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THE TRAINING OF HEALTH LABORATORY PERSONNEL (TECHNICAL STAFF)

Fourth Report of the WHO Expert Committee on Health Laboratory Services

WORLD HEALTH ORGANIZATION

GENEVA

1966

WHO EXPERT COMMITTEE ON HEALTH LABORATORY SERVICES

Geneva, 7-13 December 1965

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THE TRAINING OF HEALTH LABORATORY PERSONNEL (TECHNICAL STAFF)

Fourth Report of the WHO Expert Committee on Health Laboratory Services

1. INTRODUCTION

The WHO Expert Committee on Health Laboratory Services met in Geneva from 7 to 13 December 1965.

The meeting was opened by Dr P. Dorolle, Deputy Director-General. After explaining briefly the status and functions of expert committees, he gave a short review of the various aspects of the training of technical laboratory personnel,[1] who constitute the backbone of every clinical and public health laboratory service. He stressed the importance of clear definitions of the various categories of technical personnel, the designations of which vary considerably from one country to another. Dr Dorolle mentioned the necessity for training programmes to be adapted to the needs and potentialities of countries at various stages of development.

It was also necessary to bear in mind that well-organized training systems for technical laboratory personnel will facilitate the establishment of a professional status and satisfactory conditions of work comparable to those of civil servants and other comparable health workers, and so make it possible to obtain better personnel.

Dr G. Z. Williams was elected Chairman, Dr O. Adeniyi-Jones Vice-Chairman, and Dr R. E. Nassif Rapporteur.

2. GENERAL CONSIDERATIONS

While health laboratory services are playing an increasingly important role in the various health fields, there is a conspicuous shortage, even absence, of health laboratory personnel in many parts of the world. This shortage has forced many authorities to employ insufficiently qualified personnel in responsible positions. Such a practice is dangerous and urgent consideration should be given to corrective measures that can be speedily applied.

[1] Throughout this report, the term "technical (laboratory) personnel" is used to describe health laboratory technologists, technicians and laboratory assistants; it does not include the more highly skilled medical and scientifically qualified staff.

Although in some countries health laboratory technology has made great progress and technicians have achieved significant status, in many others there is no governing legislation or professional society, and the profession of laboratory technician has little or no status. There is great confusion in titles, responsibilities, and qualifications, and a marked feeling among technicians that they are neglected and their efforts are unrecognized. As a result, the profession is unattractive and recruitment is lagging far behind the needs.

Health authorities must recognize these essential needs and must appreciate the fact that lack of adequate laboratory services has serious repercussions on the health of the entire nation and hence on the total economy. The present age is witnessing a rapid crumbling of time and space barriers producing much faster spread of disease, with the result that the health—or ill health—of one country is no longer the concern of that country alone, but concerns all other countries no matter how far away they may be. The health laboratory is essential to the global fight against disease, which in turn demands reliable and comparable laboratory results. Such results cannot be obtained if the staff are not qualified and placed in positions suitable to maintain their standard.

The Committee considered the criteria for adequate technical performance and the related definitions, classification, basic educational requirements, technical training and career development for technicians. Whereas previous WHO Expert Committees [1] have drawn attention to the problems of selection and training of auxiliary personnel, this report is particularly concerned with the training principles and programmes for health laboratory technicians.

3. DEFINITION, FUNCTIONS AND RESPONSIBILITIES OF VARIOUS CATEGORIES OF TECHNICAL LABORATORY PERSONNEL

> " It is the human element in the service that is the determining factor for the quality of the work. Mere physical facilities cannot replace a good laboratory staff: it cannot be overemphasized that the worth of the service depends primarily on staff quality." [2]

3.1 Definition of technical laboratory personnel

The technical laboratory personnel are all those individuals who work in one or another area of a health laboratory and whose primary functions

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[1] *Wld Hlth Org. techn. Rep. Ser.*, 1956, **109**; 1957, **128**; 1959, **161**; 1961, **212**; 1962, **236**.

[2] *Wld Hlth Org. techn. Rep. Ser.*, 1962, **236**, 24.

and responsibilities are the accurate and reliable performance of the various laboratory procedures assigned to them and the reporting through appropriate channels of the results they obtain ; they may or may not be university graduates, and may or may not be certified (see page 17).

