +31 (0) 20 668 4579
Email: communication@kit.nl
Website: www. kit.nl

IDA Foundation

Slochterweg 35
1027 AA Amsterdam
P O Box 37098
1030 AB Amsterdam
Netherlands
Tel: +31 20 403 3051
Fax: +31 20 403 1854
Email: info@idafoundation.org
Website: www.idafoundation.org

The Sphere Project

26-18, av Giuseppe Motta
1202 Geneva
Switzerland
Tel: +41 22 730 45 23
Fax: +41 22 730 49 05
Email: on web page use email form
Website: www.sphereproject.org/

Médecins Sans Frontières, International (MSF)

(also known as Doctors Without Borders)
78 rue Lausanne
P O Box 116
1211 Geneva 21
Switzerland
Tel: +41 22 849 8484
Fax: +41 22 849 8404
Email: office-gva@geneva.msf.org
Website: www.msf.org.en

MSF has the following Procurement Centres: 1) MSF Supply (Brussels, Belgium) www.transfer.be/; 2) MSF Logistique (Bordeaux, France) www.msflogistique.org/; and 3) MSF Holland Procurement Department (distributors).

MSF has local offices which can be contacted for urgent request in the following countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Czech Republic, Denmark, France, Germany, Greece, Hong Kong, India, Ireland, Italy, Japan, Kenya, Luxembourg, Mexico, Netherlands, Norway, Senegal, South Africa, South Korea, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, and United States of America. Local MSF offices are listed at http://www.msf.org/contact; click on the name of the country to show the address and the contact details in that country.

Médecins Sans Frontières

MSF Supply (Relief Supplies & Services)
Chausée de Vilvorde 140
1120 Brussels
Belgium
Tel: +32 (0) 2 249 10 00
Fax: +32 (0) 2 249 10 01
Email: office-msfsupply@brussels.msf.org
Website: www.msfsupply.be
The manual: Logistical Management of Humanitarian Supply can be found on the website.

Médecins Sans Frontières - MSF Logistique

3, Rue du Domaine de la Fontaine
33700 Mérignac - France
Tel: 33 (0)5 56 13 73 73
Fax: 33 (0)5 56 13 73 74
Email: office@bordeaux.msf.org

Médecins Sans Frontières Amsterdam Procurement Unit (APU)

Plantage Middenlaan 14, 1018 DD Amsterdam, Netherlands
(+31) 020-520 8700
Website: http://www.artsenzondergrenzen.nl/msf-supply-logistics.aspxs

Relief International, UK Office

Development House
56-64 Leonard Street
London ECA 4LT
United Kingdom
Tel: +44 20 7065 0871
Fax: +44 020 7357 9122
Email: info@ri.org
Website: www.ri.org/

Relief International, USA Office

1101 14th St. NW
Suite 1100
Washington, DC 20005, USA
Tel: +1 (202) 639 8660
Fax: Not given
Email: info@ri.org
Website: www.ri.org/

Project Hope

PO Box 96340
Washington, DC 20090-6340
USA
Tel: +1 540 837 2100
Fax: +1 540 837 9052
Email: HOPE@projecthope.org
Website: www.projecthope.org

Logistics Cluster

C/o World Food Programme (WFP)
Via Cesare Giulio Viola 68
Parco dei Medici
00148 Rome
Italy
Tel: +39-06-65131
Fax: +39-06-6590632
Website: www.logcluster.org/logistics-cluster

Logistics Cluster is an Inter-Agency Standing Committee (IASC) coordination mechanism hosted by WFP that is responsible for coordination, information management, and, where necessary, logistics service provision to ensure an effective and efficient logistics response takes place in humanitarian emergency missions. It is activated when there are response and coordination gaps in addressing humanitarian needs in emergency and disaster situations.

To find out about the latest updates regarding a disaster, go to http://www.logcluster.org/

WASH Cluster – Water Sanitation Hygiene

UNICEF Geneva
5–7 Avenue de la Paix
1211 Geneva
Switzerland
Tel: +41 22 909 5329
Fax: +41 22 909 5902
Email (general enquiries): globalwashcluster@gmail.com
Website: http://washcluster.net/

The Global Water Sanitation and Hygiene Cluster, or Global WASH Cluster (GWC), is a partnership grouping 32 partners which aims to improve coordination and humanitarian response in the WASH Sector. As the Cluster Lead Agency (CLA) for the Global WASH Cluster, UNICEF is responsible for establishing broad partnership bases (that is, "clusters") that engage in activities in the following main areas: Setting Standards and Policies. The WASH CLA is responsible for consolidating and disseminating standards, as well as identifying "best practice" for areas requiring technical expertise.

Annex 2. Reference laboratories for communicable diseases[1]

Environmental Microbiology and Safety Reference Laboratory

Porton Down
Culture Collections
Public Health England
Salisbury SP4 0JG
United Kingdom
Tel: +44 (0) 1980 612512
Fax: +44 (0) 1980 611315
Email: culturecollections@phe.gov.uk
Website: www.phe-culturecollections.org.uk
The website, under 'Services', includes the following: Technical support, Glossary, and Culture Collections, where products are given

National Reference Laboratory

PHE Colindale
61 Colindale Avenue,
London NW9 5EQ
United Kingdom
Tel: +44 020 8327 7160 / 7325
Fax: Not given
Email: fwe.nrl@phe.gov.uk
Website: www.gov.uk/government/collections/uk-national-reference-laboratory-for-food-microbiology

Centers for Disease Control and Prevention

1600 Clifton Rd, NE
Atlanta, GA 30333
U.S.A.
Tel: +1 800 CDC INFO or +1 800 232 4636
Fax: not given
Email: ADPolicy@cdc.gov
Website: www.cdc.gov/

Website for the CDC Special Pathogens Branch: http://www.cdc.gov/ncezid/dhcpp/idpb/diagnostic-techniques/index.html

[1] Specimens should only be forwarded to these laboratories following consultation. Proper shipping containers must be used. All regulations for shipping hazardous high-risk specimens must be observed.

Using the zika virus as an example, CDC provides guidance for US laboratories, and testing for zika virus Infection. The types of zika virus tests include: Molecular Test, Trioplex Real-time RT-PCR Assay, Serologic Test, Zika MAC-ELISA, and Plaque Reduction Neutralization Test. The CDC Institute and Offices give a list of support offices. This can be found at: www.cdc.gov/about/organization/cio.htm

European Centre for Disease Prevention and Control (ECDC)

Phone number: +46 (0)8 586 010 00
Fax number: +46 (0)8 586 010 01
Email: info@ecdc.europa.eu
Visiting address:
Tomtebodavägen 11a
171 65 Solna
Sweden
Postal address (for all official deliveries):
Granits väg 8
171 65 Solna
Sweden

Statens Seruminstitut

Centre for Prevention and Control of Infectious Diseases and Congenital Disorders
5 Artllervej
DK 2300 Copenhagen S
Denmark
Tel: + 45 3268 3268
Fax: +45 3268 3868
Email: serum@ssi.dk.
Website: www.ssi.dk

Reference laboratories for diagnostic testing of viral haemorrhagic fever specimens

US Army Medical Research Institute of Infectious Diseases (USAMRIID)

Medical Division
1425 Porter Street
Frederick, MD 21702-5011
USA
Tel: +1 703 428 6238
Fax: Not given
Email: On the website, go to 'Contact Us' to send an email.
Website: www.usamriid.army.mil
On the website, go to'Links' for links for: Biological Defence, Biomedical and Health, USA military and Government links

Institute of Tropical Medicine Antwerp

Nationalestraat 155
B-2000 Antwerp
Belgium
Tel: +32 03 345 55 55
Fax: not given
Email: +32 receptie@itg.be
Website: www.itg.be/

Health Systems Trust

PO Box 808
Durban 4000
South Africa
Tel: +27 31 266 9090
Fax: +27 31 266 9199
Email: hst@hst.org.za
Website: hstorg.za

Virology departments and institutes

This is a collection of the websites of virology departments of universities and research institutes around the world.
Web: virology.net

Laboratories and WHO collaborating centres for the diagnosis of ebola or marburg virus disease

WHO collaborating centre for reference and research on viral haemorrhagic fevers and arboviruses

National institute for communicable diseases
Private Bag x 4
Sandringham 2131
South Africa
Tel: +27 (0) 11 386 6382
Fax: +27 (0) 11 882 37 41
Email: januszp@nicd.ac.za

International centre for medical research in Franceville

BP 769
Franceville
Gabon
Tel: +241 (07) 85 06 13
Fax: +241 67 70 95
Email: Eric.Leroy@ird.fr

Kenya Medical Research Institute (KEMRI)

P. O. Box 54628
Nairobi
Kenya
Tel: +254 (02) 2722541 ext. 3391
Mobile: +254 (07) 22 759492
Email: RSang@kemri.org
Email 2: Rsang@wrp-nbo.org

Uganda Virology Research Institute

Plot 52-59 Nakiwogo Road / PO Box 49
Entebbe
Uganda
Bus: +256 (41) 320 387
Mobile: +256 (75) 650 251
Email: arbovir@infocom.co.ug

WHO Collaborating Centre for Arboviruses and Viral Hemorrhagic Fevers

Institut Pasteur, Dakar
BP 220
Dakar
Senegal
Tel: +221 (33) 839 92 23
Fax: +221 (33) 839 92 10
Email: asall@pasteur.sn

WHO Collaborating Centre for Viral Hemorrhagic Fevers

National Center for Emerging and Zoonotic Infectious Diseases
Centres for Disease Control and Infection
1600 Clifton Road
Atlanta, Georgia 30333
United States of America
Tel: +1 (404) 639 1122
Fax: +1 (404) 639 1118
Email: snichol@cdc.gov

WHO Collaborating Centre for Emerging and Zoonotic Diseases Detection, Diagnostics, Reference and Research

National Microbiology Laboratory – Public Health Agency of Canada
1015 Arlington Street
Winnipeg, Manitoba R3E 3R2
Canada
Tel: +1 (204) 784 5923
Fax: +1 (204) 789 21 40
Email: gary_kobinger@phac-aspc.gc.ca

National Reference Centre – WHO Collaborating Centre for Arboviruses and Viral Haemorrhagic Fever Reference and Research

Institut Pasteur, Lyon,
21, avenue Tony Garnier
69365 Lyon - Cedex 07
France
Tel: +33 (4) 37282440
Fax: +33 (4) 37282441
Email: ntordo@pasteur.fr
Stephan Gunther, Director

WHO Collaborating Centre for Arbovirus and Haemorrhagic Fever Reference and Research

Bernhard-Nocht-Institut For Tropical Medicine (BNI)
Bernhard-Nocht-Str. 74
20359 Hamburg
Germany
Tel: +49 (40) 42818 930
Fax: +49 (40) 42818 378
Email: guenther@bni.uni-hamburg.de

Annex 3. Assessment checklist for laboratory suppliers[1]

Name of supplier: ----------

Physical location: ----------

Contact address and telephone and fax numbers: ----------

E-mail/website: ----------

Contact person: ----------

Date of last assessment: ----------

Date of current visit: ----------

Name of items: (more details of products in Annex 3-a) ----------

Name of assessor: ----------

Link with the product:

Manufacturer

Distributor

Other

1. GENERAL Products being provided, brands, export/import, map of warehouse, number of employees, last inspection of NAFDAC, documentation re previous inspections, kind of transport for the products, from where do they arrive, how long they stay at the airport/customs, controls during transportation? Temperature or humidity monitoring?

OVERALL IMPRESSION

_____

_____

_____

_____

_____

_____

_____

[1] Reproduced with kind permission of and adapted from Médecins Sans Frontières, Operations Centre, Amsterdam.

Kind of laboratory materials provided:	Do we buy?	
Glassware	YES	NO
Plastic ware	YES	NO
Reagents	YES	NO
Consumables	YES	NO
Nonconsumables	YES	NO
Equipment	YES	NO
Culture media	YES	NO

Other _____

_____

_____

Brands:

Import

Local

Products imported from:		
Inspections done by:		
Registers from inspections available:	YES	NO
Length of time at airport/customs:		
Monitoring of temperature/humidity during transport:	YES	NO
List of products available	YES	NO
Brochures/catalogues available	YES	NO
Culture media	YES	NO

Staffing		
Number of qualified laboratory technicians?		
Number of qualified biomedical engineers	YES	NO
Training attended (give frequency and duration)		

In-house: _____

By manufacturer _____

Other: _____

Culture media	YES	NO

2. CERTIFICATIONS

Precise: _____

_____

Do you receive certificates of analysis for products? _____
Checked?_____

3. QUALITY CONTROL Internal quality control, external quality control, physical appearance of products, certificate of analysis, labelling, records

_____
_____
_____
_____
_____
_____

Is there a system for approving/selecting suppliers/ manufacturers?	YES	NO
Is there a laboratory in the company able to perform quality control on the products?	YES	NO
Are there registers of quality control?	YES	NO
Discrepancies registered?	YES	NO
External quality control available?	YES	NO
Laboratory expert available and properly qualified for the controls?	YES	NO
Accuracy of product and quantity against the packaging list?	YES	NO
SOPs available for the reception, quality control and dispatch procedures?	YES	NO
Labelling:	YES	NO
Batch number	YES	NO
Manufacturer	YES	NO
Manufacturing date	YES	NO
Expiry date	YES	NO
Instructions for storage	YES	NO
Precautions for handling, safety measures	YES	NO
Specifications	YES	NO

Quality grade for reagents (i.e. extra pure, pure, analytical grade) YES NO

Is there repacking or relabelling procedures carried out? _____. If so is it licensed? _____

Do we buy those repacked/relabelled products? _____

ADDITIONAL NOTES ON QUALITY CONTROL

_____
_____
_____
_____
_____
_____

4. STORAGE FACILITIES Good conditions for storage (light, temperature, humidity), registers, clean area, secure, stock system, classification system, fire extinguisher, separate area for damaged or expired stocks, enough space, room temperature and humidity recording? If there is a container is it in the shade, well ventilated?

_____
_____
_____
_____
_____
_____
_____

Cold room for cold items? Is it overloaded? Calibrated?	YES	NO
Back-up generator system in place? Automatic switch on? Capacity?	YES	NO
Clean and disinfected facilities, free from dust and pests?	YES	NO
Secured facilities?	YES	NO
Stock records available and properly filled?	YES	NO
Temperature/humidity records twice daily?	YES	NO
Fire extinguisher available?	YES	NO

Separated area for expired/damaged stock/reception and dispatch areas?	YES	NO
Does the storage system allow rapid/not-confused location of items?	YES	NO
Are all the items placed on pallets or shelves?	YES	NO
Is there a recording for room temperature and humidity?	YES	NO
Are the boxes stacked too high on top of each other?	YES	NO
Are the shelves labelled clearly and does this correspond to the actual?	YES	NO
Are liquids and dangerous items stored on low shelves?	YES	NO
Do they store flammable with toxic? Acid near base?	YES	NO

Do they do a physical stock take?_____ Frequency? _____

How many persons working in the store: _____

_____

Defined positions: _____

_____

What stock rotation procedure is used? FEFO/FIFO?

5. SERVICE PROVIDED Delivery of supplies, training for equipment, guarantee and maintenance, calibration of equipment

_____

_____

_____

_____

_____

_____

Delivery:	YES	NO
Keep stock?	YES	NO
Delay for delivery	YES	NO
International service	YES	NO
Cold chain available		
Monitoring of temperature during transport	YES	NO
	YES	NO

Documentation at delivery/billing Transported with clear identification	YES	NO
Types of transportation used? Courier/lorry/van?	YES	NO
Minimum shelf life of stock?	YES	NO
Training provided on site for equipment/techniques (if required):	YES	NO
Guarantee for major equipment:	YES	NO
Regular maintenance for major equipment on site	YES	NO

6. ADDITIONAL CONSIDERATIONS Other contact with this supplier? Constant supply assured from the company? Payment discussed and agreed?

_____

_____

_____

_____

_____

_____

NGOs in contact with the supplier? YES NO

Comments _____

_____

_____

Constant supply assured from the company? YES NO

Comments _____

_____

_____

Payment agreement discussed? YES NO

Comments _____

_____

_____

Are there written standard operating procedures for customer complaints and batch recall?

Was there any recall in the past? Give details and how it was handled?

How do they ensure traceability of all produce?

Annex 3a.

