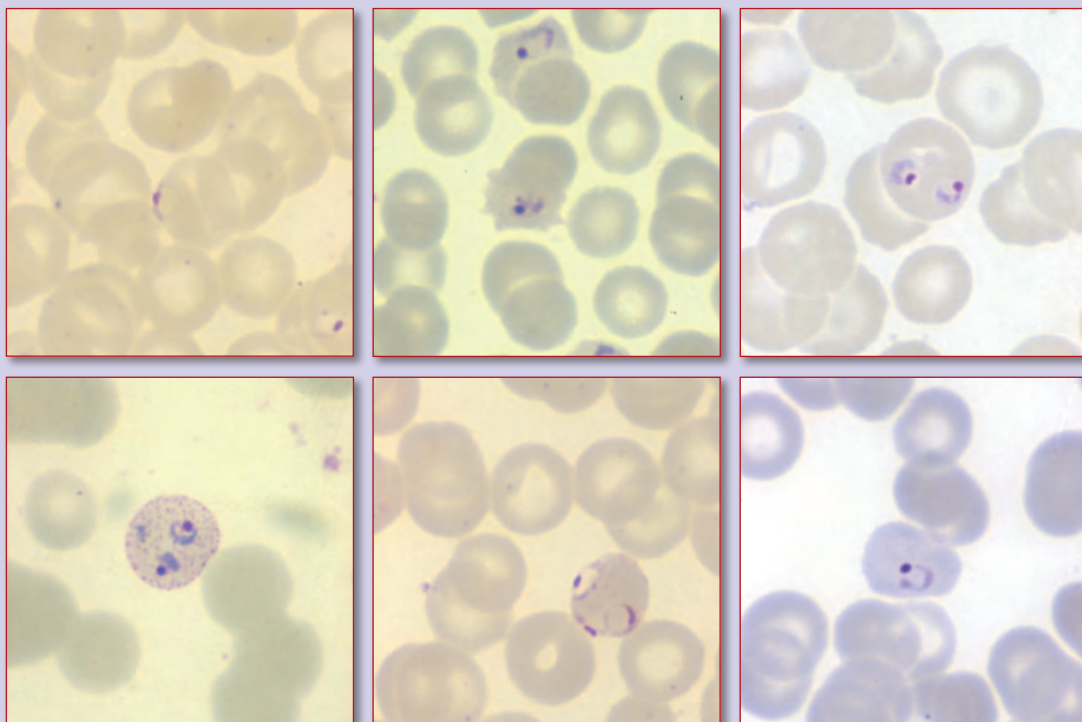


Basic **MALARIA MICROSCOPY**

Part II. Tutor's guide



Second edition



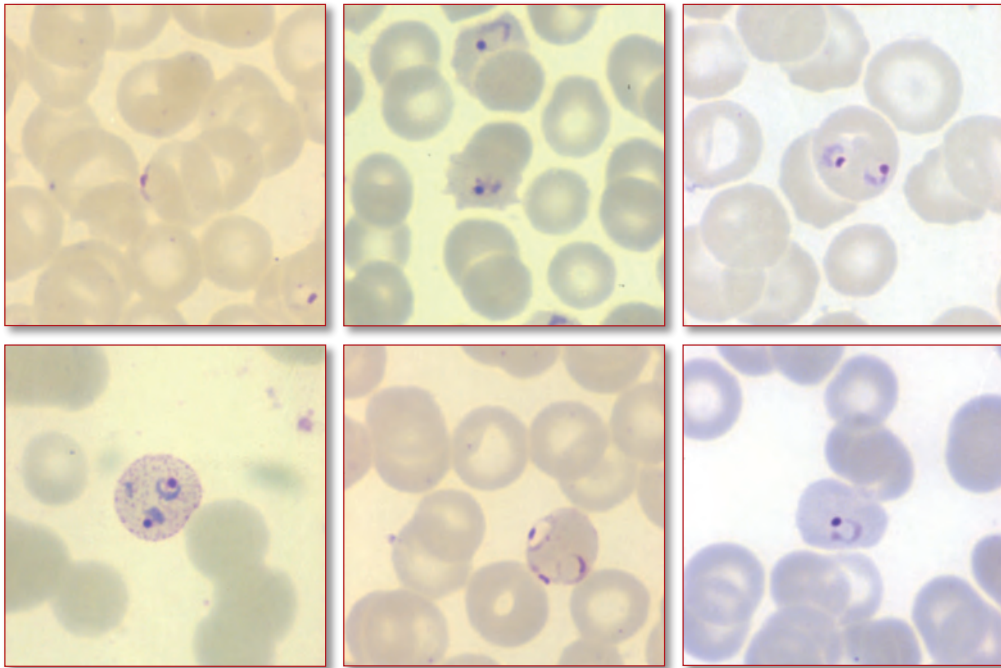
World Health
Organization

This second edition of the *Basic Malaria Microscopy* package is a stand-alone product, providing all that is needed to conduct a complete training course. It has been compiled by John Storey on the basis of the feedback received from a wide range of professionals and experts who have been using the first Edition of the *Basic Malaria Microscopy*, published by WHO in 1991. It still contains the beautiful and accurate water-colour illustrations prepared for the first edition of the manual by the late *Yap Loy Fong*. Experience has shown that colour drawings are best in training new recruits to recognize parasite stages and species, because single plane pictures help students to extrapolate from what they see under the microscope, focussed at a number of focal planes, to a complete view of the parasite. Later, they can move from drawings and use microphotographs, which will have an additional, positive impact. The training course is further strengthened if copies of the WHO *Bench aids for malaria microscopy* are also made available to trainees.

Front cover, inserts: photomicrographs of Giemsa stained thin films showing clockwise from top left: early trophozoites (ring stages) of 1) *Plasmodium falciparum*, 2) *Plasmodium vivax*, 3) *Plasmodium malariae* and 4) *Plasmodium ovale*; and mature trophozoites of 5) *Plasmodium falciparum* and 6) *Plasmodium vivax*.

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Part II. Tutor's guide



Second edition



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Preface to the second edition

An informal WHO consultation on quality assurance for malaria microscopy, held in Kuala Lumpur, Malaysia, in 2004 recommended that the 1991 edition of WHO's *Basic malaria microscopy*¹ be revised. This second edition is the result of that recommendation.

Few real changes in the microscopy of malaria have occurred since 1991, but much has changed in the way malaria is diagnosed and treated. There is better understanding in remote communities that malaria is a medical emergency and requires rapid diagnosis and treatment. As part of efforts in many countries to expand access to treatment, microscopy services are being renewed and upgraded. Parasitological confirmation of a diagnosis of malaria will strengthen the surveillance of malaria and improve control of the disease.

Microscopists are vital to malaria programmes, and their diagnostic and technical skills are relied on in both curative services and disease surveillance. Thus, training in malaria microscopy must be sound and must reach today's high standards. When microscopists are trained and able to make quality-assured diagnoses of malaria, communities at risk have greater confidence in their services, and both patients and prescribers benefit.

The training package presented here has been adjusted to meet the changed conditions. The training manual is divided in two parts: a *Learner's guide* (Part I) and a *Tutor's guide* (Part II). The package includes a CD-ROM, prepared by the United States Centers for Disease Control and Prevention, which contains microphotographs of the different malaria parasite species and technical information in PowerPoint format, which can be shown during training sessions and referred to by the participants. Emphasis is placed on teaching and learning, including monitoring and evaluating individuals and the group during training.

The Basic Malaria Microscopy programme continues to use the 'competence-based' concept of achieving set targets of competence. Attempts have been made to indicate the appropriate standards that will qualify a participant for graduation and for progress between learning units. The levels of competence to be attained at the end of this training course are the minimum levels defined in the WHO *Malaria microscopy quality assurance manual*². For example, "Reaching 80% accuracy in diagnosing malaria parasites" (assessed against a standard set of microscopy slides) is considered achievable by every participant. It is recognized, however, that some programmes may not yet be able to reach such standards and initially must set their own. The course organizers should indicate the standards they expect trainees to reach. As the trainees, once they have graduated, will be making decisions that determine the management of a potentially fatal disease, a high standard of competence must be ensured.

This second edition of the Basic Malaria Microscopy package is a 'stand-alone product', providing all that is needed to conduct a complete training course. It still contains the beautiful and accurate water-colour illustrations prepared for the first edition of the manual by the late Yap Loy Fong. Experience has shown that colour drawings are best

1 WHO. *Basic malaria microscopy: Part I Learner's guide; Part II Tutor's guide*. Geneva, World Health Organization, 1991

2 WHO. *Malaria microscopy quality assurance manual*. Manila, Western Pacific Regional Office, 2009.

in training new recruits to recognize parasite stages and species, because 'single plane' pictures help students to extrapolate from what they see under the microscope, focussed at a number of focal planes, to a 'complete view' of the parasite. Later, they can move from drawings and use microphotographs, which will have an additional, positive impact. Thus, the training course is further strengthened if copies of the *Bench aids for malaria microscopy*¹ are also made available to trainees.

The text for this edition was extensively revised by John Storey, on the basis of reviews by Professor Ahmed A. Abdel-Hameed Adeel, Dr Hoda Atta, Dr Andrei Beljaev, Dr David Bell, Dr Andrea Bosman, Ms Leigh Dini, Dr John Frean, Dr Mohammad A. Khalifa, Dr Derrick Klarkowski, Dr Ken Lilley, Dr Earl Long, Dr Majed Al Zedjali and Dr Raman Velayudhan. In addition, Donato Esparar, Ronald Espina, Sherwin Galit, Zenaida Grad, Felisa Guballa, John Fiel Porto and Arlene Leah Santiago tested and made valuable comments on the new keys to thick and thin films in the *Learner's guide*.

This project was coordinated for the WHO Global Malaria Programme by the WHO Western Pacific Regional Office and received financial support from AusAid and the Russian Federation, for which grateful acknowledgement is made.

¹ WHO. *Bench aids for malaria microscopy*. Geneva, World Health Organization, 2009.

Introduction

Using the two modules

Facilitators should use the *Tutor's guide* and the *Learner's guide* together throughout the course.

Take the time to read both modules now. It will be too late if you wait until the course starts.

Read each learning unit—not only those that you will be teaching. This will make the teaching methods clear and clarify each person's responsibilities.