3.2 Categories of technical laboratory personnel

Various categories of technical personnel are recognized—and needed—depending upon their educational qualifications, experience and assigned duties and responsibilities. The categories and titles listed on the left-hand side of the table below are recognized and recommended. The table also indicates the equivalent title used by two other WHO Expert Committees.

Titles recommended by present Committee	Titles used by earlier Committees	
Level A – Graduate Technician	Professional [1]	Medical Technologist [2]
Level B – Non-Graduate Certified Technician		Laboratory Technician [2]
Level C – Certified Assistant Technician	Auxiliary [1]	Laboratory Assistant — Multiple-skill [2]
Level D – Non-Certified Assistant Technician		Laboratory Assistant — Single-skill [2]
Level E – Laboratory Aide [3]	Ancillary [1]	Laboratory Attendant [2]

The more commonly used titles for level B technicians in various countries are listed in Annex 1.

The multiple functions of a health laboratory were previously defined in the third report of the WHO Expert Committee on Health Laboratory Services.[2] Even with the best training possible it is difficult to produce fully competent polyvalent technical personnel. Every effort must be made to have technicians who, upon completion of training, can be assigned to any of the usual disciplines (chemistry, bacteriology, etc.) of the health laboratory, whether it is concerned with human medicine, veterinary medicine, environmental hygiene, or other aspects of public health. Specialization may become necessary later, eventually requiring special courses.

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[1] *Wld Hlth Org. techn. Rep. Ser.*, 1961, **212**.

[2] *Wld Hlth Org. techn. Rep. Ser.*, 1962, **236**.

[3] Although the laboratory aides are not technical personnel and should not be so considered, they are included here because they are employed in relatively large numbers to assist the technical staff by performing unskilled procedures, washing and sterilizing glassware and other laboratory equipment, taking care of laboratory animals, and carrying out other forms of manual labour. They work under the constant supervision of technicians and scientific staff.

Detailed descriptions of the functions and responsibilities of each category are given below (section 3.3). Training is discussed in section 4 (page 9) and promotion possibilities in section 5 (page 16).

The criteria used for classification are :

(*a*) the level of general education ;

(*b*) the length of the training period ;

(*c*) the level of special subjects of study ;

(*d*) the function the individual will be called upon to perform.

In all instances, personal integrity, tidiness, diligence, initiative and assurance of performance are essential. Errors may cause damage or loss of equipment, time and supplies with consequent loss of money and delay in work. More important, errors may cause injury to patients and even loss of life.

3.3 General duties

3.3.1 *Graduate technician* (level A)

Basic functions :

(*a*) Supervision of other technical personnel (levels B, C and D) and laboratory aides.

(*b*) Administrative duties assigned by the director of the laboratory.

Scope :

This job is concerned with technical teaching and administrative responsibilities. The incumbent is required to ensure that all procedures and regulations established by the director are followed by all staff supervised.

The incumbent should be able to recognize and correct errors and defects that may occur in routine work under his supervision.

Detailed functions :

(*a*) Immediate supervision of subordinate staff.

(*b*) Participation in the setting up of new or approved procedures with the approval of the director.

(*c*) Performance of standard or special tests.

(*d*) Preparation of special standards and reagents and control of those prepared by subordinates.

(*e*) Training of subordinates and students.

(*f*) Assisting medical and scientific staff in laboratory teaching.

(*g*) Preparation of periodic reports of activity and maintenance of inventory of stocks.

(*h*) Performance of other technical work or related duties as assigned.

(*i*) Participation in research work as assigned.

Supervision received: From medical and scientific staff.

Supervisory responsibilities: Administrative and technical supervision of subordinate personnel; exercises considerable initiative and judgement in supervising his area and in establishing new procedures.

3.3.2 *Non-graduate certified technician* (level B)

Basic functions:

(*a*) Performance of all routine and some special laboratory procedures.

(*b*) Assisting in the training and supervision of subordinate technical personnel.

(*c*) Assisting in teaching.