MSF CODE	MSF DESCRIPTION	BRAND SUPPLIED	PRICE	

Annex 3b. Documentation provided

1. Company profile	YES	NO
2. Registration/trading certificates	YES	NO
3. Manufacturer certification	YES	NO
4. Distributorship papers from the manufacturer	YES	NO
5. Product list	YES	NO

Annex 4. Collecting water samples for microbiological examination[1]

Although it may seem a simple matter to collect a sample of water, errors can occur and special care is therefore needed; problems can also arise independently of the sampling technique used. Unless valid samples are collected, the careful work that is carried out in the subsequent analysis could be a complete waste of time.

Water can be divided into three basic types for the purposes of sampling:

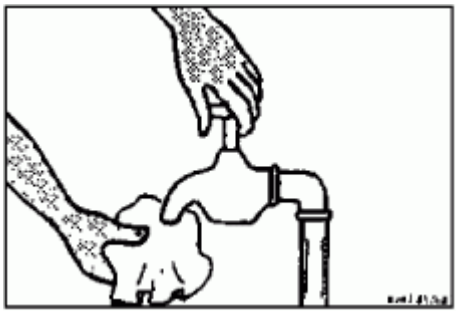
- water from a tap in a distribution system, or from a fixed hand pump, etc.
- water from a watercourse or reservoir (river, lake, tank)
- water from a dug well, etc., where sampling is more difficult than from an open water source.

A. Sampling from a tap or pump outlet

The steps to be followed in sampling from a tap or pump outlet are described in sequence below:

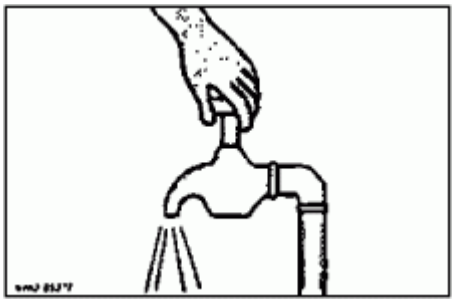
1. **Clean the tap**

   Remove from the tap any attachments that may cause splashing and, using a clean cloth, wipe the outlet in order to remove dirt.



2. **Open the tap**

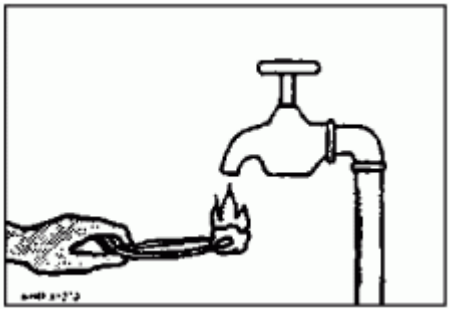
   Turn on the tap at maximum flow rate and let the water flow for 1–2 minutes. Then turn the tap off again.



[1] Also refer to: J. Bartram J, Mäkelä A, Mälkki E. Field Work and Sampling. In: Bartram S, Ballance R, editors. Water Quality Monitoring. A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes. Published on behalf of the United Nations Environment Programme and the World Health Organization; 1996. Available at http:(http://www.who.int/entity/water_sanitation_health/resourcesquality/waterqualmonitor.pdf).

3. **Sterilize the tap**

Sterilize the tap for a minute with the flame from an ignited cotton-wool swab soaked in alcohol. Alternatively, a gas burner or cigarette lighter may be used.

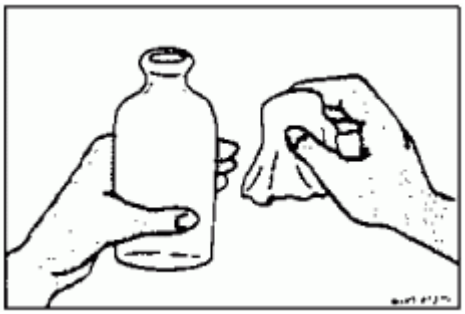


4. **Open the tap prior to sampling**

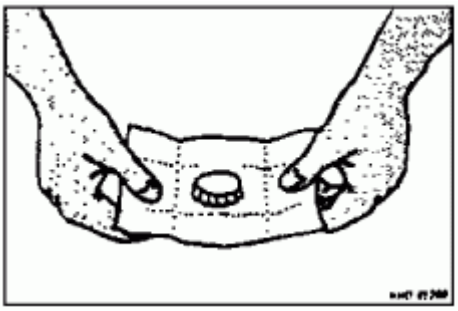
Carefully turn on the tap and allow the water to flow for 1–2 minutes at a medium flow rate.

5. **Open a sterilized bottle**

a) Standard technique: untie the string round the protective brown paper cover and pull out or unscrew the stopper.

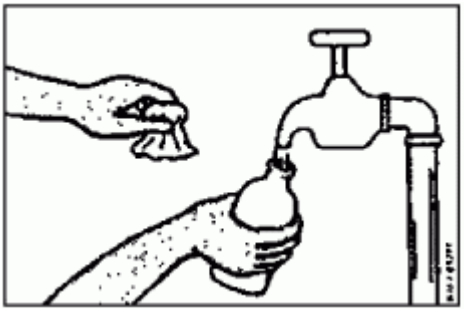


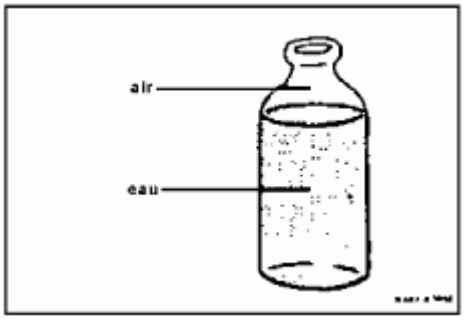
b) Hand-operated capping machine technique: untie the string round the protective brown paper cover and remove the cover, while an assistant opens the packet containing the sterile cap.



6. **Fill the bottle**

Holding the cap and protective cover face downwards so as to prevent entry of dust that might carry microorganisms, place the bottle directly under the water jet, and fill. A small air space should be left to facilitate shaking at the time of inoculation prior to analysis.

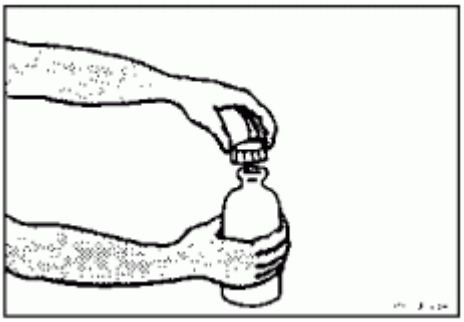


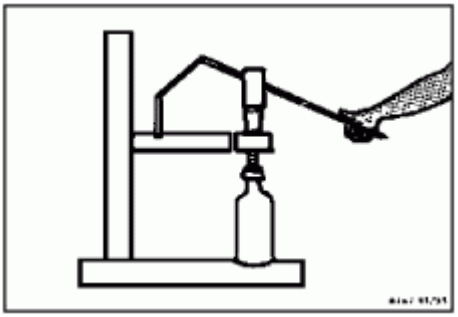


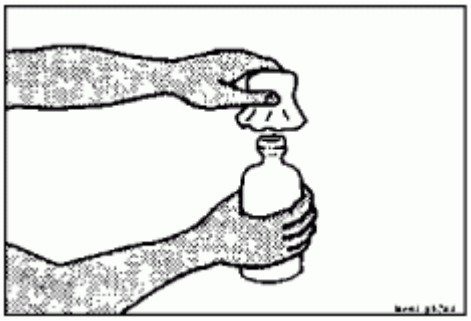
7. **Stopper or cap the bottle**

a) Standard technique: place the stopper in the bottle or screw on the cap and fix the brown paper protective cap back in place with the string.

b) Hand-operated capping machine technique: place the cap in position and then secure it using the capping machine; attach the protective brown cover with the string.





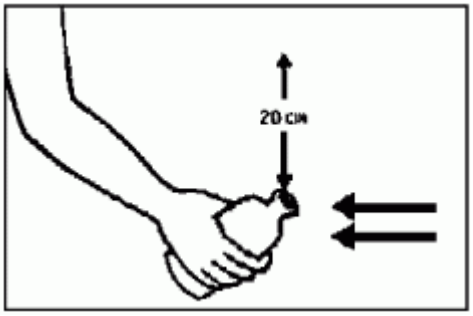


B. Sampling from a watercourse or reservoir

1. Open a sterilized bottle using one of the techniques described in A.5 above.

2. Fill the bottle.

   Holding the bottle by the lower part, submerge it to a depth of about 20 cm, with the mouth facing slightly upwards; if there is a current, the bottle mouth should face towards the current.



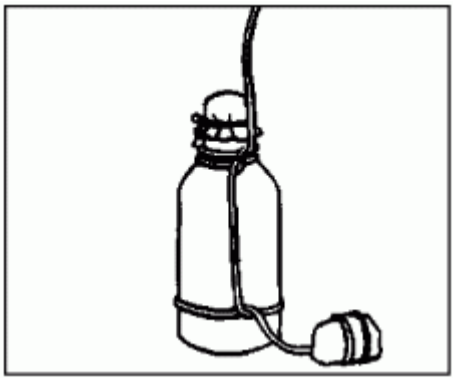
3. Stopper or cap the bottle as described in A.7 above.

C. Sampling from dug wells and similar sources

Every effort needs to be made to avoid contamination and losing the sterilized bottle. As you approach the well, look for a raised area where animals have not left faeces. Select a 'clean looking' stone to use as a weight for the bottle. The stone should allow the bottle to make a fairly rapid descent. Avoid a very heavy stone as this may cause the string to break.

1. **Prepare the bottle**

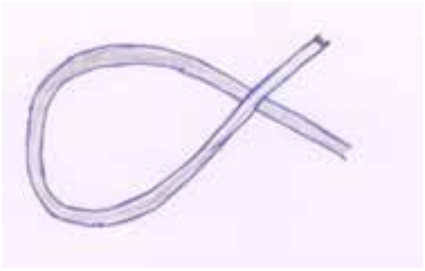
With a piece of string, attach a stone of suitable size (it needs to be a heavy stone) to a sterilized sampling bottle, as shown in C. 2. below.



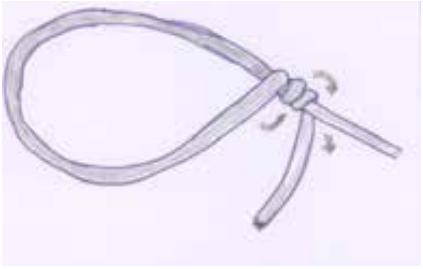
2. **Attach string to bottle**

a. Bottle tie knot

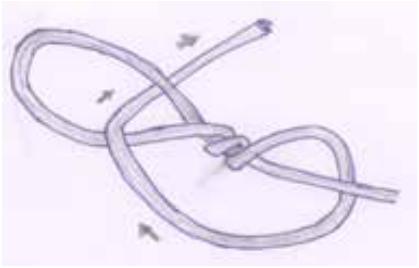
Remember to allow enough free string – perhaps 700 mm – in your tying end to also tie a half hitch on the bottle and a stone on the end of the string.



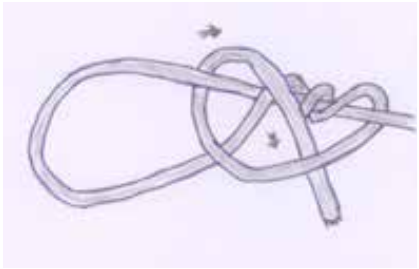
b. Wrap the free end around the holding end of the string three times.



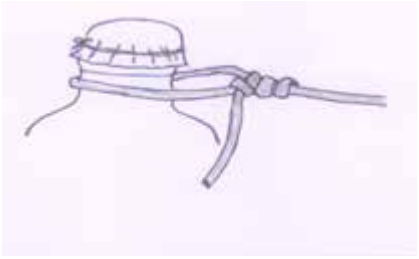
c. Push the free end through the 'eye' of the knot from the 'top'.



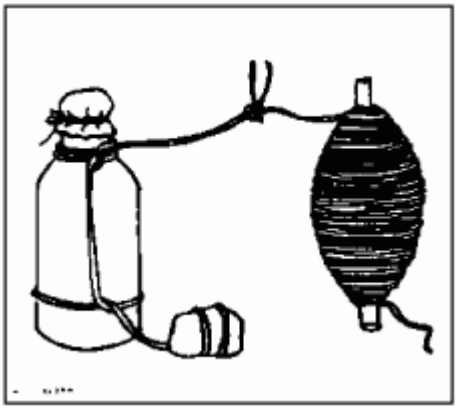
d. The free end is then pushed 'down' through the loop you have made.



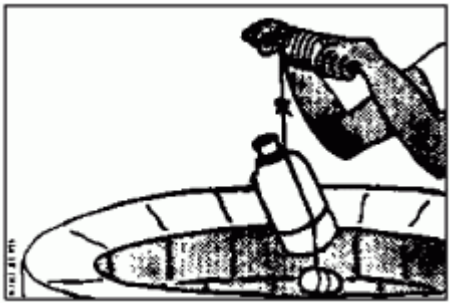
e. Tighten.



Take a 20 m length of clean string rolled around a stick and tie the end to the end of the string you used to tie the stone to the bottle. Open the bottle as described in A.5. above.

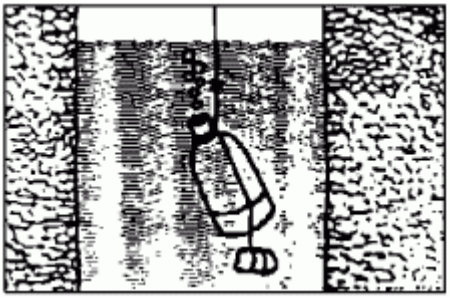


3. **Lower the bottle**



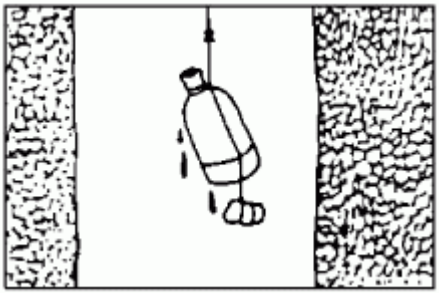
Lower the bottle, weighted down by the stone into the well, unwinding the string slowly. Do not allow the bottle to touch the sides of the well, where it may pick up dirt. If the weight (the stone) is quite heavy the bottle will go down quickly and miss sampling near the surface – providing at the start some string is kept unwound and free. Do not take the sample from near the surface – a true and representative sample should be taken from below the surface of the body of water (it does not have to be taken from one particular depth, but it is important to miss sampling the water at the surface).

4. **Fill the bottle**



Immerse the bottle completely in the water and lower to the bottom of the well.

5. **Raise the bottle**



Once the bottle is judged to be filled, rewind the string round the stick to bring up the bottle. If the bottle is completely full, discard some water to provide an air space. Stopper or cap the bottle as described in A.7 above. Label the bottle with the location, time and date.

Source: *(35)*

Annex 5. Manufacturers of water-testing kits[1]

Delagua Water-Testing Ltd.