Who are the modules intended for?

The basic malaria microscopy training package is made up of two modules and constitutes a framework in which trainers construct their course. It provides the minimum information required to train people in Giemsa malaria microscopy. It mainly targets people with a relatively low educational level on entry to the course; trainers can adjust the course for participants with higher levels of education. Workers currently responsible for malaria microscopy will also benefit from the *Learner's guide*. They will learn the process leading to the identification of malaria parasites, either by participating in a basic training course or during refresher training.

The *Tutor's guide* (*Basic malaria microscopy*, Part II) is designed to assist trainers instructing health workers in basic malaria microscopy. The participants should ideally also be given a copy each of the WHO *Bench aids for malaria microscopy*¹. If not, several copies should be made available as reference material, for use by the trainees.

Even experienced teachers will find portions of the modules useful, and they are simple to translate into other languages.

Certain parts of the CD-ROM complement the text of the learner's manual, e.g. the method for aligning the condenser, and the tutor can make optimal use of the CD-ROM during the relevant modules of the course.

How long does the course last?

The tutor will decide the length of the course on the basis of factors such as the available budget, the participants' educational (or entry) level and available resources. The higher the level of education, the shorter the training time required. As training is expensive in time and money, it must be effective. Experience with these training materials shows that

¹ WHO. *Bench aids for the diagnosis of malaria infections*. 3rd ed. Geneva, World Health Organization, 2007.

health workers with a range of educational levels, without previous experience in malaria microscopy, can reach acceptable competence within 4–5 weeks of intensive training. Laboratory technicians and health workers from health centre laboratories with previous experience in malaria microscopy can achieve the required competence within 11–12 days of intensive training.

Direct interviews with candidates may not be possible, but it is important to find the most suitable people for the course. Learners must be able to:

- read, comprehend and write English or the language into which the *Learner's guide* has been translated and in which the course is run;
- correctly follow simple written and verbal instructions;
- have good eyesight and hearing;
- differentiate the colours red and blue¹;
- be sympathetic to the health problems of poor communities; and
- after completion of the course, be willing to live and work in a community far from their home.

How is the training designed and what is its content?

The principal objectives of the training course are listed in the Introduction to the *Learner's guide*.

Please read this now.

The *Learner's guide* facilitates the teaching of each task in basic malaria microscopy, following each step of the routine in the correct sequence. For example, learners are taught to clean and wrap micro-slides before they learn how to make blood films on newly cleaned slides. In the process, learners acquire the knowledge, skills and attitudes needed to reach high levels of competence and reliability.

Competence- or performance-based training is effective for teaching complex skills and knowledge and economical in money and time. The overall learning objectives are given in the Introduction to the *Learner's guide*, and the objectives of each learning unit are listed at the beginning of each unit.

A learning objective summarizes the knowledge, skills and sometimes attitude that each learner must acquire and demonstrate mastery of by the end of the learning unit. The trainer must be satisfied that learners have achieved these objectives before allowing them to proceed to the next learning unit. The methods used to monitor each participant's progress and achievement are described later in this guide.

Although it is more convenient for learners to proceed together from one learning unit to the next, competence-based training allows slower learners to move through a unit at their own pace. Thus, one trainee may work alone on one unit while the rest of the group has moved on to another. Slower learners require additional attention from the facilitator, but experience shows that they are stimulated to catch up with the main group quickly.

¹ Many workers stress the importance of this aspect. The author has experienced only two cases of 'colour-blindness' over many years of teaching: one in a highly skilled supervisor with 10 years' experience, whose work was unaffected by his condition, and the other in an applicant who had other visual problems that precluded his participation.

Who is responsible for running the course?

As the manager of the training programme, the course tutor is responsible for designing and running it. He or she does not, however, do it alone. Teaching is more effective when there is a group of competent trainers or facilitators, who should be skilled microscopists but need not be trained teachers. Each facilitator is responsible for a group of three to five trainees throughout the course. Small group-centred training allows greater contact between learner and facilitator and among learners, resulting in better learning.

The *Tutor's guide* and the *Learner's guide* can help the tutor to design and run the course, but the final results will depend on the enthusiasm and dedication of the training team and the willingness of the participants to acquire new knowledge and skills.

This may be the first time you have organized and run such a course, or you may be an experienced teacher. Whatever your experience, the importance of using the two modules together as you proceed through the learning units will become clear. Facilitators should have one copy each of the *Tutor's guide* and the *Learner's guide*. Sharing one copy of the *Tutor's guide* among trainers does not work.

As the training manager, it is your responsibility to finalize the curriculum and the timetable. You will also have to explain the learning objectives and the monitoring and evaluation methods used and give the learners and facilitators any other support they may need. The activities are planned and developed with the team of trainers.

If some facilitators are not experienced teachers, do not worry. About 3 weeks before the course starts, you should hold a 3–5-day training-of-trainers course to ensure that each trainer is familiar with the competence-based system and how it functions. Even if some facilitators have participated in previous training-of-trainers courses, they will benefit from a refresher and orientation course, and you will ensure that everyone is aware of the current methods of lesson planning and teaching skills. Subsequently, they will be better prepared to design and plan their own training materials. The training-of-trainers course is described later.

This training programme describes a standard method of Giemsa malaria microscopy that is successfully practised in malaria programmes worldwide.

Why give learners a guide?

Giving learners a full set of notes at the beginning of the course ensures that:

- Each learner has the same set of notes to refer to and work with.
- They need not take extensive notes during lessons and can concentrate on the presentation and discussions.
- They can spend time reading the guide rather than trying to interpret notes taken down during lessons, which may not be error-free.¹
- Learners who want to make additional notes are free to do so.
- A reference to any part of the *Learner's guide* can be found quickly by everyone in the class.
- The guide can be taken home to be used as a reference.

¹ Research shows that many students make a wide range of errors during note-taking.

How is the course run?

Lectures and presentations should be kept to a minimum. Demonstrations, practical sessions, field visits, discussion groups and role-play involving the learners are the most effective ways to teach.

Participants learn more when they are actively involved. Listening to someone talk for long periods is not effective for learning.

How will the course be monitored?

Judging the success of a course can be difficult. It is based on the answers to several questions.

How well did the group learn?

This is determined by monitoring each learner's performance in every learning unit and by assessing the skills acquired in later units of the programme. How well each participant has retained knowledge, skills and competence is evaluated 6–12 months after graduation, in a follow-up assessment.

How did the learners view the training?

Responses to this question yield useful information, especially those from the short evaluations of the training course by the participants during and at the end of the course. Feedback during the course indicates improvements that could be made, and feedback at the end of the course, including from facilitators, will help improve similar training.

Positive feedback is always well received. Participants usually react well when they see that care has been taken in preparing and running the course and when they can observe their own progress.

Is a certificate or diploma provided on graduation?

It is important to award a certificate that records the final achievement of each graduate. The awarding of a certificate of achievement indicates to successful graduates that they have reached the recommended level of competence. In some programmes, the awarding of a certificate of competence is listed in a national register. The certificate should be re-evaluated (and thus re-registered) regularly, such as every third year, as is done in many programmes.

Awarding a certificate of attendance alone is not recommended, as it might imply that the participant has reached an acceptable level of competence when she or he might not have done so.

Competence in basic malaria microscopy should be viewed seriously. International bodies such as WHO, collaborative training institutions and national governments encourage the establishment and implementation of recognized standards. A system for in-service training and competence assessment must be established, with recognition of successful participants. It is important that trainees be aware that a career structure is in place. As their skills increase, they can progress to supervisory levels, so that microscopy standards continue to be monitored by national and international collaborators.

Use of the *Learner's guide* and the *Tutor's guide*

The two modules are flexible and can be used together by trainers, in various ways.

For basic group and in-service training

Using the *Learner's guide*, the trainees are guided systematically through Learning units 1–10, moving to the next unit only once they have demonstrated that they have achieved the required level of skill. Facilitators use the *Tutor's guide*, the Bench aids and materials in the CD-ROM for comprehensive training.

For refresher training

Previously qualified staff can take the course to update their knowledge and skills. Participants may use the *Learner's guide* and facilitators the *Tutor's guide*. In view of the higher level of knowledge at entry, the time spent on the early units should be modified in accordance with areas of strength or weakness. Training takes about 2 weeks.

As reference materials

Malaria workers, administrators, programme managers, laboratory staff and others will find the *Learner's guide* useful as a reference for the correct methods of doing tasks associated with Giemsa malaria microscopy.

In lesson planning and teaching skills

Trainers will find the guidelines in the *Tutor's guide* useful as a reference for planning training and improving individual lessons and teaching skills.

Planning the training course and the training-of-trainers course

To help plan the courses, the sequence of learning units and their content are shown graphically below, with directions for each step of planning.

You must go through this exercise. Even if you have little experience in planning, you will find it is easy to do so with your course facilitators, step by step.

1. Decide on the final syllabus or course content (also called the 'curriculum').
2. Establish the length of the course, the timing, the timetable and the kinds of training materials you will use.
3. Decide the number of participants you can teach at one time.
4. Establish their preferred entry level.
5. Calculate the space needed and the number of support staff required.
6. Confirm the number of facilitators and their responsibilities.
7. Select other part-time teachers and inform them of the subjects they will teach.
8. List the supplies, equipment and other materials required, and initiate ordering.
9. Plan other activities, such as opening and closing ceremonies, publicity, certification, national recognition and follow-up.
10. Plan and run the a training-of-trainers course.

The training sequence

Malaria the disease: Covers the importance of malaria to morbidity and mortality and in perpetuating the poverty cycle. Participants may have experience in this topic, and discussions should be held to highlight its importance.



Cleaning and storing microscope slides: The first step in the skills sequence. From this point, participants must willingly follow the procedures correctly. Cutting corners can prejudice results. The methods presented and the reasons for following the system are based on years of experience.



Keeping accurate records: Without accurate records, there will be no patient details for follow-up and no precise data for reporting to supervisors and to higher levels in the system. There will be no infrastructure. Ensuring the accuracy of details on patients and other areas leads to reliable record-keeping and avoids mixing up patients.



Preparing blood films: Essential for accurate, reliable malaria microscopy. Mastery of blood film-making (thick and thin) and ensuring a high standard are the cornerstone of this unit. Sound knowledge of blood-borne pathogens and routine measures for personal protection are essential to good laboratory practice.