Scope: This job is primarily concerned with either

(*a*) the performance of routine laboratory work, the exact nature of which is determined by the laboratory discipline in which the incumbent is employed and by the type of work in progress,

or

(*b*) the preparation of specimens and reagents needed by laboratory course work, the maintenance of equipment and stocks used, and the setting-up of the necessary apparatus.

Detailed functions:

(*a*) Collection of such specimens as he is trained to collect and as local traditions and regulations permit.

(*b*) Performance of standard laboratory procedures as assigned.

(If the incumbent is assigned to a teaching laboratory he has to have this ready for course work (lectures and laboratories) and to provide the faculty and students

with the supplies and materials they need for their work.)

(*c*) Preparation and testing of reagents and media.

(*d*) Preparation of simple standards, solutions, suspensions, etc.

(*e*) Operation, cleansing and maintenance of equipment.

(*f*) Performance of any other technical work assigned.

(*g*) Submission of reports of all results and keeping of records of all procedures performed and results obtained.

(*h*) Requisition of supplies and maintenance of inventory of same, where required. Maintenance of stock inventory.

Supervision received : From medical and scientific staff and graduate technician.

Supervisory responsibilities : Supervision of assistant technicians (levels Cand D) and laboratory aides.

3.3.3 *Certified assistant technician* (level C)

Basic functions :

(*a*) Accurate repetition of well established laboratory procedures.

(*b*) Carrying out of detailed written instructions.

(*c*) Operation and reading of recording instruments, accurate calculation of results, reporting of data.

(*d*) Performance of the necessary clerical work.

Scope : This job is concerned with the performance of well defined standard routine tests as well as helping in preparing teaching material where a teaching programme exists.

Detailed functions :

(*a*) Carrying out of standard procedures (chemical, biological, etc.) as assigned.

(*b*) Operation of equipment and instruments needed for the job.

(*c*) Recording and reporting of results.

Supervision received : From technicians at levels A and B.

Supervisory responsibilities : When required by special circumstances responsibility for supervision of technicians at level D and laboratory aides may be assigned.

3.3.4 *Non-certified assistant technician* (level D)

Basic function : Assisting in the performance of technical duties.

Scope : Performance of the simpler routine laboratory procedures.

Detailed functions :

(*a*) Performance of simple laboratory analyses and procedures such as routine urinalysis, preparation of smears, simple staining techniques, etc., and assistance in the preparation of simple reagents and media.

(*b*) Operation of instruments and apparatus and accurate recording of results.

(*c*) Care of equipment used.

Supervision received : From technicians at levels A, B and possibly C.

Supervisory responsibilities : None (except supervision of laboratory aides).

Note : Workers who have been trained to perform a single-skill technique and who are employed in field work, such as blood-smear examination in malaria eradication campaigns, are classified in this group.

4. TRAINING PROGRAMME

4.1 Basic training

The Committee firmly believes that the training of each group should be carefully planned and supervised to ensure that all students receive adequate theoretical and practical training which will enable them to know not only the " how " but also the " why " of the techniques which they learn. It is essential that students be given basic training in all aspects of health laboratory work to enable them to work in any discipline of the laboratory they may be assigned to as well as providing them with the necessary foundation upon which any " superstructure " of specialization could be built, should development and conditions in their country demand such specialization. However, such polyvalent basic training should

be limited to laboratory disciplines and must not include such subjects as the operation of X-ray machines, electrocardiographs, electroencephalographs, etc. Instruction in the use of these machines should be given to a separate group of individuals in a different programme of instruction.

4.1.1 *Methods of training*

The methods of training in current use vary from pure apprenticeship with little, if any, theoretical teaching, to intensive formal didactic teaching with little practical work; training of the latter type is usually given in a classroom instead of " at the bench " of a health laboratory. Each system has advantages and disadvantages. A combination of the two systems should be used. An adequate ratio of theoretical to practical training suitable for all countries and for all the categories of technical staff under consideration would be 1 : 2 (one-third theoretical). The proportion of time devoted to theoretical training may have to be increased in countries where the level of general education is too low to enable students to understand the theory necessary for intelligent laboratory work. In such cases, the additional time would be devoted to filling the gaps in general education.

The Committee recognizes that *temporary* compromises may be necessary in countries where no facilities exist, in order to enable such countries to start programmes of their own. It also recognizes that no single programme is suitable for all countries, but that countries have to adapt programmes to meet their regional, national or local conditions.