Bacteriological and basic chemical/physical tests
Unit 2, The Old Dairy
Church Lane
Lower Fyfield
Marlborough SN8 1PX
United Kingdom
Tel: +44 1672 861 198
Fax: +44 1672 861 724
Email: sales@delagua.org
Website: www.delagua.org

Wagtech Water Technology Division

Bacteriological and basic and advanced chemical/physical tests
Palintest Ltd, Head Office (UK)
Palintest House
Kingsway
Team Valley
Gateshead NE11 0NS
Tyne and Wear
United Kingdom
Tel: +44 191 491 0808
Fax: +44 191 482 5372
Email: info@wagtech.co.uk
Website: www.wagtech.co.uk

Hach Company *Various Country Offices*

Bacteriological and basic and advanced chemical/physical tests
PO Box 389
Loveland CO 80539
United States
Tel: +1 800 227 4224; +1 970 669 3050
Fax: +1 970 669 2932
Email: Contact nearest country office
Website: www.hach.com

[1] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

Interfarm As

Bacteriological and basic chemical/physical tests
Øvre Måsan 10 D
1385 Asker
Norway
Tel: +47 6758 1130
Fax: +47 6758 1132
Email: post@interfarm.no
Website: www.interfarm.no

Idexx United States *Various Country Offices*

Bacteriological tests
1 IDEXX Drive
Westbrook ME 04092
United States
Tel: +1 800 321 6733; +1 207 556 0300
Fax: +1 207 556 4630
Email: water@idexx.com
Website: www.idexx.com/water

Hanna Instruments Ltd

Chemical/physical tests
Eden Way
Pages Industrial Park
Leighton Buzzard LU7 4AD
Bedfordshire
United Kingdom
Tel: +44 1525 850 855
Fax: +44 1525 853 668
Email: sales@hannainst.co.uk
Website: www.hannainst.co.uk

Merck And Co, Inc *Various Country Offices*

Chemical/physical tests
One Merck Drive
PO Box 100
Whitehouse Station NJ 08889-0100
United States
Tel: +1 908 423 1000

Email: contact nearest country office
Website: www.merck.com

Lovibond Water Testing

The Tintometer Ltd
Lovibond House
Sun Rise Way
Amesbury, SP4 7GR
United Kingdom
Tel: +44 (0)1980 664800
Fax: +44 (0)1980 625412
Email: water.sales@tintometer.com
Website: www.lovibondwater.com
Bacteriological and basic and advanced chemical/physical tests
Helpful internet links for the selection of water-testing methods, equipment, manufacturers and suppliers

Irc International Water And Sanitation Centre

Bezuidenhoutseweg 2
2594 AV The Hague
PO Box 82327
2508 EH The Hague
The Netherlands
Tel: +31 70 30 44 000
Fax: +31 70 30 44 044
Email: general@irc.nl
Website: www.irc.nl

India Water Portal

Arghyam
#599, 12th Main, 4th Cross
Indiranagar, HAL 2nd Stage
Bangalore 560008
Karnataka
India
Tel: +91 80 41698941; +91 80 41698942
Fax: +91 80 41698943
E-mail: info@arghyam.org
Website: www.indiawaterportal.org/channels/water-quality

Annex 6. Tool box[1]

- Allen keys (also known as hex keys), nickel plated, 1.5 mm–6 mm (1/16″–1/4″) set on ring
- Brush (paint flat), 20 mm or 25 mm
- Brush (paint round), 2 cm diameter
- Bolts (assorted) and nuts
- Circuit board lacquer (spray can) to protect circuit boards from humidity and environmental attack.
- Circuit board cleaner (spray can)
- Drill (hand crank)
- Drill bits (hardened drills for use with metal and wood) set of 12 drill bits, interval 0.5 mm, high stainless steel, sizes 1 mm–10 mm
- Dust remover (spray can) for the removal of dust from electronic, electric and optical devices
- Electrical tape, roll, 1
- File, bastard (half round), 300 mm
- Forceps, artery, haemostat, straight, stainless steel, 140 mm or 180 mm, multiple ratchet
- Hammer (sheet metalworker's), 200 g
- Hammer (claw), 250 g
- Handle (for files), 2
- Knife (tungsten carbide), for cutting glass tubing and glass rod
- Knife (trimming knife), with retractable blade
- Knife blades, 1 spare set
- Lubricating device (oil can)
- Lubricating device (spray can) to dispense moisture, penetrate, protect, clean and loosen corroded nuts and bolts
- Mirror, inspection, 55 mm diameter, long reach, swivel head, length = 370 mm
- Pick-up tool, pearl catch (nut-launcher); will clip to and hold small nuts, bolts and washers

[1] Useful information about tools can be found in a number of equipment catalogues, such as the Oxfam Supply Centre Equipment Catalogue, available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwi24e-qzajOAhWj7YMKHVwjBTgQFgglMAE&url=https%3A%2F%2Fwww.oxfam.org.uk%2Fequipment%2Fcatalogue%2Fdownloads-available%2FEquipment_Catalogue_latest_edition%2Fat_download%2Ffile&usg=AFQjCNH-a1g2aYjKRAzi7I-58avyKQ25eA
Look in the catalogue for: Tool kit, Site; Tool kit, Engineers; Took kit, Communications; and Tool kit, Electrical.

- Pliers, cutters, insulated, 125 mm
- Pliers (combination), insulated, 180 mm
- Saw (hacksaw), adjustable frame to accept blades of various sizes
- Saw (hacksaw) blades for metal, medium
- Scissors
- Screws (assorted), slotted, both sheet metal and wood screws
- Screwdriver, for cross-headed screws, no. 1
- Screwdriver (jewellers'), slot/Phillips; three-slotted tip and three Phillips cross-point, with knurled grip
- Screwdrivers, insulated handle, pan head, that is, blade type for slotted screws, metric: M3 (3 mm or .1181 inches/3/32″), M4 (4 mm or .1574 inches/1/8″), M5 (5 mm or .1968 inches/3/16″), M6 (6 mm or .2362/ just under 1/4″); set of 4
- Solder, general purpose electrical grade, wire with flux at its centre (rosin-cored)
- Soldering iron (electric), 60 W (or 12 V), with a tip of 1.5 mm or 2.3 mm (or butane)

Annex 7. Alphabetical listing of laboratory testing items (including water-testing)

Note: It is recommended that the reader view equipment catalogues for specific items, such as the UNICEF Supply Catalogue,[1] the Emergency items catalogue (Volume 2) of the International Federation of Red Cross and Red Crescent Societies,[2] and the Oxfam Supply Centre Equipment Catalogue.[3] Visiting the Logistics Cluster website[4] could also be useful.

Acetic acid, glacial, 1 L, bottle
Adhesive tape, zinc oxide, 75 mm × 5 m
Alcoholic disinfectant, ethanol and propanol at 70%–80% v/v
Alcoholic disinfectant, ethanol and propanol at 70%–80% v/v 2 L
Aluminium sulfate (or alum cake), 100 kg, to clear muddy water
Ammonia solution, concentrated
Analyser, automated, haematology
Analyser, blood gas, hand-held, multipurpose
Analyser, coagulation analyser; and rapid prothrombin time (INR) analyser reagent cartridge for prothrombin time (PT) or activated clotting time (ACT)
Antiseptic, chlorohexidine, 5% per litre, or: antiseptic, chlorohexidine 5% per litre/70% ethanol with 2% iodine
Applicator stick, wooden, box of 100
Aprons/laboratory coat, disposable plastic
Autoclave bags or non-leak bags suitable for incineration
Autoclave, portable
Bag, autoclave, 20 L
Bag, biohazard
Bags, plastic, self-sealing, medium size
Bags, plastic, self-sealing, small
Balance, mechanical, beam single pan model, 0–300 g, 1/100 g
Ball-point pen, black
Ball-point pen, red

[1] https://supply.unicef.org/unicef_b2c/app/displayApp/(cpgsize=5&layout=7.0 12_1_66_68_115_2&ui area=2 &carea=4F0904BE39BB068AE10000009E711453 &cpgnum=1)/.do?rf=y

[2] http://procurement.ifrc.org/catalogue/#2_205

[3] www.oxfam.org.uk/equipment/catalogue/downloads-available/

[4] http://www.logcluster.org/logistics-cluster, and: http://www.logcluster.org/logistics-emergency-teams

Bandage, plastic, small
Basin, plastic, diameter 285–310 mm
Batteries for calculator
Battery-powered microscope light source for back-up
Beaker, glass, low form, spouted, 100 mL
Beaker, glass, low form, spouted, 500 mL
Beaker, plastic, 100 mL
Beaker, plastic, 500 mL
Beaker, plastic, 1 L
Beaker, plastic, low form, spouted, 1000 mL
Beaker, plastic, spouted, 50 mL
Bleach (household 5%) or commercial
Blood administration set with 180 micron filter infusion device
Blood bags with anticoagulant and attached needle, 250 mL, with integrated second bag for plasma separation
Blood bags with anticoagulant and attached needle, 350 mL, with integrated second bag for plasma separation
Blood bags with anticoagulant and attached needle, 450 mL with integrated second bag for plasma separation
Blood grouping cards (intended for bedside use to reconfirm ABO compatibility at time of transfusion between patient and selected unit)
Blood grouping test, monoclonal anti-A antiserum, dropper bottle
Blood grouping test, monoclonal anti-B antiserum, dropper bottle
Blood grouping test, monoclonal/polyclonal anti-D antiserum, dropper bottle
Blood grouping test, reverse, A1 and B Cells (30%–40%), set
Blood grouping test, Rh negative control, dropper bottle
Blood grouping tile, with wells, minimum 5 wells
Blood pressure cuff
Blood trip scale with 585 ± 2g trip counterweight (can be made from blood bag filled with sand). Also, need 580 g and 590 g bags for trip scale quality control
Blood tube mixer, flat, rocker type
Books, manuals, guidelines and documents (including WHO's publications), relevant to testing to be performed
Bottle, dropper, polypropylene, brown with lid, 60 mL
Bottle, dropper, polypropylene, clear with lid, 60 mL

Bottle, glass (used to hold the blood transfusion refrigerator thermometer in a glycerol solution), approximately 500 mL
Bottle, glass, brown, screw-cap, 500 mL and 250 mL or smaller? For WBC staining solution
Bottle, glass, brown, screw-cap, 1 L
Bottle, glass, brown, with 1–10 mL bottle-top dispenser, 1 L
Bottle, swan-neck jet, plastic, 250 mL
Bowl, plastic, may be obtained locally
Box, slide, plastic, for 50 slides
Box, slide, plastic, for 100 slides
Broom
Brucellosis, rapid diagnostic test
Brush (for cleaning test tubes), large, 50 mm diameter
Brush (for cleaning test tubes), nylon or bristle head, head diameter about 12 mm
Brush (for cleaning cylinders), nylon or bristle head, large size, 70–90 mm diameter head
Brush (for cleaning cylinders), nylon or bristle head, small size, 40–50 mm diameter head
Brush, scrubbing
Brush, stiff bristles (to clean filters)
Bucket, metal (10–12 L), may be obtained locally
Buckets, fire containment, metal (to contain sand, dry soil or water)
Buffer tablets, pH 6.8, for staining blood smears for differential counting depending on the stain used
Buffer tablets, pH 7.0, for Leishman stain, blood bank serology ABO blood groups and compatibility testing
Buffer tablets, pH 7.2, one tablet to make 100 mL, for Giemsa staining
Burner, Bunsen, with gas/air regulation
Cabinet, hazardous material cabinet, medium size
Calcium hypochlorite
Calculator
Calculator batteries (spare)
Capillary tubes, haematocrit, heparinized (for the direct collection of capillary blood), 75 mm long, box of 250
Capillary tubes, haematocrit, plain (for use with anticoagulated blood), 75 mm long, box of 250

Carbol Fuchsin, solution, 1 L (for Ziehl Neelsen stain preparation)
Card, control blood grouping, bedside
Cary-Blair solution vials (with indicators for preservation and transport specimens)
Cary-Blair transport medium, bottles or tubes
Cell washer, automated, blood bank
Centrifuge, electric, bench-top model; swing-out rotor
Centrifuge, electric, manufacturer's recommend spare parts
Centrifuge, rotors and buckets; recommended, swing-out rotor with bucket inserts suitable for 3–7 mL blood tubes or equivalent fixed-angle rotor suitable for 3–7 mL tubes
Centrifuge, serology, specialized low g-force centrifuge
Centrifuge, spare parts: rubber feet, fuses, carbon brushes for analogue models
Centrifuge buckets with insert 5–7 mL tubes
Centrifuge buckets with insert 10–12 mL tubes
Centrifuge buckets with insert 50 mL Falcon tubes
Cerebrospinal fluid (CSF), chemistry test kit for glucose
Cerebrospinal fluid (CSF), chemistry test kit for protein
Cerebrospinal fluid (CSF), test kit, for cryptococcus antigen (serology)
Cetylpyridinium chloride, 50 g, bottle
Chlorine detection, titrator, digital, detection range: 20–70 000 mg/L
Chlorine detection, WataTest reagent kit, detection range: 1000–7000 mg/L
Chlorine detection, Serim Monitor for Chlorine test strip, detection range: 100–750 mg/L
Clips, metal, used with hand sealer when stripping blood from tubing (or dielectric sealer)
Clock, wall-mounted
Cold-box, for storing blood with ice packs, coolant, cardboard/plastic card to separate blood units from icepacks
Cold-box, leak-proof (for storage and transport of samples to laboratory)
Cold-box, vaccine carrier, overall dimensions: 24 × 24 × 33 cm, internal dimensions: 15 × 15 × 19 cm, storage capacity 1.7 L, ice packs
Capillaries, heparinized
Capillaries, plain
Commercial syphilis RPR test kit

Container (for urine), polystyrene, non-sterile, 20–60 mL capacity, wide-neck
Container, sharps, 5 L, cardboard for incineration
Containers (for urine, stool), polypropylene, 25–60 mL capacity, leak-proof screw-cap, wide-neck
Containers (for sputum), polypropylene, 60–120 mL capacity, leak-proof screw-cap, wide-neck
Containers, triple packs, IATA compliant, for sample transport
Control card, cold chain monitor
Coombs control cells (for antihuman globulin test)
Coombs reagent (antihuman globulin), monoclonal/polyclonal
Coplin jar, 60 mL, glass
Cotton wool, hydrophilic, roll, 500 g
Cotton-wool balls
Counter, mechanical differential, 5 keys with totalizer
Counting chamber, Neubauer, new improved bright line, double grid
Counting chamber cover glass, planed, for counting chamber, 20 × 26 mm
Cover glass, 20 × 20 mm
Cryptococcus antigen detection kit (serology)
Cylinder, measuring, plastic, graduated, spout, 250 mL
Cylinder, with clear graduations, polypropylene, spout, 10 mL
Cylinder, with clear graduations, polypropylene, spout, 50 mL
Cylinder, with clear graduations, polypropylene, spout, 100 mL
Cylinder, with clear graduations, polypropylene, spout, 500 mL
Cylinder, with clear graduations, polypropylene, spout, 1000 mL
Dengue, rapid diagnostic test kit
Depressor, tongue, wooden
Detergent containing enzyme; may be obtained locally
Device for stripping blood from donor pack tubing
Digital thermometer for body temperature
Disinfectant, commercial, directed against viruses
Disinfectant, hypochlorite granules 70% or liquid household bleach
Disinfectant solution, hand-washing, waterless cleaner
Dispenser, 1 L with plunger calibrated 1–10 mL delivery
Distiller (electricity operated), flash-vaporizing water, compact, light-weight (or water deionizer system)

Donor health screening questionnaire (see Annex 13)
Dust cover
EIA analyser with washer and incubator (complete system), to include printer and consumables associated with EIA kits.
Eosine powder (red), indicator grade, 25 g pack, or solution
Eraser (rubber), for erasing marking by pencil
ESR rack (to fit the ESR tubes)
ESR vacuum system or disposable ESR pipettes/tubes
Ethanol, denaturated, 70% v/v, 1 L (fuel for heating slides and used as a disinfectant)
Ethanol, denaturated, 95%, 1 L
Eye wash, solution, 1 bottle + eye cup
Eye-shield (goggles, clear shatter-resistant polycarbonate and fitted with side shields)
Field stain A, solution, 250 mL, bottle
Field stain B, solution, 250 mL, bottle
Film, sealing, plastic (parafilm) roll, 10 cm × 38 m
Filter paper, sheet, large, general purpose
Filter paper, Whatman no.1, circles, 12:5 cm
Filter paper, Whatman no. 4, discs, general purpose
Fire blanket
Fire extinguishers, multipurpose dry chemical or carbon dioxide powder models
First aid kit
Forceps, slides, stainless steel, 150 mm, Kühne
Forceps, stainless steel, blunt end, 105 mm long
Forceps, stainless steel, flattened bent and blunt end, 105 mm long
Formalin
Freezer, stand-alone, chest type. Capacity–small but generally > 50 L; Capable of reaching < –20 °C. May use available freezer if temperature requirement met
Fuchs–Rosenthal counting chamber
Fuchs–Rosenthal counting chamber cover glass
Funnels, polypropylene, 65 mm diameter, preferably ribbed
Funnels, polypropylene, 90 mm diameter, short end, preferably ribbed
Gas, cylinder, for gas stove
Gas stove, small