Staining blood films with Giemsa stain: Other stains can be used, but Giemsa is the stain of choice for malaria microscopy. When used correctly, Giemsa stain is reliable. Learning the two main methods and when each should be used is the objective of this unit. Basic steps for troubleshooting will help people who will work in remote areas.



The microscope: Correct use and care of this instrument require regular practice and familiarity with all aspects of the daily routine. Protection from dust, dirt, grease, oil and fungal growths and the correct preparation for transport between stations are essential parts of this unit.



Examining blood films: Starting with uninfected blood, the participant goes through the steps and practice of recognizing the appearance of common components of blood with oil-immersion microscopy. Some common inclusions and artefacts that may be seen in thin and thick blood films are illustrated.



Examining blood films for malaria parasites: This unit helps participants to identify the presence of malaria parasites and to recognize the different stages and the morphological characteristics specific to the four species, while concentrating on identification of *P. falciparum* and *P. vivax* in thick films to 80% accuracy.



Routine examination of blood films: Attaining accepted standards in malaria microscopy is essential to ensure the reliability of laboratory staff. This unit focuses on important aspects of routine examination, including establishing parasite density. Practice is key to reaching the goals, and enough time must be allotted for the participants to gain the required experience.



Supervisory aspects of malaria microscopy: Essential to the smooth functioning of malaria control activities. Participants must be aware that supervision and monitoring individual performance support their work. Supervisors themselves must recognize the need to meet standards in their own work.



Follow-up: Participant follow-up is an essential part of good training. As it is often it is forgotten, it must be planned.

The syllabus or course content

The tasks described in the trainee's job description will help decide subjects for the syllabus.

The subjects outlined in this course reflect the activities essential for malaria microscopy. The job descriptions of such workers vary by country. Include other routine responsibilities that trainees may have.

The Contents of the *Learner's guide* lists the subject areas to be covered by this syllabus, and each learning unit is divided into a number of subunits or topics. Go through each unit and calculate how much time you will need to devote to each topic. For example, Learning unit 1, 'Malaria, the disease', has six learning objectives, while the text is divided into four main sections dealing with various aspects of the disease. Consider how long it will take you to reach each learning objective and whether this is best achieved by a short lecture, a group discussion, a video or a combination of these methods.

Length of the course, timing, timetable and types of training activities

After calculating the time required for each learning unit and subunit, fit the various learning activities into the framework of the training programme.

You may have little control over the duration of training. For example, you may have been allowed only 4 weeks, when you had planned for 5. Such limitations are common, and the planning team has to adjust the course on the basis of the available time.

Tables 1 and 2 at the end of this section show a simple method for allocating time to each learning unit and the resulting timetable. This is just one approach and is intended to be only a guide to organizing your training. It cannot take account of other factors that may influence your planning, such as the length of your working day and week or public holidays.

To make teaching effective, consider using some of the following methods.

- In **short lectures**, the trainer introduces the subject in a brief 10–15-minutes talk, perhaps with use of an overhead projector or a slideshow, leading to a group discussion. Short lectures are an effective learning tool when they allow feedback. Consider allowing participants to lead the discussion.
- **Group discussion** is an effective learning method that allows sharing of knowledge and experience. It is a stimulus to problem solving.
- **Practical fieldwork**, or fieldwork, usually takes place in the laboratories of rural hospitals and community health centres. Learners experience the everyday activities involved in malaria microscopy. The most successful practical sessions offer opportunities to acquire greater competence in worker–patient interactions.

The following three activities reinforce learning but can take time to prepare.

- **Demonstration:** Learners can easily be introduced to the appearance of malaria parasites under the microscope by a simple demonstration.
- **Videos and DVDs:** Short videos show learners what a particular place or situation looks like without having to be there, and they can open discussion.
- **Role-play:** This is a powerful tool for training in the right way to ask a patient to provide a blood film, for example. Trainees take the roles of the various people involved: the patient, the clinician (doctor or nurse) and the laboratory technician.

There is no formal script, and each person acts out what she or he considers to be the appropriate dialogue. Afterwards, there is a discussion of what was done correctly and the problems that might arise in real-life situations. Reference is not made to the performance of particular participants in the role-play.

When planning the timetable, allow for evaluation during and after the course and for other activities, such as laboratory cleaning, record completion and compilation and travel to and from fieldwork.

Number of participants and their selection

Decisions about participants may depend on the personnel needs of the human resources department or those of the national malaria control programme, the educational levels of the candidates, the number of microscopes available and, most importantly, the size of the training budget.

Space needed and number of support staff required

Once the number of trainees has been decided, calculate the training space and support staff required. Trainees from other parts of the country may need accommodation. Include any plans for travel to rural areas for practical work. Each of these aspects must be addressed before a final figure can be reached.

One room for presentations, discussions and small group activities and another for laboratory and practical work are usually sufficient. The laboratory should have secure, bench-type tables. There should be at least one sink with running water. The benches and tables should be 75 cm high, with one adjustable stool per trainee.

A power supply may not be available, and some participants will return to areas where there is no electricity. If this is so, it is recommended that each microscope is fitted with a sub-stage mirror and a battery-powered light-emitting diode (LED) microscope lamp to ensure a well-lit oil immersion field. If this is not available and microscopists must rely on daylight as the light source, the working benches must face windows or unobstructed open doors. Using daylight as the light source should be the last option.

Facilitators

Select facilitators from a core of experienced trainers, who may therefore be familiar with the objectives of the national programme. If not, tell facilitators what their role is and give them time to prepare materials for the course. This can be done during the training-of-trainers course conducted before the training course starts.

Other teachers

In addition to full-time facilitators, other teachers may be requested to address a particular subject, such as 'Policies of the national malaria control programme', 'Aspects of supervision' and 'Regular reporting'. Such sessions are usually short and led by senior staff from provincial or central level. When you invite a teacher to participate, indicate your preference for interactive sessions rather than didactic, formal presentations. Such sessions are an excellent opportunity for the participants, as they will hear national policies explained by senior staff.

Supplies, equipment and other materials

Supplies and equipment should be ordered well in advance of the course, as many items can be difficult to obtain at short notice. The basic equipment and reagents required for the training course are listed in Annex 1.

Learners' equipment

Each learner should be provided with the following:

- a copy of the *Learner's guide*, to be kept after graduation;
- one binocular microscope and an LED lamp.

Note: Participants should train on a microscope similar to the one they will use on returning home. Do not use systems that participants will be unable to reproduce at home. If power or a microscope light is not available, use daylight, but only as a last resort. A number of simple LED lamp systems are available that are cheap and easy to operate.

- a notebook, for occasional written notes and taking down instructions;
- a ballpoint pen;
- a supply of graphite pencils, medium to hard, and blue, red, brown and black pencils for drawing;
- a small pencil-sharpener, an eraser and a ruler; and
- a simple electronic calculator.

In addition:

If possible, give each participant a set of the *WHO Bench aids for malaria microscopy* (2009). These contain excellent photomicrographs, showing the various stages of parasite species in humans. They will provide support during training and back at home. The colour drawings of parasites in the *Learner's guide* and the photomicrographs in the *Bench aids* complement one another.

Teaching equipment

Depending on the situation, the following should be available:

- an overhead projector, a supply of acetate sheets and coloured marker pens;
- a personal computer (PC) with a compact disc reader and a colour printer;
- a liquid crystal display (LCD) projector linked to the PC;
- a 'teaching microscope', fitted with two to five viewing heads. Various models are available, but the more viewing heads, the more difficulty it is to keep them fungus free.

Note: An expensive alternative to the teaching microscope is a microscope connected to a television monitor, which allows a larger number of viewers to see a specimen being examined, increasing the opportunity for discussion and learning. Microscopes linked to a monitor through the PC that shows digital pictures do not yet reach the magnifications required. The area is changing rapidly, and progress is expected.

- a projector for 35-mm slides with an automatic slide feeder;

Note: Largely replaced by PCs with LCDs. Perfectly adequate sets of slides are available that show the various blood elements, parasite stages and species, and they remain a valuable teaching aid.

- a screen for the overhead projector, LCD or 35-mm projector;

Note: A white cotton sheet, light-coloured wall or white matt-painted board can be an adequate substitute. A whiteboard reflects projected light and is no use as a screen.

- a large black or green chalkboard and coloured chalks or a whiteboard with water-based, coloured markers; and

Note: A thin metal sheet placed underneath a white surface allows use of magnetic visual aids.

- one flipchart per group with adequate supplies of 'butcher's' paper or newsprint.

Note: Flipcharts can be purchased but can be easily constructed from local materials.

The room in which visual aids will be used should be air-conditioned and have curtains or screens so that the room can be slightly darkened.

Glassware, chemicals and reagents

You will probably have available most of what you need for the training. The minimum requirements are listed in Annex 1.

Reference slide sets for demonstration purposes and accreditation of trainees

A set of reference slides of Giemsa-stained thick and thin blood films containing the species that the trainees are likely to see locally should be available. It should consist of 25–30 slides of *Plasmodium falciparum* and *P. vivax* specimens, with, if possible, examples of the less common *P. malariae*. *P. ovale* is rare outside parts of Africa but should be included if available. Recommendations for preparing sets of training slides are given in the WHO manual for malaria microscopy quality assurance.¹

Note: Obtaining well-stained slides of parasites representative of each species can be difficult and take up valuable time and money. A national slide bank can provide well-validated slides. Under tropical conditions, slides will have a life expectancy of 1–3 years but will last 5–10 years or longer if the blood film is mounted with a neutral mountant and covered with a coverslip.

Opening and closing ceremonies, certification, national recognition and follow-up

These activities are an important part of the course. Publicity for the course can help inform communities about the measures being taken to control malaria and what they can expect as the outcome of a particular training programme.

Follow-up is frequently forgotten during planning but is essential to ensuring the feedback that training requires. Graduates should be visited at their workplaces 6–12 months after graduation to see how they are performing microscopy in the community, to assess the effectiveness of the training and whether adjustments should be made for the next training programme. Procedures for follow-up visits are described in the WHO manual for malaria microscopy quality assurance.¹

Training-of-trainers course

Training of trainers is an important activity, although some facilitators may consider that they have enough teaching experience and do not need to participate. Until an experienced team is in place, this attitude should be discouraged, as it is important that facilitators are aware of their responsibilities. Some trainers may find it more interesting to have an independent, experienced trainer run the course.