Countries having absolutely no provision for any type of training should obtain assistance from qualified foreign personnel to help them start their national service. In addition, they should send a suitable number of candidates for training in other countries, preferably those where health conditions and standards are similar to their own, until facilities for local training are available. All basic training should be provided locally. Thus, the methods of training or teaching will necessarily depend on two important factors:

(*a*) availability of facilities;

(*b*) level of basic general education of candidates.

4.1.2 *Organization of training*

Two major types of training are recognized:

(*a*) *Full-time courses.* In this form of training students have no responsibility other than to attend the laboratory course as learners of practical methods and their theoretical background. At no time during the course are they considered as technicians or used as such. This type of programme seems to be best suited for candidates who are newcomers to laboratory work.

It is emphasized that the student must be exposed to all the disciplines of the health laboratory, in order to receive polyvalent experience.

(*b*) *Part-time courses.* This type of training has to be given to laboratory workers who may lack formal training and who are desirous of self-improvement, or to those who are being trained under an apprenticeship system in which they do not receive adequate theoretical and sufficiently diversified instruction.

It is the opinion of the Committee that in-service, or apprenticeship, training without a programmed course of theoretical and practical instruction should be completely replaced by formal school training on a full-time basis. If, for various local considerations, apprenticeship training is to be temporarily retained, every effort should be made to ensure that adequate theoretical knowledge is provided.

Countries where no facilities for laboratory instruction exist should at the outset develop a system of full-time instruction. Outside assistance may be required until local talent and facilities become available. It is better to make certain from the start that the training scheme is a good one than to find out, after time and money have been lost, that the system used is unsatisfactory and has to be changed. Furthermore, it cannot be sufficiently stressed that the best available instructors must be employed, because on them depends the success of the investment that countries make in their future technicians.

It is essential that the authorities appreciate that the quality of the work of the trained technician is more important than its quantity or variety, and that what really matters is the accurate and reliable performance of the procedures taught.

Training may be given in government or private technology schools or training centres, in health laboratories or within a university setting, provided that the necessary organization is available. There must be adequate means for evaluating and recognizing student progress.

4.1.3 *General educational requirements and methods of selection of trainees*

(*a*) *Basic general educational requirements*

The following are the minimum educational requirements that must be met before candidates can be accepted for training for each category of technical staff.

Graduate technician (level A):

The requirements for students wishing to train as graduate technicians are those of the university or college in which they wish to enroll.[1]

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[1] The course of study for graduate technicians may be of four or five years' duration leading to a bachelor's degree in science or in medical technology.

Non-graduate certified technician (level B):

Candidates in this category must have successfully completed their ordinary secondary education (ten to twelve years of total schooling) and must have received their secondary school certificate. It is recommended that the secondary school courses include mathematics, general science (chemistry and physics) and general biology.

Certified assistant technician (level C):

Candidates in this category must have completed six (preferably eight) years of general primary education.

Non-certified assistant technician (level D):

Candidates in this category must be able to read, write and perform elementary arithmetic. They should preferably have completed their primary education (6 years).

The above are the basic minimum educational requirements for candidates. The Committee recommends that, whenever possible, all candidates should have completed secondary education including mathematics, general science and general biology.

In exceptional cases where candidates fail to meet all the requirements for acceptance at one of levels B, C and D, but have had experience in laboratory work and have shown special ability and performance, the requirements may be modified to allow such candidates to proceed to a higher level of training.

(*b*) *Methods of selection*

There is no single or best method for the selection of candidates. Different countries have used, and will continue to use, different methods and means (scholastic records, interviews, examinations, etc.). Any method that produces the desired information—assessment of basic knowledge and ability and of whether the candidate is likely to become a good technician—may be considered acceptable.

Lower and upper age limits for admission to training should be set by the individual country or school after consideration of the educational background of the candidates, the opportunities for their employment upon completion of training, and the needs of the country. The Committee agrees that 16 to 18 years is an optimum age range for beginning training.

Sex should not be a limiting factor in selection. The number of applicants of either sex varies with varying socio-economic and cultural patterns.