Gauze, sterile (for arm preparation in blood donor room)
Gauze pads, 2 in × 2 in, or equivalent
Gauze pads, 4 in × 4 in, or equivalent
Giemsa, stain, solution, 500 mL, bottle
Glass bottle, approximately 500 mL
Gloves, examination, non-latex, disposable, large/medium/small
Gloves, rubber, heavy duty (for cleaning)
Gloves, stout leather (for taking sharps containers to incinerator)
Glucometer, hospital grade, point of care; able to record and store user and store the lot number of test reagent; lock-out function if quality control not performed (must have manufacturer-supplied quality control system)
Glucometer, quality control, to be used in accordance with manufacturer's recommendation
Glucometer, test strips, compatible with the glucometer
Glucometer battery set/pack spare suitable for use in purchased glucometer
Glycerol, ≥ 100 mL
Gram stain kit (programmes that prefer to use individual stains should substitute the individual stains crystal violet, iodine and saffarin, plus the decolourizer of choice – acetone, acid alcohol, ethanol)
Graph paper
Gravity water filter, 10 L, fountain, four candles, used with self-sterilizing ceramic elements (candle filter)
Haemoglobin reagent solution
Haemoglobinometer, battery set/pack, spare suitable for purchased meter
Haemoglobinometer, microcuvettes, disposable
Haemoglobinometer, quality control to be used in accordance with manufacturer's instructions
Haemoglobinometer, self-calibrating, able to: auto-check for lipaemia, to be operated at > 30 °C (if applicable), tropicalized, non-condensing (if applicable)
Haemoglobinometer test cuvettes compatible with the haemoglobin meter
Hand/arm antimicrobial scrub solution: disposable povidone–iodine scrub 0.75% or disposable povidone–iodine swab stick 10% Hand/arm antimicrobial scrub solution: 10% povidone–iodine
Hand-sanitizer, waterless or equivalent (for use in blood donor room)
Hand-tally counter, mechanical hand counter, plastic- or metal-cased

Hazard safety labels with official symbols on yellow background, measuring 38 mm × 380 mm
Heat block, 37 °C
Hepatitis B surface antigen (HBsAg), EIA compatible with EIA analyser
Hepatitis B surface antigen (HBsAg), rapid diagnostic test
Hepatitis C virus (HCV), EIA for hepatitis C antibody (anti-HCV) compatible with EIA analyser
Hepatitis C virus (HCV), rapid diagnostic test for hepatitis C antibody (anti-HCV)
High-quality microscope objectives immersion oil, 1 L
HIV-1 and 2, EIA compatible with EIA analyser
HIV 1, 2, rapid diagnostic test
Hydrochloric acid, 37%, 1 L or tuberculosis decolourizer
Hydrochloric acid, concentrated 500 mL
Incinerator
Incubator, portable
Indian ink suspension
Iodine povidone, 10% solution/25 chlorohexidine, 200 mL dropper bottle and 70% isopropanol or 70% ethanol
Isopropanol
Jeweller's screwdrivers, set (general maintenance)
Labels (assigned blood unit number in a systematic manner as mentioned), donors' blood group (A, B, AB and O) and RhD type, positive/negative and labels indicating tested non-reactive to HIV1/2. HBV, HCV and syphilis serology markers
Labels, permanent self-adhesive (general purpose labelling)
Labels, to write patient's name and identification on blood bags to be issued to patients
Lamp (spirit burner), 65–100 mL, metal body preferred, with screw-cap
Lamp, spirit wick, (spare for lamp spirit), 7 mm diameter
Lancet, disposable, sterile, standard type
Leishman stain, high quality, 500 mL bottle (or Wright or May–Grünwald-Giemsa stain)
Lens-cleaning solution, 1 L
Lint-free cleaning cloth
Lodophor (povidone)

Lugol's iodine, 1 L (solution 0.3%)
Lunchbox, small, plastic, local purchase (moist box)
Malaria, rapid diagnostic test
Mask, micro droplet protection, meeting or exceeding the N95 standard
Measuring jug, polypropylene, graduated tall jug, 5 L
Meningococcal meningitis, serology test kit
Metal clips and hand sealer or dielectric sealer
Metal container (saucepan or similar) of sufficient size to accommodate a metal test tube rack accommodating 10–12 mL tubes
Methanol, absolute, AR
Methylene blue, Kinyoun stain, 1 L (for tuberculosis staining)
Microhaematocrit centrifuge, 15 000× g, (g = relative centrifugal force)
Microhaematocrit centrifuge, spare rotor rim gaskets, usually packet of 10
Microhaematocrit reader (if not integrated into the centrifuge)
Micro-loop, Pasteur, handle and loop, nickel chromium
Micro-loop, Pasteur, nickel/chromium
Microscope, dropper bottle for immersion oil, 50 mL
Microscope, fuses
Microscope, halogen lamps as specified by the microscope manufacturer (not needed if LED microscope)
Microscope, immersion oil, high-quality
Microscope, lens-cleaning paper, sheet
Microscope, lens-cleaning solution
Microscope, light microscope. Refer to Module 2a: Basic equipment and consumables
Microscope, lint-free cleaning cloth
Microscope case (with handle) for transport and storage
Mop
Mortar, porcelain 150 mL + pestle
Mount, wall, for 2 bottles eye wash
Needles, 21G/19G
Non-detergent steel wool pads
Oil, immersion, 50 mL, dropper bottle
Paediatric butterfly collection sets
Paper, filter, white, sheet

Paper, lens-cleaning, sheet
Paperclips, package
Parafilm, 4–6 cm wide roll
Parafilm (sealing plastic) roll, 10 cm × 38 m
Pens, ball-point (non-toxic), black
Pens, ball-point (non-toxic), red
Pens, diamond marker (for writing on glass), with aluminium handle (avoid retractable-point pen)
Pens, permanent marker, black
Pens, permanent marker, red
Pencil, normal writing, HB (dark, medium hardness). A harder, dark pencil is 5H; for those wanting a softer yet dark pencil, use a 3B. Grease pencil to write on glass, plastic, and metal.
Pencil sharpener
Petri dish, glass, approximately 120 mm diameter, with lids
pH meter, calibration solution set, pH 4, 7, 10 (or + 0.01); 500 mL each
pH meter, electrode cleaning solution
pH meter, portable, battery type, measuring interval: 6–8 pH, resolution: 0.02 pH; temperature-compensated measurement, calibratable, rugged casing
pH meter (if detachable electrodes), spare electrode
pH paper, pH 1–11
pH paper/strips, measuring interval 4.0–8.0
Phenol crystals 500 g
Pipette, automatic, 10–200 µL tip
Pipette, automatic, 100–100 µL tip, yellow
Pipette, automatic, 100–1000 µL tip, blue
Pipette, automatic, adjustable volume, 20–200 µL
Pipette, automatic, adjustable volume, 100–1000 µL
Pipette, glass, graduated, 10 mL. The automatic pipettes and cylinders can replace the graduated pipettes.
Pipettes, graduated, polypropylene, 1 mL
Pipettes, graduated, polypropylene, 5 mL
Pipettes, graduated, polypropylene, 10 mL
Pipettes, multi-channel (for EIA analyser), 50–200 µL
Pipettes, single channel, adjustable (for EIA analyser), 50–200 µL

Pipettes, transfer, 3 mL, sterile
Pipettes, transfer, non-sterile, polyethylene, 3 mL, 0.5 mL graduation
Pipette filler, with thumb-wheel lever, (Pi-pump), green, 10 mL
Pipette tips, yellow, box including tray for 100 tips (empty)
Plasma extractor
Plastic bags, self-sealing, medium, for general storage and local transport of samples
Plastic bin liners, disposable
Plate, cooking, metal, ribbed surface, with handle, shallow tray construction with shallow walls, minimum size 15 × 20 cm (used by some programmes for staining)
Plate for VDRL test, 8 ring per plate
Povidone-iodine, arm preparation solution: scrub 0.75% or disposable povidone-iodine swab-stick/packs 10% or 2% chlorohexidine with 70% isopropanol swab stick/packs
Powerful disinfectant (with measuring beaker and scoop) for cleaning up spills, soaking equipment or wiping benches.
Pregnancy, rapid diagnostic test
Pressure cooker, top loading, capacity 12 L, used with external heat source; or pressure cooker (field autoclave), top loading, capacity 14 L; spare parts for pressure cooker: lid sealing gasket, safety plug, timer
Primus stove with gas cylinder
Protection paper for bench, absorbent, 50 cm × 50 m
Protective clothing, laboratory coats or gowns
Rack, capable of holding 12 × 75 mm tubes
Rack, for 15 mL conical tubes, with caps
Rack, for slides, expandable, stainless steel
Rack, for tubes 50–100 × 5–15 mm diameter
Rack, for tubes 100–125 × 15–20 mm diameter
Rack, plastic or wood (for drying slides)
Rack, for 7–10 mL tubes
Rack, test tube, metal, to accommodate 10–12 mL tubes – small 4-hole (to fit saucepan)
Rack, test tube, 24 place, white nylon-coated wire, for tubes 100–125 mm × 15–20 mm diameter
Rack, tube, 4 × 10, for 13/14 mm tubes
Rack, tube, 4 × 12, squares, for 18 mm tubes, stainless steel

Rack, tube, for 13/14 mm tubes
Rack, tube, for 13 × 80 mm tubes
Rack, tube, for 63 × 9.5 mm tubes
Rack, tube, for 75 × 10–13 mm tubes
Reagent bottles, high-density polyethylene, leak-proof cap, 250 mL
Receptacle, waste, with attached lid stainless steel, 12 L, foot operated
Refractometer (urinalysis)
Refrigerator: dedicated blood bank refrigerator with a built-in temperature monitor and a temperature alarm system, and transparent display doors (standard electric, photovoltaic, kerosene or gas), able to provide an internal air temperature of between 2 °C and 8 °C, electric (compression type) 110/230 V AC. Refer to blood bank modules
Refrigerator, electric, compression type, 110/230 V AC, 140 L (size may vary based on the needs at the site, internal air temperature of between 2 °C and 10 °C, with a separate freezer compartment, non-automatic defrost
Refrigerator, vaccine storage refrigerator or cold box (for short term storage only, < 12 h).
Registration books: separate registers suggested for donor selection, laboratory pre-transfusion testing, donor collection and patient transfusion
Registration books (for recording details of patients and test results), standard registration books used in-country or exercise books, A4, ruled, preferably hard-backed
Request forms
RhD negative control, 10 mL
Rod, glass, 250 mm, diameter 6–7 mm
Rods, stainless steel adjustable length rods (for slide staining) in holders with levelling screws, for fitting across sink, minimum length 290 mm
Rotator, orbital type, for agglutination test, 110/230V
Ruler, 30 cm
Ruler, flexible (for preparing graphs)
Safety cabinet (at a minimum fitted with effective extractor fan and exhaust system)
Saline, physiological saline, laboratory grade, plastic bottles, or physiological saline, clinical infusion bags/bottles.
Saline, physiological solution, sodium chloride, 0.9%. Alternatively clinical infusion physiological saline packs. Clear, no particulate matter, pH 7.0 Minimal cation content

Scale, bathroom type
Scale, blood bag, trip type, with 585 ± 2 g trip counterweight or blood bag mixer, electric with auto shut-off, electric (alternative to trip scale)
Scale, spring balance for weighing blood
Scissors, 17 cm, blunt ends
Scissors, domestic, pointed end
Scissors, sharp tip
Scrubbing brush
Sealant, plastic, or modelling clay or Plasticine
Sealer, hand-operated (used when removing blood from tubing)
Sharps disposal container, small
Sharps container, large
Silica gel, self-indicating, 100 g
Slides, 76 × 26 mm, 1–1.2 mm thickness, plain, good quality (for malaria)
Slides, 76 × 26 mm, 1–1.2 mm thickness, twin-frosted ends (one end frosted both sides for easy labelling using a graphite pencil
Slide holder, cardboard, flat, capable of holding 20 slides
Slide mailer, polyethylene or cardboard, with integral push-in lid
Slide warmer (used when preparing blood smears for malaria examination)
Small stickers/labels for daily sample accession number used to track samples and segments of issued blood units
Sodium dichloroisocyanurate (NaDCC), 1.5 or 1.67 g tablets, used to prepare a chlorine-releasing disinfectant more stable than sodium hypochlorite; non-effervescent tablets are recommended; Haz-Tab tablets (formulated using sodium dichloroisocyanurate) are an alternative
Sodium hydroxide pellets, 100g
Sodium hypochlorite (bleach), local purchasing
Spare candle filter, 18 cm
Spare fuses
Spare lamps
Spare parts for autoclave
Spatulas, polypropylene, length 100 mm
Spectrophotometer (to determine protein and glucose in CSF), kinetic, bench-top
Spectrophotometer, test cuvettes compatible with the spectrophotometer
Spectrophotometer or colorimeter, (to determine haemoglobin)
Stapler, paper, hand-held

Staples, size compatible with stapler
Steel wool pads, non-detergent
Sterile gauze for arm prep
Stethoscope
Storage bottle, glass, open neck, large opening (to contain sand/phenol mix for loop cleaning)
Storage bottle, plastic, 100 mL
Storage bottle, plastic, 1000 mL
Stripper (for removing blood from tubing)
Swab, 70% isopropanol alcohol, (wipes), disposable; 2% iodine (swabs)
Swab, alcohol, (wipes), disposable
Swabs, cotton, sterile
Syphilis TP rapid kit, commercial
Syringe, disposable, 5 mL
Tally counter, hand, manual, plastic- or metal-cased
Test, A(A1), 3%–5% v/v red cells, 10 mL, dropper bottle
Test, A(A1), 30%–40% v/v red cells
Test, B, 3%–5% v/v red cells
Test, B, 30%–40% v/v red cells
Test, blood grouping, anti-A, 10 mL, dropper bottle
Test, blood grouping, anti-AB, 10 mL, dropper bottle
Test, blood grouping, anti-B, 10 mL, dropper bottle
Test, blood grouping, polyclonal/monoclonal blend anti-RhD
Test, Coombs, suspension of washed red blood cells in a physiological saline solution 3%–5% v/v, to validate negative anti-human globulin (AHG)
Test, polyclonal, anti-human globulin (Coombs reagent) for full crossmatch
Testing collection set, premade bags with sterile 4 in × 4 in gauze
Test tubes, 7–10 mL, glass
Test tubes, 15 mL, conical bottom, with caps
Test tubes, conical end, 10–12 mL, non-sterile
Test tube brush, medium 18 mm diameter
Test tube brush, nylon or bristle head, large size, 70–90 mm diameter head
Test tube brush, small 12 mm diameter
Test tube brushes, small 12 mm diameter, medium 18 mm diameter and large 50 mm diameter

TK staining bottles, brown and clear
Thermometer, −30 °C to 0 °C or similar, red spirit thermometer recommended
Thermometer, −10 °C to +110 °C, a red spirit thermometer is recommended, general use.
Thermometer, alcohol stem, at least −10 °to +50 °C
Thermometer, clinical (for use in blood donor room)
Thermometer, maximum–minimum, −30 °C to +50 °C
Thermometer, maximum–minimum, at least −30 °C to 0 °C
Thermometer, maximum–minimum, at least −10 °C to +50 °C
Thermometer, maximum–minimum, at least 0 °C to +40 °C
Thermometer, spirit-filled, maximum–minimum, 0 °C to +50 °C
Timer, mechanical, 1–60 minutes, with ringer
Toilet paper, rolls (for cleaning laboratory equipment)
Tool kit, for general purpose laboratory use (see Annex 6)
Tourniquet rubber band, 100 × 1.8 cm or similar
Transfer pipettes, 3 mL, sterile
Transfer pipettes, non-sterile, polyethylene, 3 mL (transfer pipettes), 0.5 mL graduation
Transport container, triple packing (for transport of infectious substances) class 6.2
Treponema pallidum rapid diagnostic kit[5]
TST (time, steam, temperature) control indicator strips[6] (in a pressure cooker: 15 minutes at a pressure of 103 kpa (15 psi), raising the temperature of steam to 121°C)
Tube, centrifuge, 15 mL, conical bottom
Tube, glass, culture, screw-cap, 5 mL
Tube, standard, 12 × 75 mm tube, glass, screw-cap, 5 mL
Tube, standard, glass, 10 × 75 mm
Tube, standard, glass, 12 × 75 mm
Tube, standard, glass, 15 × 160 mm general use
Tube, tight-fitting screw-cap, sterile, 10–12 mL

[5] User-friendly, and do not require specialized equipment. However, RDT may remain reactive in individuals who no longer have an active infection. Polymerase chain reaction (PCR) in equipped laboratories is a valid method for diagnosing *Treponema pallidum* in testing of ulcers for diagnosis of primary syphilis.

[6] TST (time, steam, temperature) test strips contain dyes that undergo a sudden and distinct colour change once they have been heated to the sterilization temperature for a sufficient time.