¹ WHO. *Malaria microscopy quality assurance manual*. Manila, Western Pacific Regional Office, 2009.

From ____ To ____

Example of a timetable

Week 1 of 5

Period	Day 1	Day 2	Day 3	Day 4	Day 5
1 08:00-08:50	Arrival and registration of participants	Cleaning and storing of slides A/D	Record forms and how to use them B	Collecting blood films (field trip) C	Weekly spot test (written or oral) E
2 09:00-09:50	Opening ceremony	Cleaning and storing of slides B	Blood films (and how to make them) A	Collecting blood films (field trip) C	Weekly spot test (written or oral) E
3 10:10-11:00	General information and issue of supplies	Cleaning and storing of slides B	Making blood films D/B	Collecting blood films (field trip) C	Discussion of spot test results A/E
4 11:10-12:00	Introduction to the course and how it will function A	Cleaning and storing of slides B	Making blood films B	Collecting blood films (field trip) C	Discussion of spot test results A/E
5 13:00-13:50	Timed pre-test and feedback A/E	Cleaning and storing of slides B	Making blood films B	Collecting blood films (field trip) C	Film on malaria D
6 14:00-14:50	Malaria, the disease A	Record forms and how to use them A/D	Making blood films B	Travel back to training center C	Group discussion on malaria film A
7 15:00-15:50	Malaria, the disease D	Record forms and how to use them D/B	Briefing and preparation for field work A	Packing and storing collected films and completing forms C	Learner assessment of week 1 and feedback to facilitator E
		Meeting with facilitators to review training activities		Meeting with facilitators to review training activities	Meeting with facilitators to review training activities

Note: A = presentation B = practical C = field work D = film, demonstration, role play E = evaluation

Week 2 of 5

Example of a timetable (continued)

From ____ To ____

Period	Day 1	Day 2	Day 3	Day 4	Day 5
1 08:00–08:50	Staining blood films with Giemsa stain A	The microscope A	Examining blood films A/D	Examining blood films for malaria parasites D/A	Weekly spot test (written or oral) E
2 09:00–09:50	Staining with Giemsa (plus pH of diluent) A/D	The microscope A/D	Examining blood films B	Examining blood films for malaria parasites D/A	Weekly spot test (written or oral) E
3 10:10–11:00	Staining with Giemsa (plus pH of diluent) D	The microscope B	Examining blood films B	Examining blood films for malaria parasites B	Discussion of spot test results A/E
4 11:10–12:00	Staining blood films with Giemsa stain D/B	The microscope B	Examining blood films B	Examining blood films for malaria parasites B	Discussion of spot test results A/E
5 13:00–13:50	Staining blood films with Giemsa stain B	The microscope B	Examining blood films B	Examining blood films for malaria parasites B	Discussion of spot test results A/E
6 14:00–14:50	Staining blood films with Giemsa stain B	The microscope B	Examining blood films for malaria parasites A	Examining blood films for malaria parasites B	Learner assessment of week 2 and feedback to facilitator E/A
7 15:00–15:50	Staining blood films with Giemsa stain B	Examining blood films A	Examining blood films for malaria parasites A	Examining BF for malaria parasites and daily record of work done A/B	Weekly record of work done A/B
	Meeting with facilitators to review training activities	Meeting with facilitators to review training activities		Meeting with facilitators to review training activities	Meeting with facilitators to review training activities

Note: A = presentation B = practical C = field work D = film, demonstration, role play E = evaluation

From ____ To ____

Example of a timetable (continued)

Week 3 of 5

Period	Day 1	Day 2	Day 3	Day 4	Day 5
1 08:00–08:50	Examining blood films for malaria parasites D/A	Examining blood films for malaria parasites D/A	Examining blood films for malaria parasites and artefacts D/A	Examining blood films for malaria parasites and artefacts D/A	Weekly spot test (written or oral) E
2 09:00–09:50	Examining blood films for malaria parasites A/D	Examining blood films for malaria parasites A/D	Examining blood films for malaria parasites and artefacts A/D	Examining blood films for malaria parasites and artefacts A/D	Weekly spot test (written or oral) E
3 10:10–11:00	Examining blood films for malaria parasites B	Examining blood films for malaria parasites B	Routine examination of blood films for malaria parasites A	Routine examination of blood films for malaria parasites B	Discussion of spot test results A/E
4 11:10–12:00	Examining blood films for malaria parasites B	Examining blood films for malaria parasites B	Routine examination of blood films for malaria parasites A	Routine examination of blood films for malaria parasites B	Discussion of spot test results A/E
5 13:00–13:50	Examining blood films for malaria parasites B	Artefacts in blood films B	Routine examination of blood films for malaria parasites B	Routine examination of blood films for malaria parasites B	Learner assessment of week 3 and feedback to facilitator E/A
6 14:00–14:50	Examining blood films for malaria parasites B	Artefacts in blood films D	Routine examination of blood films for malaria parasites B	Routine examination of blood films for malaria parasites B	Learner assessment of week 2 and feedback to facilitator A/E
7 15:00–15:50	Examining of blood films for malaria parasites and daily record of work done B	Artefacts in blood films and daily record of work done B	Routine examination of blood films for malaria parasites and daily record of work done B	Routine examination of blood films for malaria parasites and daily record of work done B	Weekly record of work done A/B
		Meeting with facilitators to review training activities		Meeting with facilitators to review training activities	Meeting with facilitators to review training activities

Note: A = presentation B = practical C = field work D = film, demonstration, role play E = evaluation

From _____ To _____

Example of a timetable (continued)

Week 4 of 5

Period	Day 1	Day 2	Day 3	Day 4	Day 5
1 08:00–08:50	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Discussion on field work A/E	Routine examination of blood films for malaria parasites B
2 09:00–09:50	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	The life cycle of malaria parasites A	Routine examination of blood films for malaria parasites B
3 10:10–11:00	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	The life cycle of malaria parasites D	Routine examination of blood films for malaria parasites B
4 11:10–12:00	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	The life cycle of malaria parasites D	Routine examination of blood films for malaria parasites B
5 13:00–13:50	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Supervisory aspects of malaria microscopy A	Final weekly spot test (written or oral) E
6 14:00–14:50	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Routine examination of blood films for malaria parasites B/C	Supervisory aspects of malaria microscopy A/B	Final weekly spot test (written or oral) E
7 15:00–15:50	Routine examination of BF for malaria parasites and daily record of work done B/C	Routine examination of BF for malaria parasites and daily record of work done B/C	Routine examination of BF for malaria parasites and daily record of work done B/C	Monthly records and supplies request A	Completion of weekly/monthly work record B
	Meeting with facilitators to review training activities	Meeting with facilitators to review training activities		Meeting with facilitators to review training activities	Meeting with facilitators to review training activities

Note: A = presentation B = practical C = field work D = film, demonstration, role play E = evaluation

From _____ To _____

Example of a timetable (continued)

Week 5 of 5

Period	Day 1	Day 2	Day 3	Day 4	Day 5
1 08:00–08:50	Discussion of spot test results A/E	Time flexible: to be filled as needed	Time flexible: to be filled as needed	Discussion on supplies to take back to duty station	Free
2 09:00–09:50	Discussion of spot test results A/E			Individual counselling before returning to duty station	Closing ceremony and presentation of proficiency certificates
3 10:10–11:00	Discussion of daily/weekly/monthly reports and supplies A			Individual counselling before returning to duty station	
4 11:10–12:00	Discussion of daily/weekly/monthly reports and supplies A			Individual counselling before returning to duty station	
5 13:00–13:50	Return of supplies and equipment			Individual counselling before returning to duty station	Final meeting of the facilitators to evaluate the course, decide on report writing, and discuss changes to be made in future courses
6 14:00–14:50	Return of supplies and equipment			Individual counselling before returning to duty station	
7 15:00–15:50	Return of supplies and equipment			Individual counselling before returning to duty station	

Note: A = presentation B = practical C = field work D = film, demonstration, role play E = evaluation

Notes

Learning unit 1

Malaria, the disease

The learning objectives of this unit are shown in the *Learner's guide*. The points listed below indicate approaches to each of the six learning objectives.

In this Learning unit, trainers should be able to:

-
- **emphasize** that malaria is a potentially fatal disease;
 - **help** trainees to memorize the common clinical signs and symptoms of malaria;
 - **explain** why 'semi-immune' individuals with circulating malaria parasites do not appear to be ill;
 - **explain** that malaria is caused by the presence of malaria parasites in a patient's red blood cells;
 - **explain** that some female *Anopheles* mosquitoes can transmit malaria from one person to another; and
 - **emphasize** that reliable diagnosis of malaria depends on identifying malaria parasites in a properly made, correctly stained blood film, which must be correctly examined under a microscope by a trained microscopist.
-

This unit will make a greater impression on learners if a senior person at the central level of the health services presents it and leads the discussion. The objectives of the national malaria control programme should be explained, emphasizing the importance of malaria microscopy for early diagnosis and treatment. Even a short participation in an open discussion will impress on participants the importance of the work they will do after training, especially as 'back home' is usually a remote, poorly served community.

However you organize this unit, you will provide some basic information on malaria and listen to participants' perceptions and experiences. Many will have seen cases of malaria and will make meaningful contributions to the discussion. You might be surprised by the extent of the group's collective knowledge of the disease, while being in a good position to correct common misunderstandings.

This unit can be described as providing information that is 'nice to know', as participants do not need to remember every detail. The *Learner's guide* contains a diagram of the complete life cycle of the malaria parasite, and you will present the cycle in the blood.

Points to highlight:

Falciparum malaria is a life-threatening disease and can evolve rapidly to severe illness and death if not recognized and treated with effective medicines. Highly sensitive diagnoses are therefore a core competence to be attained in this training course.

If 'malaria' is wrongly diagnosed in patients without the infection, they may be treated for malaria and not further investigated. They might therefore not be treated for an illness that is also serious.

This Learning unit does not follow the usual approach to competence-based learning; that is, participants do not have to demonstrate that they have reached a standard before moving to the next learning unit. The unit has been included so that learners become aware of the complete cycle of malaria parasites before beginning the portion of the course that involves them most. You need not expect participants to recall with great accuracy other aspects of the life cycle, unless such knowledge is part of their job description.