(*c*) *Teachers*

The product of any system of instruction depends on the interaction of two essential factors: the student and the teacher. It is important to emphasize that students must possess enough background and intelligence to understand and complete the course. Teachers must be those who can

and *do* teach. The role teachers play in the learning process cannot be overemphasized.

The Committee believes that in any laboratory system there must be a special selection and training of senior technical staff to work in and teach particular disciplines. Such instructors are selected by the director of the service and must be full-time employees. Where the number of students is large enough the selected individuals may be required to devote all their time to teaching. The medical and scientific staff should also actively participate in teaching and must not allow other duties to interfere with their attendance at a scheduled session of teaching. In addition, all other technicians—especially those at levels A and B—should participate in the teaching of students.

When teaching is conducted outside the framework and jurisdiction of the health laboratory, a consultant group from the qualified laboratory personnel should be designated to advise and assist the school or institute.

4.1.4 *Elements of the curriculum and syllabus*

(*a*) *Curriculum*

The Committee believes that the curriculum should be structured to provide the student with polyvalent education and training, i.e., in all disciplines of health laboratory work. The importance of theoretical instruction has already been discussed; suffice it to say at this time that all categories of trainees (A to D) should be taught the theoretical principles of the techniques they learn and their significance at a level in keeping with their general educational background and their learning capabilities. In addition to the basic courses, such as chemistry, haematology, bacteriology, etc., the curriculum should include ethics, the regulations governing the transport of laboratory specimens and the reporting of disease, and elements of laboratory organization and management. Curriculum planners and teachers must at no time lose sight of the fact that health laboratory services are only one part of the many involved in community health, that in fact the various health facilities and programmes are indivisible, and that laboratory workers are an integral part of the health team.

A specimen syllabus for a course of training in health laboratory technology is presented in Annex 2. Although this syllabus is designed for level C assistant technicians in a specific part of the world, it could serve as a basis for more advanced courses (level B) and could be adapted for use in other parts of the world.

The Committee also believes that even under the best conditions a programme cannot lead to the formation of good technicians in less than two years, and that for most countries and many years to come the great bulk of technicians will be composed of non-graduate certified technicians (level B).

(*b*) *Examinations*

The Committee believes that examinations to evaluate student achievement and performance are necessary during and at the termination of the course. It also emphasizes that a representative of the national or state health authority, or of a state-recognized professional society should supervise the examinations which serve as basis for licensing and which may be given by the school, and/or the professional society or the state. The examination should include a written theoretical part, a practical part, and an oral part, the latter to provide a means for the overall assessment of the candidate.

Schools and training centres should also have a system for marking student performance. The choice of system is left entirely to the school or government, but no matter which system is used it should recognize outstanding performance.

4.2 Post-basic specialization training

In some countries where health laboratories are advanced, specialization of technicians exists in all laboratory disciplines, such as clinical chemistry, microbiology, etc. In the graduate group (level A), specialization usually occurs within the training period by concentration on a basic science, with the addition of its clinical applications during training and experience in the health laboratory. These individuals specialize from the beginning and remain specialists in their chosen field. In the non-graduate certified technician group (level B), specialization more often results from practice and attendance at refresher courses in one aspect of the health laboratory operations. Sometimes the technician takes a formal course of advanced study after some years of experience in polyvalent activity. Occasionally in this group specialists are selected during the initial formal training period.

4.2.1 *Needs, opportunities and advantages of technical specialization*

Ultimately, if people are to benefit from the rapid and continuing progress of science in the health fields, such advances must be applied to everyday prevention, control, diagnosis and treatment.

The rapid development of technical specialization in central, reference and research laboratories reflects the tremendous increase in specific medical, public health and related knowledge and technology, for it has become impossible for any one person to attain the maximum competence in every aspect of laboratory theory and practice. Although for many decades in most countries the generally trained, polyvalent technician will perform 90% or more of the laboratory work, especially in the outlying and smaller health facilities, there will be a growing need for specialized tech-

nical staff who excel in certain knowledge and skills to provide the supervision, training, management and research in the various laboratory subdivisions in academic institutions, reference and central health laboratories and research.