Tube, vacuum, citrate, 3 mL or similar, lavender top
Tube, vacuum, EDTA, 3–5 mL
Tube, vacuum, plain, 3 mL or similar, red top
Tuberculosis decolourizer, commercial; alternatively: 3% v/v 3% hydrochloric acid alcohol[7]
Typhoid, rapid diagnostic test kit
Stain dispensing containers, 500 mL, clear and opaque
Universal transport medium (Copan)
Urinalysis test strips for pH, density (specific gravity), protein, glucose, ketones, blood, nitrite, leucocytes (one strip)
Urinalysis test strips, quality control for test strips, 2 levels
Vacutainer and disposable hypodermic needle
Vacuum system holder and 21G/23G/butterfly needles supplied by the same manufacturer
Vibrio cholerae test kit
Wall charts for malaria rapid diagnostic testing, WHO
Wash bottles, 250 mL, polythene
Waste receptacle, stainless steel, 12 L
Waste receptacle, stainless steel, foot pedal-operated lid
Water bath, 37 °C
Water bath, 2 L, microprocessor controlled, visual temperature, minimum temperature range of 30 °C to 40 °C
Water bath, 20 L, microprocessor controlled (temperature adjustable) – either steel with integrated heating or Perspex with separate heater able to be clamped to the wall of the water-bath, able to be heated to a maximum of 42 °C
Water, bottled
Water purification, brush, stiff bristles (to clean filters)
Water purification, spare candle filter, 18 cm
Water storage container, polyethylene, 20 L, with handle and removable tap
Water-testing (portable meter for basic physical tests): arsenic testing device, hand-held, digital type with operating instructions. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumable for conductivity meter: 1 probe cleaning solution. Refer to water-testing modules (Chapter 6)

[7] Caution: flammable

Water-testing (portable meter for basic physical tests): consumable for conductivity meter: 1 spare EC-probe (if detachable). Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumable for conductivity meter: calibration solution, appropriate for chosen measuring interval, 250 mL. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumable for pH meter: 1 electrode cleaning solution. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumable for pH meter: 1 spare pH-electrode (if detachable). Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumable for turbidity meter: 1 bottle calibration solution, 500 mL. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumable for turbidity meter: 1 cuvette cleaning solution. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumables for pH meter: calibration solutions (buffer solutions 1, 2 and 3), 500 mL each. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): consumables for turbidity meter: 5 sample cuvettes and caps; 1 cuvette cleaning solution; 1 bottle calibration solution; 500 mL. Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): photometer, portable, digital type, direct-reading (for testing many chemical parameters). Refer to water-testing modules (Chapter 6)
Water-testing (portable meter for basic physical tests): portable conductivity meter, measuring range: 0–3000 µS/cm, resolution: 1 µS/cm
Water-testing (portable meter for basic physical tests): portable pH meter, minimum measuring interval: 4–10 pH, resolution: 0.02 pH
Water-testing (portable meter for basic physical tests): portable turbidity meter, measuring interval: 0–50 NTU (or higher), resolution: 0.01 NTU
Water-testing kit (basic physical/chemical tests). Recommended items to include: measuring cylinder or beaker, 500 mL (separate purchase), Pasteur pipettes (× 5), ball-point pen, cigarette lighter, pencil (wax) or permanent marker pen, electric cable with crocodile clips for operation of incubator via mobile battery, fuses for charger, set (× 2), spare batteries for: pH meter (when included). Refer to water-testing modules (Chapter 6)

Water-testing kit (for bacteriological testing and basic physical/advanced chemical tests). Refer to water-testing modules (Chapter 6)
Water-testing kit, complete (for bacteriological testing and basic physical/ chemical tests). Refer to water-testing modules (Chapter 6)
Water-testing kit (advanced chemical tests), consumable: DPD (N,N diethyl-p-phenylenediamine sulfate) no. 1 tablets (× 250)
Water-testing kit (advanced chemical tests), consumable: phenol red tablets (if the comparator also measures pH) (× 250)
Water-testing kit (advanced chemical tests), consumable: culture medium (membrane lauryl sulphate broth), 38.1 g or 500 g container
Water-testing kit (advanced chemical tests), consumable: DPD no. 3 tablets (× 250)
Water-testing kit (advanced chemical tests), consumable: membrane filters, individually sterile and wrapped, 200 per pack
Water-testing kit (advanced chemical tests), consumable: membrane pads, 100 per pack
Water-testing kit (advanced chemical tests), consumable: pad dispenser
Water-testing kit (basic physical), consumable: colour discs (for colour comparator system) and tablet reagents for the following test: chlorine (minimum 250 tests), set.
Water-testing kit (basic physical), consumable: culture medium (membrane lauryl sulphate broth), 38.1 g or 500 g container
Water-testing kit (basic physical), consumable: DPD (N,N diethyl-p-phenylenediamine sulfate) no. 1 tablets (× 250)
Water-testing kit (basic physical), consumable: DPD no. 3 tablets (× 250)
Water-testing kit (basic physical), consumable: membrane filters, individually sterile and wrapped, 200 per pack. Refer to water-testing modules (Chapter 6)
Water-testing kit (basic physical), consumable: membrane pads, 100 a pack
Water-testing kit (basic physical), consumable: pad dispenser
Water-testing kit (basic physical), consumable: phenol red tablets (if the comparator also measures pH), packet of 250
Wick (spare for lamp spirit), 7 mm diameter
Wright Stain (250 mL/500 mL bottle)

Annex 8. Manufacturers of photovoltaic equipment[1]

Siemens AG

Freyeslebenstrasse 1
91058 Erlangen
Germany
Tel: +49 180 524 70 00
Fax: +49 180 524 24 71
Email: support.energy@siemens.com
Website: www.energy.siemens.com

BP Solar Ltd

International Headquarters
1 St James's Square
London, SW1Y 4PD
United Kingdom
Tel: +44 (0) 20 7496 4000
Fax: +44 (0) 20 7496 4630
Email: Not given
Website: www.bp.com

Morningstar Corporation

8 Pheasant Run
Newtown PA 18940
USA
Tel: +1 215 321 4457
Fax: Not given
Email: info@morningstarcorp.com
Website: www.morningstarcorp.com

Naps Systems Oy

Pakkalankuja 7
FI-01510 Vantaa
Finland
Tel. +358 20 7545 666
Fax: +358 20 7545 660

[1] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

Email: group@napssystems.com
Website: www.napssystems.com

Polar Power Inc

249 Gardens Blvd
Gardena, CA 90248
USA
Tel: +1 (310) 830 9153
Fax: +1 (310) 719 2385
Email: Go to 'Contact' on website
Website: www.polarpower.com

Dulas Ltd

Dyfi Eco Park
Machynlleth
Powys SY20 8AX
United Kingdom
Tel: + 44 (0) 1654 705 000
Fax: + 44 (0) 1654 703 000
Email: Go to 'Contact' and use 'Quick Enquiry' form on website
Website: www.dulas.org.uk

Helpful documents to download:
"How To Use Photovoltaic Energy?" lists provided on the website below include:
Internet addresses
Manufacturers/suppliers of photovoltaic products
Website: www.howtopedia.org/en/How_to_Use_Photovoltaic_Energy %3F

Annex 9. Manufacturers of microscopes[1, 2]

Olympus Europa SE & Co. KG

Wendenstrasse. 14–18
20097 Hamburg
Germany
Tel: +49 40 23773 0
Fax: +49 40 233765
Email:info@olympus-europa.com
Website: www.olympus-europa.com

Carl Zeiss Microscopy GmbH

Carl Zeiss Strasse 22
73447 Oberkochen
Germany
Tel: +49 7364 20 -0
Fax: +49 7364 20 6808
Email: use contact form on website
Website: www.zeiss.com

Elcomatic Ltd

16 Kyle Road
Irvine
Ayrshire KA12 8JU
Scotland
Tel : +44 01294 274914
Fax : Not given
Email : user@elcomatic.co.uk
Website: http://www.elcomatic.co.uk/
Elcomatic supply the Gillet & Sibert Tropical Medicine Microscope. Features making it very useful in locations where the electricity supply is poor/non-existent

[1] Illumination: the desirable LED illumination (as indicated in the microscope module and Chapter 8) is a white LED lamp (luminous flux min.700 lm; service life: min.15,000h). For more information on LED illumination for microscopes, see the following websites: http://www.microbehunter.com/advantages-of-led-microscopes/ http://www.microscopy-k.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artmay04/iwled.html
WHO document: 'Fluorescent light-emitting diode (LED) microscopy for diagnosis of tuberculosis policy'. Policy statement. www.who.int/tb/publications/2011/led_microscopy_diagnosis_9789241501613/en/

[2] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

include: a battery unit capable of being charged from mains electricity; and a car cigarette lighter or solar panel. They also supply a portable haemoglobinmeter, which includes: a mains battery charger or optional solar panel; reusable cuvettes; and all materials necessary to prepare lysed blood samples.

Leica Microsystems

Ernst-Leitz-Strasse 17-37
Wetzlar, 35578 Germany
Tel: +49 6441 29 4000
Fax: +49 6441 29 4155
Email: Go to 'Contact' on the website
Website: www.leica-microsystems.com

LW Scientific, Inc.

865 Marathon Parkway
Lawrenceville, GA 30046 USA
Phone: +1 800 726 7345 or +1 (770) 270 1394
Fax: Not given
Email: info@lwscientific.com
Website: www.lwscientific.com

Nikon

Nikon Precision
Europe GmbH
1 Michaelson Square
Kirkton Campus
Livingston EH54 7DP
West Lothian
Scotland/UK
Tel. +44 1506 407142
Fax: +44 1506 407146
Email: nikon-precision@npeurope.com
Website: http://www.nikonprecision.com

Labomed

Labo America Inc.
920 Auburn Court,
Fremont, CA 94538
USA

Tel: +1 (510) 445-1257
Fax: Not given
Email:sales@laboamerica.com
Website: www.laboamerica.com

Accu-scope

73 Mall Drive
Commack, NY 11725
USA
Tel: +1 631 864 1000
Fax: +1 631 543 8900
Email: info@accu-scope.com
Website: www. accu-scope.com

Annex 10. List of some battery-operated haemoglobinometers[1]

Note: The reader is advised to refer to Module 5c (Haemoglobin meter, portable stand-alone) of this publication, and decide which type of haemoglobinometer would best suit their needs, using an internet search for different models.

Name	Power Supply / Voltage	Manufacturer
AimStrip Hb Hemoglobin Meter	4 AAA batteries or AC adaptor	Fisher Scientific
Acon Hemoglobin Meter Mission Hb Meter	4 AAA (1.5 V) or AC adaptor (Mini USB, 5 V dc, 50 mA)	ACON Laboratories, Inc., San Diego, CA, USA
DiaSpect Tm	Rechargeable internal battery (provides up to 40 days of continuous use)	EKF Diagnostics
EKF Hemo Control hemoglobin analyser	Integrated rechargeable battery (100 hours)	EKF Diagnostics, USA
Elcomatic Haemoglobin Meter	Battery (rechargeable)	Elcomatic Ltd, UK
Haemoquick photometer	Rechargeable battery and 100 – 240 V AC	Medisynthana
HemataStat II™ Microhematocrit Centrifuge	Optional rechargeable battery pack for field use	EKF Diagnostics
Hemochroma plus	Battery (4 AA)	Boditech
Hemocue Hb 201 System Hemo Test	110 VAC or 5 x AA battery	HemoCue
Hemochroma Hemoglobinometer	Battery powered (and 100 ~ 240VAC SMPS adapter, optional)	Boditech
Hemo Control Hemoglobin Analyser	Integrated rechargeable battery (100 hours)	EKF Diagnostics
Insight Hb Haemoglobin testing system B	3 AAA batteries	Point of Care Testing Ltd, UK

[1] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

Stanbio Stat-Site MHgb Hemoglobinometer	Battery	Fisher
STAT-Site M Hemoglobinmeter	battery operated (One battery for up to 1 000 tests),	Stanbio Laboratory (an EFK Diagnostics company)
The 8000-Hemofast Hemoglobinometer	2 CR 2032, 3.0V coin batteries	All.Diag
UltraCrit Plus Hematocrit Analyzer (Also provides a haemoglobin calculation).	Integrated rechargeable lithium battery, or AA batteries. Powered by mains electricity	EKF Diagnostics

Annex 11. Manufacturers of photovoltaic refrigerators and freezers[1,2]

Kissmann

Gundermannstrasse 7
80935 Munchen
Germany
Tel: +49 89 3135632
Fax: +49 89 3148115
Email: info@kissmann.net
Website: www.kissmann.net

Norcoast Refrgeration Co

P O Box 402
Moffat Beach
Queensland 4551
Australia
Tel: +61 7 5491 1849
Fax: +61 7 5491 7627
Email: norcoast@norcoast.com.au
Website: www.norcoast.com.au

Sun Frost

PO Box 1101
Arcata, California 95518
USA
Tel: +1 707 822 9095
Fax: +1 707 822 6213
Email: info@sunfrost.com
Website: www.sunfrost.com

[1] Emergency Field Operations, World Health Organization, EHA/FIELD/99.1 provides a list of laboratory supplies and laboratory equipment and refrigerators for cold chain, including photovoltaic solar refrigerators. Available at http://www.who.int/hac/techguidance/tools/7661.pdf

[2] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

Sun Danzer

11135 Dyer, Suite C
El Paso, Texas
TX 79934, USA
Tel: +1 915 821 0042
Fax: +1 775 201 0236
Email: international@sundanzer.com or medical@sundanzer.com
Website: www.sundanzer.com

Annex 12. Manufacturers of water purification systems[1]

Fairey Industrial Ceramics Ltd

Lymedale Cross
Lower Milehouse Lane
Newcastle-under-Lyme
ST5 9BT
United Kingdom ST5 9BT
Tel: +44 1782 664 420
Fax: Not given
Email: filtersales@faireyceramics.com
Website: www.faireyceramics.com
Fairey Industrial Ceramics manufacture the Doulton and British Berkfield ceramic water filters.

Katadyn Products Inc.

Pfäffikerstrasse 37
8310 Kemptthal
Switzerland
Tel +41 44 839 21 11
Fax +41 44 839 21 99
Email: Use contact form on website
Website: www.katadyn.com
Cartridge filter systems

Millipore Corp.

290 Concord Road,
Billerica, MA 01821
USA
Tel: +1 (781) 533 6000
Fax: Not given
Email: Use contact forms on website
Website: www.emdmillipore.com
Laboratory water purification systems

[1] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

Bibby Scientific Ltd.

Beacon Road
Stone, Staffordshire
ST15 OSA
United Kingdom
Tel: +44 (0) 1785 812 121
Fax: +44 (0) 1785 810 405
Email: sales@bibby-scientific.com
Website: www.biby-scientific.com
Water stills, deionisers

X-Flow BV

P.O. Box 739
7500 AS, ENSCHEDE
The Netherlands
Tel: +31 (0) 53 428 73 50
Fax: +31 (0) 53 428 73 51
Email: Use Contact form on website
Website: www.x-flow.com
Mobile water treatment plants

Berkefeld – Veolia Water Technologies Deutschland GmbH

Lückenweg 5
29227 Celle
Germany
Tel: +49 (0) 5141 803 0
Fax: +49 (0) 5141 803 100
Email: berkefeld@veolia.com
Website: www.berkefeld.de
Mobile water treatment plants

Prominent Dosiertechnik GmbH

Im Schuhmachergewann 5-11
69123 Heidelberg
Germany
Tel: +49 6221 842-0
Fax: +49 6221 842-215
Email: info@prominent.com
Website: www.prominent.com
Mobile water treatment plants

Karcher Futuretech GmbH

Alfred-Schefenscker Str 1
D 71409, Germany
Tel: +49 7195 14 0
Fax: +49 71 95 14 27 80
Email: Use contact form on website
Website: www.karcher-futuretech.com
Mobile water treatment plants

Gruenbeck Wasseraufbereitung GmbH

Industriestrasse 1
89420 Hoechstaedt a. d. Donau
Germany
Tel: +49 9074 41-0
Fax: +49 9074 41-100
Email: info@gruenbeck.de
Website: www.gruenbeck.de
Mobile water treatment plants

Aqua Sun International

P.O. Box 2919
Minden, Nevada 89423
USA
Tel: +1 775 / 783 8566
Fax: +44 870 163 5682
Email: sales@aqua-sun-intl.com
Website: www.aqua-sun-intl.com
Portable, solar powered water purification systems

Ganga Enviro Systems inc.