It is more important at this stage to impress on participants the extent of malaria as a disease and its global importance. The four areas to focus on are:

- the global distribution and global impact of malaria;
- the distribution and impact of malaria in your region;
- your country's malaria situation and control programme; and
- the actions being undertaken by your national malaria control programme.

For this purpose, some statements that describe the global impact of malaria from recent official reports and publications are listed below. You may have others that better reflect the situation in your region or country. Little of this information appears in the Learner's guide, because you should ensure that the information you provide is up to date. Your presentation can be a simple handout, indicating what you want participants to remember and what is just useful background information.

Background facts about malaria

- Worldwide, there are an estimated 247 000 000 (247 million) cases of malaria per year¹.
- Approximately 85% of all cases occur in Africa south of the Sahara.
- An estimated 881 000 deaths due to malaria occur per annum, of which 91% are in Africa, mostly among children under 5 years of age.
- One child dies from malaria disease every 30 seconds.
- *Plasmodium falciparum* is the most dangerous of the four human malaria parasite species.
- In financial terms, malaria is calculated to cost more than US\$ 12 billion (US\$ 12 000 000 000) per year, globally.
- Malaria is one reason why many communities continue to live in poverty.
- Malaria, ignorance and poverty can occur together; the presence of one often leads to the other.
- The number of malaria cases and their geographical distribution are not stable, because of:
 - increasing prevalence in some areas due to expanding drug resistance;
 - the widespread availability of fake and substandard medicines;
 - global warming and expansion of malaria into favourable areas at higher elevations;
 - expansion of malaria into areas of civil or military unrest;
 - population mobility of different kinds; and
 - deforestation and some development projects.

**Remind participants to read Learning unit 2
in preparation for the next session.**

¹ 2006 estimate. WHO. *World malaria report 2008*. Geneva, World Health Organization, 2008.

Notes

Learning unit 2

Cleaning and storing microscope slides

The learning objectives of this unit are simple and straightforward. They are listed in the *Learner's guide*. Your job is to teach participants to be competent in:

- **recognizing** the importance of following standard operating procedures in malaria microscopy;
- **selecting** from previously used slides those suitable for blood films, explaining what unsuitable ones can still be used for; and
- **demonstrating** the two ways of correctly washing, drying, wrapping and storing microscope slides for blood films.

The laboratory setting and basic rules

From now, most of the training activities will take place in the laboratory. This is the time to allocate bench space to each learner and to divide the class into small groups of four to five. Organizing the space so that participants face each other across the bench or table allows for small group activities.

This is probably the first time most participants have worked in a laboratory, and they may feel strange and out of place. Take this opportunity to inform them of the basic rules that must be observed in a laboratory, explaining that they are intended for the protection of themselves, other workers, patients and visitors. The rules are listed in the orange box at the beginning of Learning unit 2 of the *Learner's guide*.

Standard operating procedures

This is probably the best time to deal with the subject of standard operating procedures. Introduce the importance of correctly following the instructions, from cleaning slides to examining a stained blood film and making a diagnosis. Emphasize the importance of each procedure in subsequent learning units, depending on your country's national malaria control programme policies and practices.

Tell participants to remember:

Poorly cleaned slides lead to substandard blood films, which in turn leads to imprecise microscopy and a diagnosis that may put a patient at risk.

To avoid this, make sure that slides are well selected, clean, wrapped and stored.

Slides for malaria microscopy

A course of this kind requires a large number of slides. If this step is included as part of the training, most of the slides required will be cleaned, dried and wrapped at this time. It may be difficult to calculate the number of slides required; however, the exercises in the *Learner's guide* allow each group to take responsibility for having enough slides ready when they need them.

This is the first time that the groups start to take responsibility for their work. This should be emphasized, as well as the need for teamwork.

In the routine laboratory setting, slide cleaning is a tedious, time-consuming job, which is frequently given to junior personnel. While this may be acceptable within the system, the importance of properly cleaned slides is not always clearly explained, and the job is often done poorly. When slide cleaning is carried out as a group activity, learners recognize the importance of selecting and working with clean, undamaged, well wrapped, correctly stored slides and understand the reason for spending time doing it.

Provide a mixture of old, scratched, frosted and new slides and ask participants to discard those that are not suitable.

**Remind participants to read Learning unit 3
in preparation for the next session.**

Notes

Learning unit 3

Keeping accurate records

Once the objectives of the learning units have been attained, they become part of daily, weekly and monthly malaria microscopy procedures. The importance of good, clearly written, accurate records for each activity cannot be over-emphasized. You should decide how many sessions this training requires. Obtain samples of record forms currently in use in different programmes. You can also show poorly designed forms to participants and ask them to identify wrong, missing or unnecessary entries. Participants will use the forms currently in use and get as much practice as possible. The learning objectives for this unit make the participants competent to:

- **identify** the correct record form(s) and register(s) for storing patient information;
- **demonstrate** accuracy in recording patient information on the appropriate form;
- **select** the correct copy of each record form or completed summary for dispatch to the supervisor;
- **describe** examples of the consequences that can occur when patients' records get mixed up; and
- **explain** why a patient's details are confidential and must not be shared with unauthorized persons.

This part of the laboratory or field routine is sometimes treated casually, as it is often assumed that every laboratory worker is competent to complete any record form correctly. This is not the case, and participants must receive sufficient practice to enable them to perform competently when they return home. In many cases, when the format and content of record forms are changed, those responsible for completing them are given no training or information for filling in the new forms.

Each programme has its own record forms. For those that are linked to a computer-based data bank, participants will require additional training, although this is usually done at district or provincial level. The forms may be single (for malaria only) or associated with other disease control programmes. The forms may vary by programme but usually include:

- a daily register of the results and the total of the blood films examined;
- a weekly summary record of slide examinations;
- a monthly summary record of slide examinations;
- a quality assurance record of the slides submitted for cross-examination and the results and feedback of that cross-examination;
- a malaria survey or special cross-sectional survey record;
- a supplies requisition form; and
- quarterly, half-yearly and annual laboratory report forms.

In this activity, learners clarify and confirm their understanding of the column titles and other terminology in the forms. In many record forms, column titles are shortened or abbreviated due to shortage of space. This is also the time to ensure that participants are aware of the possible serious consequences to patient of mistakes made in documentation and recording.

**Remind participants to read Learning unit 4
in preparation for the next session.**

Notes

Learning unit 4

Preparing blood films

This unit has nine learning objectives for participants to achieve before moving to Learning unit 5. In your teaching, you should:

-
- **emphasize** and explain why human blood should always be treated as potentially contaminated with pathogens;
 - **describe** the importance of at least four diseases found in infected blood;
 - **demonstrate** the precautions necessary to avoid direct contact with potentially infected blood;
 - **demonstrate** the action to be taken urgently when blood is accidentally contaminated;
 - **show** and allow learners to handle and memorize the materials required for making thick and thin blood films;
 - **ensure** mastery of correctly making thick and thin blood films on the same slide, suitable for malaria microscopy;
 - **demonstrate** the correct ways of labelling blood films;
 - **demonstrate** how to separate thick and thin blood films of acceptable quality from unacceptable ones, giving reasons for their rejection; and
 - **help** participants to identify common faults in thick and thin blood films and their causes.
-

As in every learning unit, the importance of practice must be emphasized, on the basis of the principle ‘Do and understand’. Fieldwork and other practice sessions should reflect this principle in both content and time.

If you have not already done so, explain the importance to the daily routine and to reliability of following established standard operating procedures. This important stage in malaria microscopy must be followed strictly, step by step, in order to maintain the necessary standard.

Making blood films

The preparation of blood films is well covered in the sequence of descriptive diagrams in Learning unit 4 of the *Learner’s guide*. Facilitators should note that this is the recommended method but that other methods are sometimes used, especially when blood films are made at a patient’s bedside or where there is no flat, firm surface on which to work. While you may be skilled at making blood films in a particular way, please teach the method described here, as it is easier for trainees to learn and results in films of higher, more consistent quality.

The best approach is probably to divide the learners into groups of two or three to work together. Have them practise thin films first, making one per slide. When they have reached the required standard, allow them to make a thin and a thick film on the same slide.

Quite a lot of blood will be needed if the learners are to have sufficient practice. In the past it was usual for learners to take blood from one another, but the discomfort of repeated sampling often made them reluctant to continue. A better alternative is to use outdated blood from a blood bank or to acquire a small sample of uninfected blood, treated with an anticoagulant, from a hospital laboratory.

Each group of learners will also require a Pasteur pipette fitted with a 5-ml rubber teat. Once each learner has shown you 10 slides with satisfactory thin and thick films, he or she should be allowed to proceed to taking blood from another member of the group. Insist on conditions as similar as possible to those the learners will encounter in the field. All collection materials, including record forms, should be assembled before sampling begins; blood films should be correctly labelled, and relevant details should be entered on the record forms.

Make sure that trainees wear protective gloves at all times during this procedure. Latex gloves can be hot and uncomfortable in tropical climates and can be a problem when the only size available is the wrong size. Try to establish, well beforehand, the sizes of gloves required and make sure there are enough of each size available. Trainees often find wearing gloves for this exercise difficult and may take them off during a long slide-making session. Emphasize that gloves must be worn throughout the preparation.

Make sure that the gloves you order are not treated with talcum powder, as this will badly contaminate slides and blood films.

A learner can be judged to be competent when he or she has prepared three or four satisfactory slides, correctly labelled and accurately recorded.

**Remind participants to read Learning unit 5
in preparation for the next session.**

Notes

Learning unit 5

Staining blood films with Giemsa stain

The objectives of this Learning unit are straightforward. As most of the activities are of the 'how to' kind, if the instructions and procedure are strictly and correctly followed, the results will be good. The importance of high-quality Giemsa staining for malaria diagnosis cannot be overemphasized. Your principal tasks are to help participants reach a level at which they can:

- **demonstrate** correct operation of the analytical balance;*
- **make up** the buffered water used to dilute Giemsa stain;
- **demonstrate** correct use of the colour comparator or pH meter;*
- **make up** the 2% correcting fluids used to adjust the pH of buffered water;
- **explain** why pH 7.2 buffered water is best for good Giemsa staining;
- **demonstrate** two correct methods of fixing thin blood films;
- **explain** when the 'rapid' and 'slow' Giemsa staining methods are used for malaria microscopy;
- **demonstrate** mastery of the rapid and slow Giemsa staining methods;
- **describe** the correct ways of handling and storing Giemsa stain; and
- **demonstrate** correct drying and storing of stained slides.