Specialized laboratories, sections of laboratories, teaching and research will provide adequate and increasing opportunities for employment, advancement, and training of specialized technical staff. In developing countries, opportunities for specialization will develop rapidly in central or reference laboratories. Moreover, in all countries this type of advanced training represents an attractive challenge and opportunity for personal growth of talented individuals of scientific bent, who for some reason cannot go on to postgraduate training in the sciences or in medicine.

4.2.2 *Education and training*

Specialization may come about in one of two ways. Non-graduate technicians (level B) working in an appropriately organized large laboratory may be assigned specialized duties on the basis of their practical experience and after taking a refresher course and receiving advanced training. Others will elect to concentrate on one discipline during their early technical training and will already have specialized by the time they enter practice. This route of specialization will be followed more frequently by the graduate technician (level A). Postgraduate specialization by the graduate technician may lead to an advanced degree and the status of a laboratory scientist, an opportunity that will never, or very rarely, be open to the undergraduate technician. Formal courses for specialist training should always include both advanced theory and advanced practical work in the appropriate specialty. Such courses should be carefully planned and organized.

The categories of specialization will usually include : clinical biochemistry ; microbiology (including such specialties as bacteriology, parasitology, mycology, virology, etc.) ; haematology, immunohaematology and blood-transfusion laboratory procedures ; histopathology and cytology ; and laboratory operation and management.

Laboratory operation and management is a type of administrative specialization that is especially appropriate for highly qualified and capable technicians (usually level B).

Educational requirements for commencing specialist training will vary with the category of technician (non-graduate or graduate), the specialization desired, and the degree of experience and advancement as well as the projected future employment (laboratory management, special laboratory, research, etc.).

Training for specialization requires careful attention to organization and planning of the curriculum, teaching and laboratory practice by a

staff with professional competence and teaching ability. Additional work in advanced basic sciences, such as physics, mathematics, etc., is highly desirable to reinforce the candidate's fundamental scientific knowledge.

4.2.3 *Titles and promotion*

Recognition of technical competence in specialization for the purpose of satisfaction in attainment, promotion and professional practice can be provided by appropriate certification and titles, which will vary with the local customs and state regulations of the country, but should always distinguish the individual and reward his accomplishment. The compensation afforded in the employment structure must also appropriately recognize this additional achievement.

Furthermore, recognition and promotion of the specialized technician will depend on his competence and ability to accept more independent responsibility, especially in the field of his advanced training and experience.

5. CAREER DEVELOPMENT AND CONDITIONS OF SERVICE

National health planning and budgeting should take into consideration the needs of the laboratory services, be they governmental or private, and provide training opportunities as well as employment of trained personnel. Opportunities for advancement and promotion should be available to all. However, promotion should be primarily on the basis of technical and scholastic achievement, although other factors, such as length of service and character, should also be taken into consideration.

The formation of professional societies or groups should be encouraged in all countries or geographical areas where there are sufficient personnel to sustain their satisfactory operation. Their main functions should be to stimulate an interchange of technical information, to improve the standard of competence of their members and to play an important role in their post-certification training.

6. CERTIFICATION AND REGISTRATION

The Committee noted with regret the lack in many countries of any official recognition of the professional status of laboratory technicians. It believes that the following should be done :

(1) Legislation defining the requirements for the training of laboratory technicians, their classification and licensing to practice, as well as the disciplinary measures and procedures to be followed when necessary.

(2) Establishment of a recognized professional society. This may be national or regional.

Optimally, every technician should be:

(*a*) Certified, i.e., possess a formal certificate of training from the school, which attests the satisfactory completion of the programme of study of that school.

(*b*) Registered, i.e., pass the official national examination and meet the requirements for practice. Registration may be at the national, state or local level and may be by the government, professional society or medical profession singly or in combination depending upon the laws of the country concerned.

(*c*) Licensed, i.e., officially recognized and permitted to work as a laboratory technician.

7. SUMMARY AND RECOMMENDATIONS

The Committee reviewed the factors involved in the selection and training of health laboratory technical personnel, and the problems which countries have in providing for such personnel. It recognizes that countries possess varying facilities and capabilities to meet their needs, that they must carefully plan the utilization of their health resources, and that the programme for health laboratory personnel must be an integral part of the overall planning for health and be designed to serve the best interest of the country. Furthermore, while it is recognized that any general recommendation made by this Committee may have to be adapted to the peculiar needs of individual countries, it is essential for the authorities concerned to remember that any compromise made in the matter of standards must be temporary.