5904 Brilland Springs Pl
Glen Allen, VA 23060
USA
Tel: +1 510 681 4614
Fax: +1 801 749 2446
Email: info@gangaenviro.com
Website: www.gangaenviro.com
Portable water purification systems

Annex 13. Example of full-length donor history questionnaire (DHQ): AABB Version 2 May 2016[1]

Are you	Yes	No
1. Feeling healthy and well today?	❑	❑
2. Currently taking an antibiotic?	❑	❑
3. Currently taking any other medication for an infection?	❑	❑
4. Have you taken any medications on the Medication Deferral List in the time frames indicated? (Review the Medication Deferral List.)	❑	❑
5. Have you read the educational materials today?	❑	❑
In the past **48 hours**,		
6. Have you taken aspirin or anything that has aspirin in it?	❑	❑
In the past **8 weeks**, have you		
7. Donated blood, platelets or plasma?	❑	❑
8. Had any vaccinations or other shots?	❑	❑
9. Had contact with someone who was vaccinated for smallpox in the past 8 weeks?	❑	❑
In the past **16 weeks**,		
10. Have you donated a double unit of red cells using an apheresis machine?	❑	❑
In the past **12 months**, have you		
11. Had a blood transfusion?	❑	❑
12. Had a transplant such as organ, tissue, or bone marrow?	❑	❑
13. Had a graft such as bone or skin?	❑	❑
14. Come into contact with someone else's blood?	❑	❑
15. Had an accidental needle-stick?	❑	❑
16. Had sexual contact with anyone who has HIV/AIDS or has had a positive test for the HIV/AIDS virus?	❑	❑

[1] See: http://www.aabb.org/tm/questionnaires/Pages/dhqaabb.aspx
This questionnaire could be used as a model to develop questionnaires appropriate to the geographical location and the situation of other countries.

17. Had sexual contact with a prostitute or anyone else who takes money or drugs or other payment for sex?	❑	❑
18. Had sexual contact with anyone who has ever used needles to take drugs or steroids, or anything not prescribed by their doctor?	❑	❑
19. Male donors: Had sexual contact with another male?	❑	❑
20. Female donors: Had sexual contact with a male who had sexual contact with another male in the past 12 months?	❑	❑
21. Had sexual contact with a person who has hepatitis?	❑	❑
22. Lived with a person who has hepatitis?	❑	❑
23. Had a tattoo?	❑	❑
24. Had ear or body piercing?	❑	❑
25. Had or been treated for syphilis or gonorrhea?	❑	❑
26. Been in juvenile detention, lockup, jail, or prison for more than 72 consecutive hours?	❑	❑
In the past **three years**, have you		
27. Been outside the United States or Canada?[a]	❑	❑
From **1980 through 1996**,		
28. Did you spend time that adds up to 3 months or more in the United Kingdom? (Review list of countries in the UK)[a]	❑	❑
29. Were you a member of the U.S. military, a civilian military employee, or a dependent of a member of the U.S. military?[a]	❑	❑
From **1980 to the present**, did you		
30. Spend time that adds up to 5 years or more in Europe? (Review list of countries in Europe.)[a]	❑	❑
31. Receive a blood transfusion in the United Kingdom or France? (Review country lists.)[b]	❑	❑
Have you **EVER**		
32. Female donors: Been pregnant or are you pregnant now?	❑	❑
33. Had a positive test for the HIV/AIDS virus?	❑	❑
34. Used needles to take drugs, steroids, or anything not prescribed by your doctor?	❑	❑

[a] Relevant to USA only

[b] For countries other than the USA, this may be replaced with: "did you receive a blood transfusion in another country? If yes, which country?"

35. Received money, drugs, or other payment for sex?	❑	❑
36. Had malaria?	❑	❑
37. Had Chagas disease?	❑	❑
38. Had babesiosis?	❑	❑
39. Received a dura mater (or brain covering) graft or xenotransplantation product?	❑	❑
40. Had any type of cancer, including leukemia?	❑	❑
41. Had any problems with your heart or lungs?	❑	❑
42. Had a bleeding condition or a blood disease?	❑	❑
43. Have any of your relatives had Creutzfeldt-Jakob disease?	❑	❑
Use this area for additional questions	**Yes**	**No**

Annex 14. Filter paper technique for collection and transport of body fluid specimens

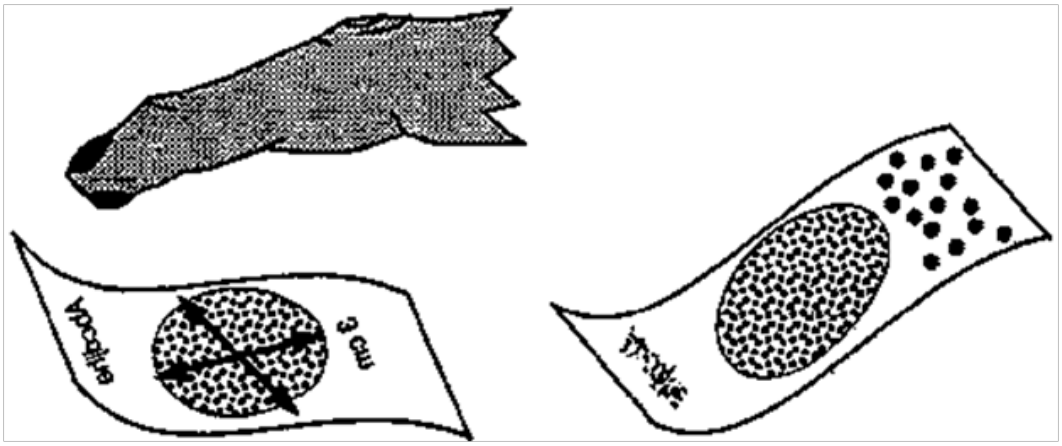
General

The transport of liquid specimens soaked on filter paper is a simple and safe procedure. The filter paper can be used in any format but is commonly incorporated into a form or card specifically constructed for sample collection. All kinds of body fluids can be absorbed, although the technique is most often used for the collection of blood. The card can be easily transferred to a distant laboratory for screening or confirmatory testing. Body fluid absorbed on a filter paper can be processed for qualitative and/or quantitative serological and immunological investigations. Suitable filter paper is Whatman no. 1 or Schleicher and Schuell. Cards with incorporated filter paper, which can also be used for registration of the patient and filing, can be obtained from Schleicher and Schuell.

Technique for blood sampling

1. The wearing of gloves is recommended for blood sampling. It is important that the filter paper surface does not come into contact with gloved hands or any other material, solutions and lotions, prior to and during the entire process of sampling.
2. Complete the patient's data on the card with a ball-point pen. Do not touch the filter paper circle area.
3. Clean the puncture site on the patient's finger tip, or heel if an infant, with 70% alcohol. Wipe the site dry with a sterile gauze. Use a sterile disposable lancet for puncture. Wipe away the first drop of blood with dry sterile gauze.
4. Gently touch the filter paper against a large drop of blood and allow the blood to soak through, until the pre-printed circle on the filter paper is completely filled. Avoid squeezing the punctured site as this will cause haemolysis of the specimen and a dilution of the blood with tissue fluids. Do not layer successive drops of blood in the printed circle because this may cause caking. Do not apply blood to the filter paper more than once. Apply blood to one side of the filter paper only. Incompletely blood-soaked circles are not acceptable.
5. Allow the blood specimen to dry for three hours in the air in a horizontal and preferably elevated position (to avoid contamination and to allow better circulation of the air around the card for drying). Do not let the specimen come into contact with any surface, direct heat or sunlight. Do not refrigerate the samples.

6. Place each dry specimen card into an envelope or a small plastic bag, add a few granules of desiccant and close the envelope hermetically for posting. Store the filter paper in a plastic bag in a cool dark dry place. Specimens that have been stored for up to three months, under appropriate conditions, may give acceptable results.



Source: *(35)*

Fig. A.14.1 Blood sampling on filter paper

Annex 15. Non-profit-making suppliers for tropical laboratories[1]

Ida Foundation

Slochterweg 35
1027 AA Amsterdam
PO Box 37098
1030 AB Amsterdam
The Netherlands
Emergency phone line, 24 hours a day, 7 days a week: +31 6 51 21 95 22
Tel: +31 20 40 33051
Fax: +31 20 4031854
Email: info@idafoundation.org
Website: www.ida.nl
The International Dispensary Association web catalogue includes diagnostic and laboratory supplies

Technologie Transfer Marburg

Auf der Kupferschmiede 1
D-35091 Cölbe
Germany
Tel: +49 6421 87373-0
Fax: +49 6421 87373-7
Email: ttm@ttm-germany.de
Website: www.ttm-germany.de

Durbin Plc

Durbin House
180 Northolt Road
South Harrow HA2 0LT
Middlesex
United Kingdom
Tel: +44 20 8869 6500
Fax: +44 20 8869 6565
Email: cs@durbin.co.uk

[1] The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned; the specific companies and products mentioned appear here as examples only.

Email: exports@durbin.co.uk
Website: www.durbin.co.uk

In 2002, Durbin bought the trading arm of the charity ECHO International Health Services. Medical Equipment (including laboratory), consumable supplies and pharmaceuticals

Solmedia Laboratory Supplies

The Parade
Colchester Road
Romford RM3 0AD
Essex
United Kingdom
Tel: +44 844 8080 900
Fax: +44 844 8080 901
Email: labsupplies@solmedialtd.com
Website: www.solmedialtd.com

United Nations Children's Fund (Unicef)

UNICEF Supply Division
UNICEF Plads, Freeport
DK-2100 Copenhagen Ø
Denmark
Tel: +45 35 27 35 27
Fax: +45 35 26 94 21
Email: supply@unicef.org
Website: https://supply.unicef.org/unicef_b2c/app/displayApp/(layout=7.0-12_1_66_67_115&carea=%24ROOT)/.do?rf=y, www.unicef.org/supply/index.php

Medic Foundation

Johannes Bosboomstraat 297312 LM Apeldoorn
The Netherlands
Tel: +31 55 355 8358
Fax: +31 55 355 8338
Email: info@medic.nl
Website: http://www.medic.nl/engels

Aid to medical laboratories in developing countries; no equipment

Annex 16. Information on bleach preparation

General information

- Chlorine is one of the few disinfectants that can safely be used in laboratories where PCR work is undertaken because it fragments nucleic acids. Other disinfectants such as quaternary ammonium compounds and alcohols precipitate nucleic acids and can give false results in PCR tests.
- Household bleach is, in general, a solution containing 3–8% sodium hypochlorite and 0.01–0.05% sodium hydroxide; the sodium hydroxide is used to slow the decomposition of sodium hypochlorite into sodium chloride and sodium chlorate.
- Calcium hypochlorite (powdered, granulated or tablets) is more stable than sodium hypochlorite, and contains a higher chlorine concentration (30–75%). The shelf life of powdered calcium hypochlorite (also referred to as high test hypochlorite or HTH) is 3 to 5 years, and as a solution if stabilized more than 30 days. Sodium hypochlorite (NaOCl), if stabilized (usually with sodium hydroxide), has a shelf life of more than 30 days, while an un-stabilized solution of sodium hypochlorite has a shelf life of 1 to 4 days or less *(9)*.
- Calcium hypochlorite precipitates may clog pipes, while sodium hypochlorite does not clog pipes.
- High test hypochlorite/70% calcium hypochlorite (bleach powder) is the recommended chlorine product to use, as it is very stable and the percentage strength is not affected as readily as with other products. However, in certain circumstances it may be necessary to use products other than high test hypochlorite/70% calcium hypochlorite for the preparation of chlorine solutions. However, the percentage strength of the product **must** be tested before making dilutions.
- Chlorine solutions used as disinfectants are made from powdered calcium hypochlorite (high test hypochlorite), granular sodium dichloroisocyanurate (NaDCC), or liquid sodium hypochlorite (NaOCl). When sodium hypochlorite is dissolved in water it is commonly known as bleach or liquid bleach (household chlorine bleach).

Always test the bleach for chlorine content.

A wide variety of chlorine bleaches are produced worldwide and are available in different base strengths. Identify the base strength of the bleach; do not take any label for granted. Test all bleaches for percentage of available chlorine before making dilutions.

Commercially available bleach, especially in developing countries, may not have a valid % chlorine label. A study of the chlorine concentration of 32 bleaches from 12 developing countries[1] demonstrated that there was a significant difference between advertised and measured chlorine concentration. Sometimes, container lids are taken off and some of the contents is removed and replaced with anything that is similar in appearance.

Table A.16.1 gives a brief description of the different bleach solutions and their uses.

Table A.16.1 Brief description of the different bleach solutions and their uses

1% chlorine solution (10 000 ppm[a]), 10 g/l	Accidental spillage of sputum or bodily fluids – anywhere including the laboratory. 10 minutes wet contact.
0.5% chlorine solution (5000 ppm), 5 g/l Called a strong solution[b]	Excreta, bodies, spills of blood and bodily fluids. Gross contamination must be removed first; pre-disinfection treatment may be required. Final disinfection applied after cleaning the surface. 10 minutes wet contact.[c]
0.25% chlorine solution (2500 ppm), 2.5 g/l	For discard containers in the laboratory.
0.1% chlorine solution (1000 ppm), 1 g/l	Disinfection of material contaminated with bodily fluids (door handles, beds, tables, stethoscopes, waste bins) and goggles. In the laboratory for routine disinfection of working surfaces and decontamination of soiled hands and gloves. 1 minute wet contact.
0.05% chlorine solution (500 ppm), 500 mg/l; a mild solution	Surfaces (not contaminated with blood or bodily fluids). Medical equipment (not contaminated with blood or bodily fluids) 1 minute wet contact. Used for washing bare hands in settings where other methods, such as soap and running water or alcohol-based hand rubs, are not available.[c]

[a] 1 ppm means a given solute exists at a concentration of one part per million parts of the solution (1 mg/L is equivalent to 1 ppm).

[b] 0.5% chlorine solution is 5000 ppm free available chlorine (FAC).

[c] Warning: washing bare hands with the strong solution (0.5%) can cause chlorine burns on hands.

Bleach preparation

It is important to remember the following:

- Always test for the percentage of available chlorine in the purchased liquid bleach and/or the chlorine powder before making any dilutions.

[1] Lantagne DS. Viability of commercially available bleach for water treatment in developing countries. Am J Public Health. 2009;99(11):1975–1978.

- Use plastic containers for mixing and storing bleach solutions, as metal containers corrode rapidly (unless they are enamel) and also affect the bleach.
- The prepared bleach should be stored in dark, cool and secure places, in an airtight plastic (non-metallic) properly labelled container that has a secure lid.
- Prepare hypochlorite solution in well-ventilated place and keep windows open when diluting or using bleach.
- **Warning:** remember always to add chlorine products to water, never the other way round.
- Clear water should be used for dilution because organic matter destroys chlorine. If only muddy water is available, add aluminium sulphate granules (alum) at a rate of 5 g to 10 litres and allow the deposit to settle. Cold water should be used for dilution; do not use hot water to dilute bleach as hot water decomposes the active ingredient of bleach and renders it ineffective.
- The well-being of aid personnel and patients depends on the effectiveness of the bleach solutions. ***Test the base stock each time you prepare a new batch and test the resulting dilution before use.*** Test the dilutions often during the day and discard and prepare a new batch when the chlorine percentage falls below the desired effective concentration.
- When you use test strips, use those that are capable of detecting the target range of FAC (the chlorine residual) so that the target FAC concentration is close to the midpoint on the test strip scale.
- Never use outdated reagents.[2]
- Store reagents in tightly sealed or capped containers, out of direct sunlight.
- Prepare a fresh disinfecting solution each day. Keep diluted bleach covered, protected from sunlight, in a dark labelled container.
- For effective disinfection, diluted bleach should be used within 24 hours after preparation as decomposition increases over time if left unused.
- Retest any reading(s) immediately when test results are inconsistent with recent tests, and repeat testing (or use a different method).
- The unused portions of the dilutions should be discarded 24 hours after preparation.
- **Warning:** sodium hypochlorite is corrosive and can cause burns to unprotected skin and eyes. Protect eyes, skin, clothing and equipment. Prepare diluted

[2] If the only bleach available is outdated, make sure that it is tested before use. Make dilutions according to the test result findings and not the concentration given on the label. This is a temporary measure. At the same time, send out a staff member to search local markets and shops for bleach that is in date and has been stored out of direct sunlight.

bleach in a well-ventilated area and keep the windows open. If sodium hypochlorite gets on skin (or hair), immediately remove all contaminated clothing. Rinse skin with water.