*This objective applies only when this type of equipment is used.

Before trainees can stain blood films, they must first make up the buffered water needed to dilute the Giemsa stain. If the analytical balance you will use to weigh the buffer salts is different from that described in the *Learner's guide*, you should provide notes (handouts) on how the balance is to be used before teaching this unit. This is a standard operating procedure, and writing it can be time-consuming. It is necessary, however, in order to provide each learner with an identical set of instructions. Inexperienced listeners make a variety of mistakes when writing notes during a presentation; for greater accuracy, ask participants not to write notes or to keep them to a minimum.

If buffer tablets are used to adjust the pH of the water in your programme, there is no reason to change the system. Each participant must be made aware, however, that buffer tablets are quickly hydrated on exposure to high levels of humidity and cannot be used to adjust pH, as an unknown amount of salts will have leached from them. The quality of standard Giemsa staining relies on use of water that is buffered to pH 7.2. If the buffer tablets are stored in a dry place in tightly stoppered tubes, they will continue to be reliable.

In this training programme, Giemsa stain is recommended for staining thick and thin blood films for routine diagnosis of malaria. This stain is used in most national malaria control programmes, and the two methods have been well tested over the past 50 years. Giemsa belongs to a group called the Romanowsky stains. Although others in this group can be used to stain malaria parasites, none is as efficient and reliable as Giemsa for large-scale malaria diagnosis. In the national malaria control programme of India, for example,

a water-based Romanowsky stain called JSB (after the stain's creators, Jaswant, Singh and Battacharji, in 1944) has been used for more than 50 years. It is economical and reliable and results in stained blood films similar to those obtained with Giemsa when used correctly. It is slightly less stable than Giemsa because it is a water-based formula. Other stains are used elsewhere. Field stain, for example, a rapid, water-based Romanowsky stain, is widely used in parts of east and central Africa. Slides are stained singly, as the stain is intended only for thick films, but a 'reverse' staining method can be used for thin films. Plate 10a of the *Bench aids for the diagnosis of malaria infections* shows this method for thick and thin films.

If the steps are followed closely and the pH of the buffered water is strictly 7.2, the standard of staining will remain consistently high. Variations in staining should always be investigated. They are usually due to a problem with the stock stain, the pH of the water or the condition of the blood films. The microscopist should repeat each step to identify the problem. As such 'troubleshooting' is usually carried out by senior microscopists, it is not included in the *Learner's guide*. The course facilitators should, however, be able to solve such problems.

Stock solutions of Giemsa are available commercially or can be made up from the basic ingredients. In national programmes, the best-quality reagents are used to make up stocks of stain in bulk at regional laboratories, following a detailed standard operating procedure. After satisfactory quality control, the stain is distributed to laboratories in the region. Buffered water cannot usually be made up centrally, because of the problem of transporting large quantities of water. In some programmes, the salts are measured, packaged in airtight packets in suitable quantities and distributed to local laboratories.

Participants should be able to make three or four slides from their own blood (obtained by fingerprick) and to stain them correctly with the rapid and the slow methods. These slides should be stored in a safe place and used by the participants to examine thin and thick films of normal blood, as explained in Learning unit 7.

**Remind participants to read Learning unit 6
in preparation for the next session.**

Notes

Learning unit 6

The microscope

The learning objectives of this unit are clear. Each trainee must be able to use and care for the compound microscope correctly. This overall target is achieved by ensuring that each learner can:

- **demonstrate** the correct set-up and use of the binocular microscope with artificial light and with natural light;
- **demonstrate** correct use of the $\times 10$ paired oculars and the $\times 100$ oil immersion objective;*
- **operate** the mechanical stage correctly;
- **name** correctly 10 component parts of the microscope;
- **describe** the correct way to maintain the microscope in good working order;
- **describe** two ways of storing the microscope correctly; and
- **demonstrate** the correct way to pack the microscope for long-distance transport.

* Or $\times 7$ oculars if used in the programme

As a matter of principle, microscopists should not routinely use daylight as the light source for binocular malaria microscopy, and an electric-powered lamp should be used. When a binocular microscope fitted with paired oculars and an oil immersion objective is used, daylight provides an insufficiently lit microscopic field; the colours are subdued and faint, leading to errors in parasite recognition and species diagnosis. Nevertheless, many laboratory staff continue to rely on daylight as the light source.

A battery-powered LED lamp should be standard issue with microscopes in areas without electricity. The additional cost is modest and can be included in the basic equipment for microscopes, with the illuminator and replacement mirror.

Making microscopy enjoyable

To most experienced laboratory workers, microscopy is an enjoyable activity. To the inexperienced newcomer with a minimum of training in science, the microscope quickly takes him or her into a micro-world that is both new and fascinating. Establishing curiosity and interest in new participants is essential and is easily done by taking the time to prepare the session.

One week before Learning unit 6 is due to start, fill one or two small jars with pond water, and add 10–15 pieces of dried grass cut into 8-cm lengths to each jar. Place the jars in a corner, away from direct sunlight, until Learning unit 6 starts.

When you start the unit, as an introductory exercise, instruct each learner to transfer one or two drops of water from the jar onto a clean micro-slide with the Pasteur pipette. Cover the water with a clean coverslip, but reduce the pressure on the fluid by supporting the coverslip with one or two small pieces of a broken coverslip.

Participants should then examine the water through the $\times 10$ and then the $\times 40$ objective and draw what they see. This helps them to describe what they see down a microscope. Help the learners to relate the size of what they see in the microscopic field to the scale on a graticule eyepiece – if you have one – or to the Vernier scale. They should see a number of free-living protozoa, paramecia, rotifers, diatoms, algae and other minute life. Thus, while learning how to use the different objectives and the mechanical stage, the learner will discover the various kinds of organisms that are found in water that appears to be clean to the naked eye.

Discuss this exercise in the group, pointing out that some of these bodies may confound a malaria diagnosis if they contaminate blood films during staining, especially if heavily contaminated water is used to make up buffer. Important lessons can be introduced here, apart from using clean buffered water in staining.

When you and your facilitators consider that the learners are sufficiently competent in using the microscope, ask them to examine ordinary blood films with the $\times 100$ oil-immersion objective. If they can examine their own blood in both fresh wet films and films that are fixed and stained, they will understand what they are examining more clearly, while continuing to enjoy examining slides.

**Remind participants to read Learning unit 7
in preparation for the next session.**

Notes

Learning unit 7

Examining blood films

This unit introduces learners to the basic macroscopic and microscopic constituents and features of blood. It leads up to Learning unit 8 and emphasizes the importance of correctly examining stained blood films in a standard way. Achieving the unit's learning objectives will mean meeting standards of mastery to ensure sustained efficiency. You will set the level of competence to be attained in this session of the training course, but a minimum 80% is achievable and recommended. This unit helps ensure a clear understanding of the need to meet increasingly exacting standards in the subsequent learning units. At the end of the unit, the learner will be able to:

-
- **list** the four major components of normal blood;
 - **demonstrate** each method used for examining a thick blood film and a thin blood film for malaria parasites;
 - **recognize** and classify the normal components of blood;
 - **name** correctly the main parts of a white blood cell; and
 - **recognize** common contaminants in blood films.
-

By this stage of the training programme, learners have become more independent and can work on their own. Most will need to question their facilitator only to clarify a point or resolve a problem. Even with such progress, facilitators must continue to be alert to the needs of individuals within the group. They must make sure that participants follow the recommended method and do not try to take 'short cuts'. Monitoring must be discreet, so that the participants are not pressured or stressed. The facilitator must be satisfied that the participants are keeping to the designated routine even when apparently unsupervised. This approach should continue throughout the remaining learning units, to the end of training, in preparation for their return home, when they will have to work efficiently without supervision.

Anticoagulants are used regularly in some programmes. If this is true in your programme, you should explain the routine in detail. You should inform the participants that some anticoagulants alter pH, with an adverse effect on staining, that cell morphology can change if a sample is left standing and that poorly dried thick films can easily float off a slide during staining.

After a description and discussion of the subject of examining blood films, participants should start by examining films of normal blood. Familiarity with the components of normal blood is a cornerstone of malaria microscopy. Every effort must be made to allow learners to become familiar with both normal and abnormal blood components. From the beginning, they should be encouraged to report anything unusual found in a routine examination to a supervisor. Lives are often saved in this way.

Participants should learn to recognize as many white cell types as possible, and facilitators must make sure (through inter-group collaboration) that everyone has a chance to see less common types when they are found during these exercises. With increasing practical experience, trainees will become more competent at differentiating between normal and abnormal blood components and foreign bodies that contaminate some blood films.

Take time to discuss the colour plate of artefacts shown at the end of this unit in the Learner's guide. Try to put together a slide collection of both common and less usual artefacts for learners to see and discuss. The facilitator should know the origin of the contaminants, how they reached the blood films and what must be done to prevent this.

A large number of contaminants in a blood film indicates poor technique. An effort must be made to trace the cause and to eliminate the problem. Retraining of some staff may be indicated after a full inspection of the laboratory and its activities.

The natural starting point for this practical work is examination of thin films. Participants must be made aware, however, that the final objective of the training is to attain competence in diagnosing malaria by routine examination of thick blood films. You should stress that the thin film is kept only for use when stage or species identification is difficult. This is a good time to explain that the appearance of blood components differs in thin and thick blood films and also that routine examination of a thick film is more efficient, as a larger quantity of blood can be examined in a shorter time. To illustrate this, ask the participants to count the number of white blood cells in five microscopic fields of the thick film and in five microscopic fields of the thin film, using the oil immersion objective. Ask them to calculate the ratio of the two and to explain the figure.

Once learners can recognize the blood components found in thin films, it is time to move to the examination of thick blood films. Not all learners will reach this stage at the same time, but this is not important. As a participant finishes working with thin films, she or he can be briefed by a facilitator about examining thick films. By the time the whole class is ready to discuss the appearance of thick film components, several participants will be able to describe the differences they have observed. Similar discussions within groups can be continued in learning units 8 and 9.

Remind participants to read Learning unit 8 in preparation for the next session.

Notes

Learning unit 8

Examining blood films for malaria parasites

You have guided the trainees through each stage and step of microscopy and have arrived at this most important point in the training. The principal objective will be to find and confirm the presence of malaria parasites and the stages and species in thin and thick blood films.

In each of the previous learning units, you have made sure that each participant reached the required level of competence or accuracy before allowing her or him to move on to the next unit. Ensuring that designated standards continue to be met is critical to this training programme.

This is a difficult unit and requires time, patience and sustained effort on the part of both the learner and the facilitator. The trainer's skills, knowledge and communication ability will sometimes be stretched to the limit as participants progress through the unit, with pressure to achieve consistent levels of skill and accuracy. The areas in which consistent accuracy is necessary are identified in the unit's learning objectives. By the end of this session, the learners will be able to:

-
- name the parts of a malaria parasite correctly;
 - distinguish malaria parasites in thin and thick films, identifying trophozoite, schizont and gametocyte stages;
 - identify two species that cause human malaria, *P. falciparum* and *P. vivax*, in thin and thick films;
 - describe and demonstrate the main morphological differences between the four species of human malaria parasite in thick and thin blood films;
 - demonstrate common contaminants seen in blood films that are often mistaken for blood components or malaria parasites;
 - recognize and name other blood parasites common to humans in their area; and
 - describe ways of preventing some artefacts from contaminating blood films.
-

If the training is designed in the right way, such as with quizzes and competitions between small groups, the pressure on the participants will remain low even as they gain experience and confidence in their diagnostic ability.

You will choose what you consider to be the most appropriate form of introduction to this unit. There is a lot to explain and many ways to do it. There should, by now, be an atmosphere of confidence among the individuals in the class and a friendly relationship between the teachers and learners. You have a wide range of resources to use for this introduction, both in the accompanying CD-ROM and in your slide-bank materials.

Following the method successfully used in the previous unit, and after your introduction, you will start learners on examination of thin films. Allow them to examine 'known' films without time constraints and without pressure to spot a parasite and identify its stage. They will achieve a great deal alone, using the *Learner's guide*, the *Bench aids* and similar materials.

Once learners have demonstrated their ability to recognize parasites and to identify the different stages and species, they can move on to examination of thick films. Remember to stress that examination of thick films for malaria parasites is the routine and that experienced microscopists refer to thin films only for occasional, more difficult diagnoses.

Whatever strategy you choose to complete the unit, you will need a large number of blood films for which the result is 'known'. These slides must have been examined previously and the results recorded in a register, with information on:

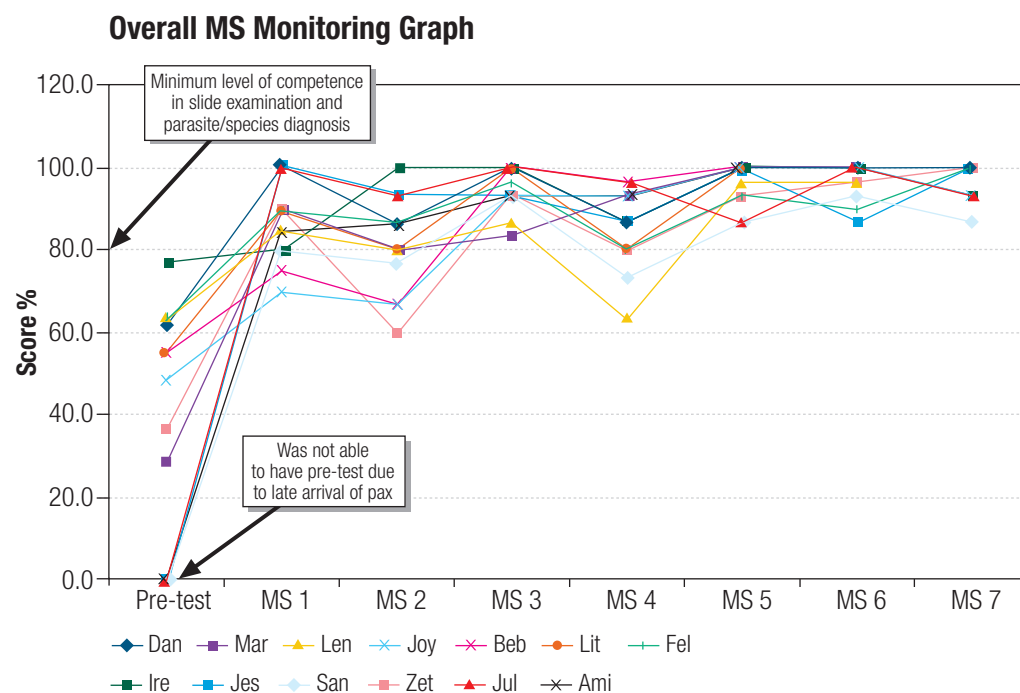
- whether the film is thin or thick;
- whether the quality of the film is good, fair or poor;
- whether the staining quality is good, fair or poor;
- whether the examination result is positive or negative for a malaria parasite (Your programme will have its own way of recording this.);
- on slides that are positive for a malaria parasite, the species (and perhaps the stages) identified;
- on slides for which the species is identified, the parasite density (see Learning unit 9); and
- other observations, including any obvious abnormalities that should be reported.

This approach carries over into Learning unit 9, and some tutors may combine units 8 and 9, especially in shorter refresher training courses. Some participants will show greater competence and move quickly to unit 9. Do not, however, lose sight of the objective, which is for each microscopist to reach the indicated level of competence before moving on to unit 9.

Participants learn more quickly and stay more interested and less pressured when they can plot their own progress in reaching the set standard. The ways in which this can be done were discussed earlier. One effective system is to give each participant 15–25 'known' slides and ask her or him to examine the films within a set time, say one slide per 10 min. The result for each slide is recorded on the appropriate form, in the established way, and the results are checked against the correct result by the learner, who plots them on a simple graph (see below). With this method, mistakes can easily be corrected by further examination of the slide. Participants can judge their own progress and decide whether they need more practice to achieve the standards. This method of training gives everyone a sense of determination and of increasing competence. The results of such self-monitoring are shown in the following graphs.

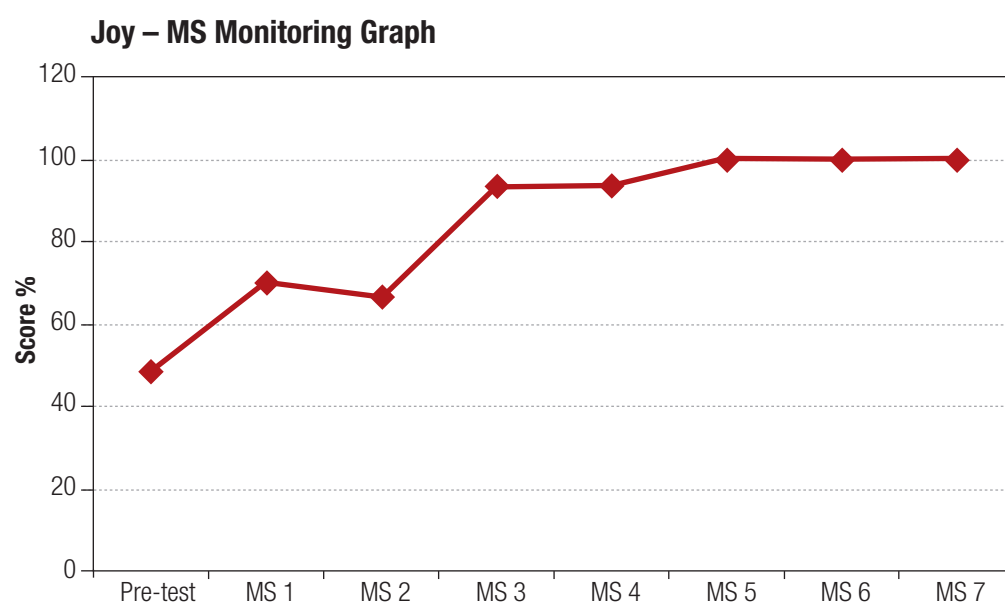
**Remind participants to read Learning unit 9
in preparation for the next session.**

Two-week refresher training course in medical techniques: plot of diagnostic accuracy



Individual progress plotted over eight test periods

Not all new learners show this smooth upward trend



Information and data kindly provided by the Philippines National Malaria Control Programme

Notes

Learning unit 9

Routine examination of blood films for malaria parasites

In the Learner's guide, this unit contains instructions for routine examination of blood films for diagnosing malaria. In this unit, the facilitators must make sure that the participants correctly follow the routine, with no deviation. By the end of the session, the learners will be able to:

-
- demonstrate consistency in Giemsa malaria microscopy;
 - demonstrate competence and consistent accuracy in identifying malaria parasites;
 - demonstrate competence and consistent accuracy in differentiating between *P. falciparum* and *P. vivax* infections;
 - explain why thick films are used routinely for malaria diagnosis and any exceptions to this rule;
 - explain why parasite counts are made and their use; and
 - demonstrate consistency in counting malaria parasites in thick blood films and expressing them as parasites per microlitre of blood.
-

Make sure that the learners clearly understand the following:

1. Routine examination is always of a thick blood film.
2. For consistency among microscopists, laboratories and national programmes, thick blood films must be examined in the standard manner.
3. For the same reason, parasite densities must be counted carefully and systematically, whether to determine a patient's response to treatment or to determine a collective response in a particular study.

Each learner's progress must be carefully monitored. Facilitators will now have a good idea of each participant's abilities in routine work and in following the recommended methods, even when they are not directly supervised.

As this unit covers the routine followed in any laboratory situation, you and the facilitators should continue to ensure the following:

1. Daily, weekly and (where appropriate) monthly records are up-to-date, correctly completed and properly stored.
2. Provide the necessary assistance to participants who will be making stores and requests for other supplies in preparation for their return home.
3. Discuss problems of laboratory management with those going to remote, isolated communities.
4. Discuss those aspects of supervision that each microscopist will follow (see Learning unit 10).