- **Warning:** With concentrated chlorine products (for example, HTH), chlorine evaporates naturally, but if certain chemicals are spilt on it, or if it is left unprotected from sunlight, the chlorine production is hazardous. Sodium or calcium hypochlorite containers should be stored in an area that will allow chlorine, which is heavier than air, to disperse. Never store chlorine products in a basement.

Preparing bleach using liquid bleach

To prepare such a solution from liquid bleach or solid calcium hypochlorite, follow the directions below. As a general rule, always make a 0.5% solution, test it, and then use this base dilution to make the other required dilutions, for example:

- 0.25% chlorine solution (1 part base [0.5% solution] to 1 part water)
- 0.1% chlorine solution (1 part base [0.5% solution] to 4 parts water)
- 0.05% chlorine solution (1 part base [0.5% solution] to 9 part water)

Preparing a strong (0.5%) chlorine solution from liquid bleach

A 0.5% chlorine solution or a solution containing 5,000 parts per million free available chlorine (an effective surface disinfectant against Ebola).

- To prepare 0.5% from 2.6% chlorine: pour 1 part liquid bleach and 4 parts water into a bucket. Repeat as often as necessary to obtain the volume you need.
- To prepare 0.5% from 3.5% chlorine: pour 1 part liquid bleach and 6 parts water into a bucket. Repeat as often as necessary to obtain the volume you need.

Chlorine in liquid comes in different concentrations. In case the available local bleach has a different chlorine concentration to those mentioned above, the following is a useful formula to use when preparing bleach:

Any concentration can be used to make a diluted chlorine solution by applying the following formula:[3]

$$\left[\frac{\%\text{ chlorine in liquid bleach}}{\%\text{ chlorine desired}}\right] - 1 = \text{Total parts of water for each part bleach}^{4}$$

[3] For the source of the formulas, see: Chlorine bleach: a trusted ally in the battle against Ebola. In: Water quality and health council [website]. 2014 (http://www.waterandhealth.org/chlorine-bleach-trusted-ally-battle-ebola/), and the USAPHC technical information paper No. 13-034-1114 Preparing and measuring high chlorine concentration solutions for disinfection (https://phc.amedd.army.mil/PHC%20Resource%20Library/TIP_No_13-034-1114_Prepare_Measure_High_Chlorine_Solutions.pdf).

[4] "Parts" can be used for any unit of measurement (for example, ounce, litre or gallon) or any container used for measuring, such as a pitcher.

Example 1: To make a 0.5% chlorine solution from 3.5%[5] bleach

$$\left[\frac{3.5\%}{0.5\%}\right] - 1 = 7 - 1 = 6 \text{ parts water for each part bleach}$$

This means 1 part 3.5% bleach should be added to 6 parts of water to make a 0.5% chlorine solution.

Example 2: To make a 0.5% chlorine solution from 2.6% bleach

$$\left[\frac{2.6\%}{0.5\%}\right] - 1 = 5.2 - 1 = 4 \text{ parts water for each part bleach; the exact calculation}$$

figure is 4.2. (It is always better to round down to get a slightly stronger solution than rounding up).

This means 1 part 2.6% bleach should be added to 4 parts of water to make a 0.5% chlorine solution.

Example 3: The only bleach to be found at the local market has a concentration of 1.25%. Use the formula to work out how many parts of water are needed for each part of bleach:

$$\left[\frac{1.25\%}{0.5\%}\right] - 1 = 2.5 - 1 = 1.5 \text{ parts water for each part bleach}$$

Rather than trying to measure 1.5 parts of water, it is better to multiply the mixed number (1.5) by a number that results in a whole number (for example, in this case 2x 1.5 = 3) AND do the same to the bleach. In this case, rather than adding 1 unit bleach to 1.5 units water, multiply both by 2 and therefore add 2 units of bleach to 3 units of water.

This means 2 parts liquid 1.25% bleach should be added to 3 parts of water to make a 0.5% chlorine solution.

[5] In countries where French products are available, the amount of active chlorine is usually expressed in degrees chlorum. One degree chlorum is equivalent to 0.3% active chlorine.

Preparing bleach using 70% chlorine powder

A) By weight: decide if 1 L, 10 L or 20 L is needed.

Solutions in % of active chlorine	Preparation	Procedure
0.1%	1.5 g/L; or 15g/10 L; or 30g/20 L	Put clean water into a plastic container. Add the chlorine powder to the water then stir well for 10 seconds. Allow deposits to settle and only use supernatant liquid. Make sure you are wearing extended personal protective equipment (PPE: gloves, mask, apron and cap).
0.5%	7.5 g/L; or 75 g/10 L; or 150 g/20 L	
1%	15g/L; or 150g/10 L; or 300g/20 L	

B) Using a tablespoon to prepare (0.5%) chlorine solution

1. Add 10 heaped tablespoons of high test hypochlorite (70% chlorine) to 20 litres of water in a bucket.
2. Stir well for 10 seconds, or until the high test hypochlorite has dissolved.
3. Wait for 10 seconds before use.
4. Label bucket "Strong (0.5%) Solution Chlorine Solution – Cleaning."
5. Cover the bucket with a well-secured lid.
6. Store in shade. Do not store in direct sunlight.

When preparing chlorine solution from calcium hypochlorite (bleach) powder,[6] calculate the amount of bleach to be mixed with each litre of water by using the following formula:

$$\left[\frac{\%\ \text{chlorine desired}}{\%\ \text{chlorine in bleach powder}}\right] \times 1000 = \text{Grams of bleach powder for each litre of water}$$

Example: To make a 0.5% chlorine solution from calcium hypochlorite (bleach) powder containing 35% active chlorine:

$$\left[\frac{0.5\%}{35\%}\right] \times 1000 = 0.0143 \times 1000 = 14.3$$

[6] When bleach powder is used, the resulting chlorine solution is likely to be cloudy (milky).

This means 14.3 grams of calcium hypochlorite (bleach) powder should be dissolved in each litre of water used to make a 0.5% chlorine solution.[7]

Testing for chlorine content

Chlorine content can be measured using liquid testers and test strips.

Wells et al.[8] found that digital titration is the most accurate method of measuring chlorine content, but that it is not an easy method and needs to be conducted by trained personnel. However, once a laboratory worker is properly trained, digital titration would give accurate results. The N, N-diethyl-p-phenylenediamine (DPD) dilution methods ranks second after titration methods. For health personnel other than laboratory workers, such as a logistics officer or nurse, the digital titration method, although accurate, is not the appropriate method of choice.

Another titration method is the WataTest, available from Fondation Antenna Technologies (used by Médecins Sans Frontières in the Ebola outbreak of 2014). For testing the real concentration of chlorine products, prepare standard stock solutions of 1% (the equivalent of 10g/L if it were 100% active, thus for HTH at 65%, about 15g/L = 10g/L x 100/65). This product does not have the precision of an electronic portable titrator, but it gives good idea of chlorine content.[9]

The Serim Monitor for Chlorine test strip for 0.05% solutions, which proved to be consistently accurate and precise across different types of chlorine,[8] should be considered. We suggest that when using the Serim strips to test at the 0.5% level, dilute 1 part of the expected 0.5% solution (being tested) with 9 parts chlorine free and clean water, then look for a result of 0.05%. Note: accuracy and precision is required when pipetting.

It is advisable to check the chlorine residual (FAC) of prepared solutions multiple times during the day to ensure the desired disinfecting concentration remains available.

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[7] See: For General Healthcare Settings in West Africa: How to Prepare and Use Chlorine Solutions-CDC. In: Centers for Disease Control and Prevention [website]. Atlanta: US Department of Health and Human Services. Available at http://www.cdc.gov/vhf/ebola/hcp/mixing-chlorine-solutions.html

[8] Wells E, Wolfe MK, Murray A, Lantagne D. Accuracy, Precision, Ease-Of-Use, and Cost of Methods to Test Ebola-Relevant Chlorine Solutions. PLoS ONE. 2016;11(5):e0152442. doi:10.1371/journal.pone.0152442 (http://journals.plos.org/plosone/article/asset?id=10.1371/journal.pone.0152442.pdf).

[9] The WataTest range is 1000–7000 mg/L. To verify solutions in % instead of g/L, count the number of WataTest drops to be added until a colour change is visually observed (the colour changes from blue to clear), and divide them by 20; for example, 10 drops/ 20 = 0.5 %, 20 drops / 20 = 1 %. For solutions with (very) low concentration: take 20 ml of chlorine solution. Count the number of WataTest drops to be added until the colour changes, and divide them by 200; for example, 10 drops / 200 = 0.05 %. (Instructions provided by Joos Van Den Noortgate, Training, Research and Development, Water, Hygiene and Sanitation Unit, Médecins Sans Frontières – O.C. Brussels. Personal communication, October 2016.)

Testing before making any dilutions

The purchased chlorine bleach, whether liquid, granular or powder must be tested.[10]

Test for liquid bleach

Test for total chlorine, using a hypochlorite test kit which uses Method 8209. The digital titrator (liquid tester) is capable of testing 0.0020 – 7.0% chlorine.

A method appropriate for a 0.05% and 0.5% solution is the Idometric Method, using sodium thiosulfate, Method 8209 (1 to 400 mg/L or 20 000 – 70 000 as Cl2, (2.0–7.0%). Per cent (%) chlorine = mg/L ÷ 10 000

A portable titrator that can be used with cartridges and pre-packaged chemicals to accurately test chlorine solution concentration in the field is available from Hach Company (USA). Reminder: digital titration is not appropriate for untrained personnel.

Test for powdered chlorine

The following method can be used to calculate the percentage of available chlorine in the original powder.

> A representative sample of the powder is taken (or several samples), mixed thoroughly and a small amount (say 1 gram) is accurately weighed. This is dissolved in distilled water to produce a solution of less than 5 per cent available chlorine (for example 1 gram of bleaching powder of about 25 per cent available chlorine dissolved in 1 litre of water, will give a solution of about 0.025 per cent chlorine). This is then diluted in distilled water to within the range of chlorine measurement (depending on the equipment and method used) and the concentration of chlorine accurately determined. The percentage of available chlorine in the original powder may then be calculated.[11]

Alternatively, you may use the following method: "Method 3: Estimated Calculation Based on Manufacturing".[12]

> Method 3: Estimated Calculation Based on Manufacturing
>
> If powdered HTH or NaDCC is used, the concentration can be estimated using the following equation:

[10] Refer to "Testing for chlorine content" and "Testing before making and dilutions" in this Annex.

[11] WHO Fact Sheet 2.19: Calcium hypochlorite, available at: http://www.who.int/water_sanitation_health/hygiene/emergencies/fs2_19.pdf

[12] See Lantagne D. Methods to Test Chlorine Solution Concentrations in Ebola Emergencies. In: WASH Liberia [website] 2014. Available at: http://wash-liberia.org/wp-content/blogs.dir/6/files/sites/6/2014/12/FS1-Methods-to-Test-Hypochlorite-Solution-R1.2.pdf

$$\frac{\text{mg}}{\text{L}} = \frac{\text{mg HTH/NaDCC x } \frac{\text{Percent Chlorine of HTH/NaDCC}}{100}}{\text{Liters}_{\text{water}}}$$

For example, if 1,000 mg (1 gram) of 65% strength HTH was added to 1 Liter of water, the resulting hypochlorite concentration is estimated at 1000*65/100/1 = 650 mg/L or 0.065%.

If quality-controlled liquid sodium chlorine solution (bleach) is used (i.e. purchased from a known reputable source that tests their solution and can provide those results to you and stored out of sunlight and heat) the concentration can be estimated using the following equation:

$$\frac{\text{mg}}{\text{L}} = \frac{\text{\% Chlorine x 10000 } \frac{\text{mg/L}}{\%} \text{ x } \frac{\text{1 Liter}}{\text{1000 mL}} \text{ x mL Chlorine}}{\text{Liters}_{\text{water}}}$$

For example, if 50 mL of 5.25% sodium chlorine solution (bleach) is added to 5 Liters of water, the resulting hypochlorite concentration is estimated at 5.25*10000/1000*50/5 = 525 mg/L or 0.0525%.

Testing using test strips

There are several commercially available test strips for testing 0.5% solutions or 0.05% solutions. These test strips allow for rapid but approximate measuring of free available chlorine. Use a test strip that is capable of detecting the target range of: 500 ppm to 10 000 ppm.

However, to test Ebola-relevant chlorine solutions, Emma Wells, Marlene K. Wolfe, Anna Murray and Daniele Lantagne, in their study entitled: "Accuracy, Precision, Ease-Of-Use, and Cost of Methods to Test Ebola-Relevant Chlorine Solutions" found that none of the test strips were sufficiently accurate or precise, with the exception of the Serim Monitor for Chlorine test strip for 0.05% solutions, which was consistently accurate and precise across different types of chlorine.[13]

Table A.16.2 shows some manufacturers of high chlorine test strips. Remember the following when using test strips for *approximate* measuring of free available chlorine.

- Do not store strips or reagents in very high temperature or high humidity conditions.

[13] Wells E, Wolfe MK, Murray A, Lantagne D. Accuracy, Precision, Ease-Of-Use, and Cost of Methods to Test Ebola-Relevant Chlorine Solutions. PLoS ONE. 2016;11(5):e0152442. doi:10.1371/journal.pone.0152442 (http://journals.plos.org/plosone/article/asset?id=10.1371/journal.pone.0152442.pdf).

- Store strips reagents out of direct sunlight.
- Keep all containers tightly sealed or capped.
- Follow the manufacturers' guidelines.
- Not all test strips are robust with regard to pH variation.
- Check for disposal dates.
- Retest any reading(s) immediately.

Table A.16.2 Some manufacturers of high chlorine test detection strips

Detection range (ppm)	Product name	Manufacturer or source
100–750	Serim Monitor for Chlorine test strip Increments: 100, 200, 350, 500, 750 ppm	Serim Research Corp. P.O. Box 4002, Elkhart, IN 46514 Tel: 800-542-4670; 574-264-3440 Fax: (574) 266-6222 Website: www.serim.com Email: lmontgomery@serim.com
0–800	Lamotte InstaTest free chlorine high-range test strip Increments: 0, 50, 100, 250, 500, 800 ppm	LaMotte Company 802 Washington Avenue, PO Box 329 Chestertown, MD 21620 Tel: 410-778-3100 ; 800-344-3100 Fax: 410-778-6394 Website: http://www.lamotte.com/en/
0–10 000	Activate High-level Chlorine Test Strips Increments: 0, 1000, 2500, 5000, 7500, 10 000 ppm	Deardorff Fitzsimmons Corporation, Customer Service PO Box 539 Merlin, OR 97532 Tel: 888-582-2700; 541-476-6065 Fax: 541-476-2336 Website: http://dfcorp.us/where_to_buy.php Email: info@dfcorp.us
0–10 000	Cole-Parmer High level Test Strips Increments: 0, 1000, 2500, 5000, 7500, 10 000 ppm Qty/pk: 50	Cole-Parmer 625 East Bunker Court Vernon Hills, IL 60061 USA Tel: 1-888-358-4717 Fax: 1-847-247-2929 Email: sales@coleparmer.com
0–10 000	Precision Laboratories extra high-level chlorine test strip Increments: 0, 1000, 2500, 5000, 7500, 10 000 ppm Qty/pk: 50 or 100 test strips	Precision Laboratories, Inc 415 S Airpark Road, Cottonwood, AZ 86326 Tel: 1.800.733.0266 Fax: 928.649.2306 Email: info@preclaboratories.com Precision Europe F25/26 Moulton Park Business Centre, Redhouse Road, Northampton, UK NN36AQ Tel: 01604 497516 Fax: 01604 497501 Email: sales@precisioneurope.co.uk

Table A.16.2 Some manufacturers of high chlorine test detection strips *(concluded)*

Detection range (ppm)	Product name	Manufacturer or source
0–10 000	Indigo 10K PPM Cl Test Strips for Hospitals Increments: 0, 1000, 2500, 5000, 7500, 10 000 ppm 100/vial	Indigo Instruments 169 Lexington Court, Unit 1 Waterloo, Ontario N2J 4R9, Canada Tel: +1 (519) 746-4761 Fax: +1 (519) 747-5636 Email: https://www.indigo.com/ Distribution & Mail 169 Lexington Court, Unit 1 Waterloo, ON, N2J 4R9
0–750 0–2000	Waterworks Free Chlorine Check Ultra High II (WW Ultra II) test strip Increments: 0, 25, 50, 200, 500, 800, 1100, 1500, 2000 ppm	Industrial Test Systems Industrial Test Systems, Inc. 1875 Langston Street Rock Hill, SC 29730, USA Tel: 803-329-9712 Fax: 803-329-9743 Toll-free: 800-861-9712 Website: http://www.sensafe.com/chlorine-tests-2/ *and* ITS Europe, LTD UK Centre for Homeland Security Building 7, Chilmark Salisbury, Wilshire SP3 5DU UK Tel: +44 (0) 1722 717911 Website: www.itseurope.co.uk

Note: When there is a need to order more test strips, where ppm needs to be considered, turn to page 342 for equivalent values.

References

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4. Collecting, preserving and shipping specimens for the diagnosis of avian influenza A(H5N1) virus infection. Guide for field operations. Annex 7. Disinfection. Geneva: World Health Organization; 2006 (http://www.who.int/csr/resources/publications/surveillance/WHO_CDS_EPR_ARO_2006_1/en/, accessed 29 September 2016).

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7. Fact Sheet 2.19: Calcium hypochlorite. Geneva: World Health Organization (http://www.who.int/water_sanitation_health/hygiene/emergencies/fs2_19.pdf).

8. How to Make Strong (0.5%) Chlorine Solution from 70% Chlorine Powder-CDC at: https://www.cdc.gov/vhf/ebola/pdf/cleaning-hand-washing-with-chlorine-powder.pdf

Purchasing liquid bleach and powdered and granular calcium hypochlorite

A buyer's guide

Photocopy these buyer's guide pages and take them to refer to when purchasing bleach

Points to consider

First enquiries. Send one of the organization's local staff members to find out where bleach can be purchased from markets or stores. When the buyer sets off to purchase bleach this staff member will then be able to take them directly to the correct merchant. Note that the buyer may have to go to the closest city.

Concentration of liquid bleach. Look for a concentration of about 5% available chlorine (Sodium hypochlorite). Note: Industrial bleach (over 20% active chlorine) are highly caustic and should be used only if no other bleach is available. Remember that a high concentration of Sodium hypochlorite also affects the decomposition rate; it decomposes faster.

Packaging of liquid bleach. Commercial bleach should be packaged in an opaque plastic bottle, high-density polyethylene (HDPE). Inappropriate packaging is low-density polyethylene (LDPE) or transparent bottles. It will have a light yellow colour and should have a strong smell of chlorine; if the bleach does not smell strongly of chlorine it may not be satisfactory for the purpose and you should look for another container that smells strongly of chlorine. To safely smell the bleach, the proper technique is to cup your hand above the container and waft the air towards your face. Try not to breathe in the air through your nose, but bring in just enough to make sense of the smell.

CAS Number.[14] Look on the label of the bottle/container for the CAS Number. This is a unique number for every chemical substance. The CAS Number for sodium hypochlorite is: 7681-52-9. The CAS Number for calcium hypochlorite is 7778-54-3.

Storage of liquid bleach in a market or shop. Particular care must be taken when purchasing liquid bleach in countries where the temperature reaches 30–38 °C and above at the hottest time of the year. Elevated temperatures (above 21 °C) affect the decomposition rate of liquid bleach. A market stall-holder may produce a container of bleach that has been stored on a high shelf near a window or skylight – avoid this bleach if possible.

Labelling on the liquid bleach bottle. The percentage of active[15] chlorine (base strength) should be stated on the bottle label. Look for 'unscented' on the label and for shelf life. For comparison purposes, here are some examples of labels in developed countries:

- Active ingredient: sodium hypochlorite 31.5g/L. No shelf life (use by date) is given.

[14] Chemical Abstracts Service (CAS) Registry Number, also referred to as CASRN

[15] Percentage of active chlorine is the amount of chlorine available for bleaching power.

- Active ingredient: sodium hypochlorite 42g/L (available chlorine 4.0%). Use before: (day/month/year).
- Active ingredient: sodium hypochlorite 6.0%; other ingredients: 94.0%: total 100% (yields 5.7% available chlorine).[16]

Local labelling. High variability is seen in commercial bleaches in many developing countries.The percentage of active chlorine may be as little as 1% in a developing country. There may be no information on the label about the percentage concentration of active chlorine. If no other bleach is available, buy what is available. If the container has an unbroken security seal/tag, date of manufacture, or use by date on the label, this is a bonus. If words on the label include "sodium hydroxide", buy that, as it is a more stable bleach. Always test for the percentage of active chlorine *before* making dilutions. Upon testing it may be found that the percentage of active chlorine is under the claimed strength.

Packaging of calcium hypochlorite. This white solid is supplied in larger amounts, 40 kg or 45 kg packed in plastic drums or buckets. If in a large plastic bucket it will probably have a white or blue lid.

Stability. Calcium hypochlorite (powder or granules) is more stable than sodium hypochlorite (liquid bleach) and contains a higher chlorine concentration (30–75%). Granulated calcium hypochlorite is more stable than the powdered form.

Look for signs of tampering. The Calcium hypochlorite container lid may have been taken off and some of the contents removed and replaced with something that is similar in appearance and size. If the label states it is the granular form look inside – the granules should all be the same size.

In summary:

- If the labels on the bleach bottles state the available chlorine percentage concentration, buy the newest bottles according to the date of manufacture or expiry date and those with the highest concentration.
- If bleach is available but none of the bottles state the available chlorine percentage concentration, then still buy those bottles. Lives depend on having bleach. Once back at the laboratory, test each bottle to find the measured chlorine concentration before dilutions are made.

[16] Some labels only state the g/L of sodium hypochlorite, for example, 42 g/L. The % available chlorine can be calculated by dividing this number by ten, for example, 42 g/L = 42/10 % available chlorine = 4.2% available chlorine. As sodium hypochlorite is heavier than water (42 g sodium hypochlorite measures less than 42ml) and the percentage of available chlorine is a by volume measurement, to be accurate this result needs to be divided by 1.05. In this case the result is 4.0% available chlorine.
In the field, as the available chlorine concentration will be tested before dilution anyway, this 5% reduction can be ignored when making purchasing decisions.

Annex 17. Information on keeping a laboratory log book and contacting a reference laboratory

Information on keeping a laboratory log book

- Many laboratory workers may keep notes about work using a laptop or other electronic device. However, laptops etc. can be affected by high magnetic fields, excessive dust or high humidity and associated condensation. These devices are also a target for thieves.
- It is strongly recommended that a hand-written record is kept each day – a "laboratory log book". A good notebook to use is a students' notebook or memo book, A4 size, wire spine 297 mm x 219 mm, 45 lines per page, and one (plastic) ring binder for holding the notebook, in addition to about five or ten clear plastic, multi-punch pockets, open at the top. Separate pages can be placed in these pockets. Do not use a loose-leaf folder, as pages can be ripped off easily and lost.
- In the "laboratory log book", start with the date and make notes about what happened that day. An entry might be: "Received this morning a lab module. Essential components for the Gram and Ziehl-Nielsen staining technique were missing. Only 300 glass slides were included. The wording on the package is: *(set out the actual wording plus any reference number)*". It would also be helpful to include descriptive headings and titles when making notes.
- The description and photographs can be submitted to the logistics office of the laboratory worker's organization when a complaint is made.
- Before starting to use the log book, use a ruler to make the margin on each page a little wider. Here at intervals special notes or reminder messages can be added. Do not write on every second line, or in no time the book will be full. Write on each line.
- While using a log book (in addition to a laptop) may be seen as repetition, it is much better to have a backup log book than to be without valuable information.

Information on contacting a reference laboratory

Laboratory workers may need to communicate with reference laboratories, not only to make use of the facilities a reference laboratory can provide, but also to ask for the advice and guidance of reference laboratory experts, who can take on a mentoring role for laboratory workers.

The best way of communicating with reference laboratory experts is face-to-face discussion; however, this will usually not be possible, as reference laboratories are generally located out of physical and personal reach of the laboratory worker in the great majority of disasters situations.

Table A.17.1 offers some of the different communication methods which may be used to contact a reference laboratory.

Table A.17.1 Methods of contacting a reference laboratory

Means of communication	Features	Advantages/disadvantages
Telephone	Instant	Allows the laboratory worker to find the most qualified person for assistance and advice
Email	Rapid, inexpensive, effective and one of the main forms of communication for laboratory workers	It allows for communication that is convenient for both receiver and sender. It allows details to be sent and received. Caution: the exact details and format of tables and charts may reach the recipient in a jumbled state. This can be avoided by sending attachments to the email in the form of PDF (Portable Document Format), Word, and Excel files, etc
Fax	Rapid	What you send is what they receive
Video conferencing or using Skype or similar	Instant feedback	Offers the laboratory worker the opportunity to discuss the matter with a wider range of specialists
Smartphones and tablets	Rapid	Photos, and microscope photographs in digital format can be sent and received

- The laboratory worker should use means of communication that work for them.
- It is highly recommended that a laboratory worker initially make a telephone call to a reference laboratory, making sure to write down in the laboratory log book (not on a scrap of paper) the full names and contact details, including email address, of the reference laboratory member of staff with the technical knowledge needed for the issue/s at hand, and the head of the reference laboratory. Offices receive many emails every day, and there can be a delay before emails are read, which is why it is important to identify the right person to send your email to.
- The telephone call should be followed up with an email.
- The expert working in the reference laboratory needs to understand the laboratory worker's situation and requests.
- The email should be kept as simple as possible; the effectiveness of written communication depends on the writing style, grammar, vocabulary, and clarity.

Questions and sentences that are vague, ambiguous or irrelevant should be avoided.

- It is better not to use symbols (such as %, etc.); instead, these should be spelled out: “per cent”, etc.
- If diagnostic samples are to be submitted to a reference laboratory, the laboratory worker should ask that reference laboratory to send them its “guidelines for the submission of diagnostic samples”.
- The laboratory worker should think about the significance of any tests they might request. Laboratory tests should contribute medically and epidemically useful information. This means that the test results will be of immediate value and provide addition information about changing disease patterns and the movement of whole populations.
- An email may reach its destination among many other emails. Emails are often not read with good focus and attention. Questions asked may not all be answered. It is good practice to number all questions, requests for which feedback is needed, and then towards the end of the email refer to them again as follows: “please answer my x (give the number/s) questions and requests.”
- The laboratory worker’s contact information should be added at the end of the message.
- Check if the email programme provider being used has the facility to notify the user when a sent email has been opened by the recipient, as an email may be delayed or not reach its destination.
- When following up a reply received on the matter at hand, do not rely on the “reply” button of the email, and double check that the email address of the person replied to is correct.

Useful abbreviations

Medical and technical abbreviations

A	ampere
ABO	blood group system
AC	alternating current
ACT	activated clotting time
Ah	commonly called "amp-hour"
AHG	anti-human globulin test (or the Coombs test)
amp	ampere
BE	base excess
CATT	card agglutination test
cm	centimetre
CRP	C-reactive protein
Copan Universal Transport Medium	Copan Universal Transport Medium (UTM-RT) is a medium for the collection and transport of clinical specimens containing viruses, chlamydia, mycoplasma or ureaplasma from the collection site to the testing laboratory
CSF	cerebrospinal fluid
DAT	direct serum agglutination test
DC	direct current
EC	electrical conductivity
EIA	enzyme immunoassay
ELISA	enzyme-linked immunosorbent assay
ESR	erythrocyte sedimentation rate
FAC	free available chlorine
FFP	fresh frozen plasma
FN	The field number referring to the diaphragm size of eyepiece in mm which defines the image area of specimen
G	gauges of needles
HBsAg	hepatitis B surface antigen
HBV	hepatitis B virus
HCO_3	bicarbonate
Hct	haematocrit; measurement of the number and size of red blood cells in the blood
HCV	hepatitis C virus
Hgb	haemoglobin
HIV	human immunodeficiency virus

Hz	hertz, the unit of frequency; one hertz has a periodic interval of one second
IgG	immunoglobulin G
IgM	immunoglobulin M
INR	international normalized ratio
IP rating	IP refers to Ingress Protection; an IP rating describes a standard of protection against intrusion (of body parts, for example, fingers), accidental contact, dust, and water. The first digit of an IP number refers to solid particle protection (for example, IP6 means the item in question is dust-tight, whereas IP5 means it is dust protected), while the second digit refers to liquid ingress protection. For example, a protective cover with a rating of IP56 means: ingress of dust is not entirely prevented (first digit: 5), but it is not able to enter in sufficient quantity to interfere with the satisfactory operation of the equipment; and the cover provides sufficient protection against water projected in powerful jets against the enclosure from any direction to ensure that water thus projected will have no harmful effects on the equipment (second digit: 6).
K	potassium
L	litre
LED	light-emitting diode
ln	lumen: the International System of Units (SI) unit of luminous flux. This is the quantity of light emitted by a light source. Lumens refer to the brightness of that source as the human eye perceives it, while the wattage of a light source refers to the power consumed to drive that source
mAh	milliamp hour. A unit for measuring electric power over time. mAh is commonly used to describe the total amount of energy a battery can store at one time
MCH	mean corpuscular haemoglobin (or mean cell haemoglobin)
MCHC	mean corpuscular haemoglobin concentration

MCL	maximum contaminant level
MCV	mean corpuscular volume (or mean cell volume)
mg	milligram
mL	millilitre
Mm	millimetre
MPN	most probable number multi-tube method
MTB/RIF	an assay for rapid and simultaneous detection of *M. tuberculosis* and rifampicin resistance-conferring mutations directly from sputum
MTCT	mother-to-child transmission
N95 respiratory mask	The N95 designation is an efficiency rating that means the mask blocks about 95% percent of particles that are 0.3 µm in size or larger
NA (microscope objectives)	objective numerical aperture
Na	sodium
N/A	not applicable
NAT	nucleic acid amplification technology
NiCd	nickel–cadmium
NiMH	nickel–metal hydride
NTU	nephelometric turbidity unit
ORP	oxidation reduction potential
P O_2	pressure of oxygen
PC O_2	pressure of carbon dioxide
PCR	polymerase chain reaction
pH	logarithm of the reciprocal of hydrogen-ion concentration in gram atoms per litre
PLTs	platelets
POC	point of care
PR	prothrombin ratio
PT	prothrombin time
PVC	polyvinyl chloride
QC	quality control
qPCR	quantitative polymerase chain reaction
RBCs	red blood cells
RDT	rapid diagnostic test
Rh	rhesus factor
RPR	rapid plasma reagin (test)
RT-PCR	reverse transcriptase polymerase chain reaction
SO_2	arterial saturation of oxygen
SA	stand-alone

TB	tuberculosis
TCO_2	total carbon dioxide
TDS	total dissolved solids
TON	threshold odor number
TST	time, steam, temperature (test strips)
TTI	transfusion transmissible infections
UV	ultraviolet
v/v	by volume
V	volt
VCT	voluntary counselling and testing centres
VDRL	venereal disease research laboratory
W	watt
Wp	watt peak capacity
× g	centrifugal force (RCF) expressed in units of gravity (times gravity or × g)
µL	microlitre
µS	microsiemens. µS/cm is a unit expressing the amount of electrical conductivity of a solution as measured between opposite faces of a centimetre cube of solution at a specified temperature. Siemens is the SI nomenclature. It is synonymous with mhos and is the reciprocal of resistance in ohms

Names of organizations

AABB	American Association of Blood Banks
DIN	Deutsches Institut für Normung (the German Institute for Standardization), an international standards organization
FDA	Food and Drug Administration (an agency of the United States Department of Health and Human Services), responsible for regulating food, dietary supplements, drugs, biological medical products, blood products, medical devices, radiation-emitting devices, veterinary products, and cosmetics in the United States
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization

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Note: A lot of useful references and guidelines are downloadable for free from international websites, including the websites of WHO headquarters and WHO regional offices; Centers for Disease Control and Prevention (CDC), USA; Médecins Sans Frontières, International (MSF); International Federation of Red Cross and Red Crescent Societies; UNICEF, etc.

This new edition of *Health laboratory facilities in emergency and disaster situations* provides information on the provision of basic laboratory services in various types of emergencies. It is aimed at all health professionals, including health care managers, physicians, nurses, laboratory personnel and other allied health staff. It will also assist international agencies, national authorities and other bodies involved in emergency and disaster relief in drawing up contingency plans for the provision of emergency laboratory services. This second edition has been comprehensively updated and expanded with detailed modules designed to meet the need for laboratory services in emergency situations while maintaining the principles of quality assurance and laboratory safety. Emphasis has been placed on ensuring that the information provided is simple yet comprehensive and appropriate, and applicable to emergencies and disasters in general, especially in the difficult environments encountered in many countries with limited resources.