**Remind participants to read Learning unit 10
in preparation for the next session.**

Notes

Learning unit 10

Supervision in malaria microscopy

This subject is well covered in the Learner's guide. It is in fact a confirmation of what has happened since the first day of the course. Supervisory activities are critical to the smooth functioning of any malaria microscopy system and must be included in all programme planning, budgeting and implementation.

By the end of the unit, participants will be capable of:

-
- **explaining** the importance of supervision to their work;
 - **explaining** ways in which they can expect their work to be supervised;
and
 - **describing** what must be provided for supervisors to allow them to supervise their work effectively.
-

It need hardly be stressed that a good supervisor is supportive of the colleagues who are being supervised and helps them solve any problems. Supervision is not policing, and poor supervision only creates further problems that negatively affect the individual and the laboratory.

Regular supervision can be conducted in various ways in different programmes. Whatever the method, it should contain an element of follow-up, whereby newly graduated microscopists are monitored as closely as possible to ensure that they and their patients have benefited from this training. One such method is described in the Learner's guide, but you may want to describe further how your programme will continue to monitor and support the participants, as part of the overall programme for quality assurance in malaria microscopy.

Note to the tutor:

After the final assessment of the course by the participants and before your facilitators disperse, discuss the training and see where improvements are needed before the next course. Model questionnaires for this purpose are provided in Annex 2.

Notes

Annex 1

Equipment and reagents required for the training course

It is difficult to predict exactly what equipment and supplies you will need for the training course, and financial constraints may limit what you can buy. Considerable savings are possible if some items can be made from locally available materials.

In addition to the equipment mentioned in Learning unit 6 of the Learner's guide, you will need:

■ blue (opaque) filters for the substage microscope	1 per learner lamp
■ objective markers (diamond-pointed) for 'ringing' interesting parasites and specimens	1 per group of 4–5 learners

General equipment

■ balance for weighing chemicals (capacity 200 g, readable to 0.01 g)	1 for the laboratory
■ deionizer to produce water for mixing with stain (a still, operated by gas, kerosene or electricity, may also be used but is less economical)	1 for the laboratory
■ resin charges for the deionizer, as recommended by the manufacturer	
■ electric hair-driers for drying slides	2 for the laboratory
■ 4-digit tally counters, hand-operated	2 for each learner
■ timing clocks, timing from 1 min to 1 h, fitted with alarm bells	1 per group of 4–5 learners
■ Lovibond Comparators, with discs for pH 6.0–7.6 and bromothymol blue as indicator	1 for the laboratory
■ plastic basins for washing slides and glassware, about 40 cm diameter, 15 cm deep	6 for the laboratory
■ wooden slide-drying racks, grooved, each to hold about 40 slides	1 per group of 4–5 learners
■ boxes of paper tissues	1 per group of 4–5 learners
■ wooden boxes for microscope slides, with hinged lids, for 100 slides stored vertically	1 per learner, plus about 6 spares
■ wooden boxes for microscope slides, with hinged lids and carrying handles, for 50 slides each side stored horizontally (sometimes called 'field collection boxes' or 'WHO slide boxes')	1 per group of 4–5 learners
■ lint-free cotton cloths for drying slides	2 per group of 4–5 learners
■ white, non-sterile, absorbent cotton wool in 500-g packages	1–2 per group of 4–5 learners
■ clipboards, 15 cm × 23 cm	1 per group of 4–5 learners
■ record forms	stocks as appropriate

Plastic and glassware

■ dropping bottles (glass or polyethylene), capacity 60 ml, with pipettes and rubber teats	20
■ narrow-necked, hard, white glass bottles with ground-glass stoppers, capacity 250 ml	20
■ as above, capacity 500 ml	20
■ glass or polyethylene measuring cylinders, with spout, capacity 10 ml, 0.5-ml divisions	10
■ as above, capacity 100 ml, 5-ml divisions	10
■ as above, capacity 250 ml, 10-ml divisions	10
■ as above, capacity 500 ml, 20-ml divisions	10
■ 'half white' microscope slides, 7.6 x 2.5 cm, thickness 1.0–1.2 mm, smooth-ground edges, packets of 72	as required
■ glass conical flasks, capacity 250 ml	10
■ as above, capacity 500 ml	6
■ as above, capacity 1000 ml	6
■ glass or polyethylene staining troughs, with ribbed interior for 20 double-thickness slides, with lids	20
■ glass or polyethylene funnels, diameter 15 cm	6
■ rimless glass test-tubes, 1.9 x 15 cm	100
■ glass pipettes with rubber teats	100
■ glass beakers with spouts, capacity 100 ml	20
■ as above, capacity 250 ml	10
■ as above, capacity 500 ml	10
■ glass or polyethylene bottles for distilled water, capacity 4.5 l, with stoppers and taps	4
■ graduated pipettes, 10 ml capacity, 0.5-ml divisions	20
■ curved white staining plates, porcelain or plastic, 4–6 mm depression	10

Reagents and stains

■ Giemsa stain powder	30 g
■ Giemsa stain solution (best quality), in bottles of 250 ml	40 bottles
■ immersion oil (tropical quality), in bottles of 25 ml	10 bottles
■ xylene (pure, sulphur-free quality as for histology)	10 l
■ methyl alcohol (anhydrous, acetone-free), in bottles of 250 ml	5 l
■ glycerol (neutral, anhydrous), in bottles of 250 ml	5 l
■ methylated spirit	5 l
■ potassium dihydrogen phosphate and disodium hydrogen phosphate in sufficient quantities to prepare 100 l of buffered water, pH 7.2	
■ detergent (locally obtained): 5 family-size packets of powder detergent or 5 l of liquid detergent	

Annex 2

Questionnaire for evaluating training

Instructions for completing the questionnaire

Use the following code to indicate the extent to which you agree or disagree with each of the statements made in the questionnaire:

- 1 Disagree strongly
- 2 Disagree
- 4 Agree
- 5 Agree strongly.

These numbers are printed beside each question. You should circle the number that corresponds most closely to your opinion.

The difference between options 1 and 2 and between options 4 and 5 is one of degree only. To oblige you to express a definite opinion, no code 3 has been included (except for question 12); this will allow calculation of a 'satisfaction index' for each question.

Take your time to complete the questionnaire. You do not have to put your name on it if you prefer not to, but please answer the questions as frankly as possible.

Section I. Overall assessment of the training

- 1. Overall, the organization of the training programme was satisfactory. 1 2 4 5
- 2. The training programme covered all the subject matter in adequate detail.
(If you disagree with this, state which subjects should have been given greater coverage.) 1 2 4 5

Comments:

- 3. The tutors and facilitators for this training course had sufficient knowledge and teaching ability to give you the necessary skills and competence. 1 2 4 5

Comments:

4. The time allocated to each part of the training was adequate relative to the total time available. (If you disagree with this, state which topic should have been allotted more or less time.)

1 2 4 5

Comments:

Section II. Relevance and usefulness of the teaching methods

5. Overall, the teaching methods used in this training course were effective.

1 2 4 5

6. The use of the various teaching methods listed below was quite appropriate.

Large group presentations

1 2 4 5

Comments:

Practical demonstrations (laboratory)

1 2 4 5

Comments:

Field work

1 2 4 5

Comments:

Small group discussions

1 2 4 5

Comments:

Self-study

1 2 4 5

Comments:

Quizzes, tests and other evaluation exercises

1 2 4 5

Comments:

Section III. Assessment of teaching materials

7. The audiovisual materials (slides, overhead projection, transparencies) used in the training were very helpful.

1 2 4 5

Suggestions for improvement:

8. The teaching materials provided were satisfactory in all respects.

1 2 4 5

Suggestions for improvement:

Section IV. Attitudes of tutor and facilitators

9. The general atmosphere of the training course made this a good learning experience. 1 2 4 5

Comments:

10. Every effort was made to help me achieve the learning objectives. 1 2 4 5

Comments:

11. I was able to achieve all the learning objectives of the training programme. 1 2 4 5

Comments:

Section V. Overall evaluation of the training

12. What overall rating would you give to this training programme?
(Circle your response.)

1 2 3 4 5
Lowest Highest

13. With regard to this training experience, state the following (giving actual examples):

(a) the three aspects that impressed you most favourably:

(b) the three aspects that impressed you least favourably:

14. If you have any additional comments regarding any aspect of the training programme, please make them below.

Analysing the responses to the questionnaire

The following method will allow you to analyse the responses to the questionnaire quite simply and quickly. Take a fresh (uncompleted) copy of the questionnaire; against each question, mark the learners' responses. For example:

5. Overall, the teaching methods used in this training course were effective.

1	2	4	5

This shows that two learners considered that the teaching methods were not effective, while 28 found that they were effective.

Now, multiply the number of answers by the corresponding coefficient:

$$(2 \times 2) + (10 \times 4) + (18 \times 5) = 4 + 40 + 90 = 134$$

The 'satisfaction index' is calculated as a percentage. For the above example, the number 134 is multiplied by 20 (i.e. 100 divided by the maximum coefficient, 5) and divided by 30 (the number of learners):

$$\frac{134 \times 20}{30} = 89.3\%$$

As the satisfaction index is calculated in such a way that 60% represents 'average' satisfaction, you should make a note of any questions for which the index is below 60%. (If there is none, identify the five questions for which the index is lowest and the five for which it is highest.) Let the learners know the results of this analysis of the responses to the questionnaire at the final evaluation session on the last day of the training programme.

Notes

Microscopists are vital to malaria programmes, and their diagnostic and technical skills are relied on in both curative services and disease surveillance. Thus, training in malaria microscopy must be sound and must reach today's high standards. This training package has been adjusted to meet the changes in the way malaria is diagnosed and treated. The training manual is divided in two parts: a learner's guide (Part I) and a tutor's guide (Part II). The package includes a CD-ROM, prepared by the United States Centers for Disease Control and Prevention, which contains microphotographs of the different malaria parasite species and technical information in PowerPoint format, which can be shown during training sessions and referred to by the participants. Emphasis is placed on teaching and learning, including monitoring and evaluating individuals and the group during training

The Tutor's guide (*Basic Malaria Microscopy*, Part II) is designed to assist trainers instructing health workers in basic malaria microscopy. The participants should ideally also be given a copy each of the WHO *Bench aids for malaria microscopy*. If not, several copies should be made available as reference material, for use by the trainees.

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