After carefully studying the situation in developing as well as in developed countries, the Committee presents the following recommendations:

1. The profession of health laboratory technical personnel should be recognized officially as a distinct entity within the health professions.

2. Training in health laboratory technology should consist in formal, well structured courses of study which give the trainee a sound basis of theoretical (one-third) and practical (two-thirds) training; a programme that fails to teach both aspects should not be considered acceptable.

3. A minimum adequate general educational background is necessary for technical training. Candidates lacking this minimum should not be accepted.

4. Four basic categories of health laboratory technical personnel are recognized:

Level A — Graduate technician (medical technologist)

Level B — Non-graduate certified technician (laboratory technician)

Level C — Certified assistant technician (multiple-skill laboratory assistant)

Level D — Non-certified assistant technician (single-skill laboratory assistant)

5. The basic training for levels A, B and C should be polyvalent. Subsequent specialization may take place at levels A and B.

6. Methods of selection of candidates should aim at discovering those who will be able to complete satisfactorily the required training and will be competent.

7. Adequate teachers should be available and facilities for the selection and training of teachers should be provided.

8. All technicians should be licensed on the basis of passing official examinations, and officially registered.

9. All technicians should have opportunities for professional growth and advancement: advanced courses, specialization, promotion, etc.

10. The formation of appropriate professional societies should be encouraged.

11. Health planning should take into consideration both the need and the positions available for technicians.

Annex 1

EQUIVALENT TITLES USED TO DESIGNATE NON-GRADUATE CERTIFIED TECHNICIANS (LEVEL B) IN VARIOUS COUNTRIES *

Austria	Medizinisch-technische Assistentin
Belgium	Assistant(e) de laboratoire
Brazil	Técnico de Laboratorio
Canada	Laboratory Technologist, Technologiste médical
Ceylon	Medical Laboratory Technologist
Chile	Técnico Laborante
Czechoslovakia	Laborant
Denmark	Laboratorieassistenter-Hospitalslaboranter
Finland	Laboratoriosairaanhoitajien (laboratory nurse) Sairaalalaborantit (hospital technician)
France	Technicien(ne) d'analyses biologiques, Aide technique diplômé
Federal Republic of Germany	Medizinisch-technische Assistentin
Lebanon	Medical Laboratory Technician
Malaysia	Laboratory Assistant
Mexico	Técnica en laboratorio clínico
Netherlands	Medisch Analyste
Nigeria	Medical Laboratory Technician
Norway	Laboratorie-Sykepleier [a] (laboratory nurse)
Poland	Technik, Laborant diplomowany
Senegal	Aide de laboratoire (très qualifié)
South Africa	Medical Laboratory Technologist
Sweden	Laboratorie-Sjuusköterke (laboratory nurse) Laboratris, Preparatris (technician)
Switzerland	Medizinische Laborantin, Laborantine médicale
UAR	Laboratory Technician
United Kingdom	Medical Laboratory Technician
USA	Medical Technician
USSR	Feldsher-Laborant (medical laborant)
Yugoslavia	Zdravstveni tehničar (health technician)

* Based on information published in the *Journal of Medical Technology*, July 1961, and on replies to a WHO questionnaire received in 1965.

[a] Also Laboratorie teknikere, Laboratorie assistent.

Annex 2

A PROGRAMME FOR THE TRAINING OF CERTIFIED ASSISTANT TECHNICIANS (LEVEL C)

The following programme was designed for the specific purpose of organized training of resident students in a defined tropical area. It should therefore be understood that modifications of subject matter will be necessitated by local conditions.

A certificate of successful achievement is obtained after completing the nine-month programme described below and passing a final examination followed by an additional two months of in-service training in an approved laboratory. One month's vacation is included in the course, which has a total duration of one year.

To provide for flexibility in the teaching schedule, the programme is presented on a weekly basis for forty weeks.

1. Daily schedule

From Monday morning to Saturday noon :

6.00 a.m.	Awakening
6.15 - 6.45 a.m.	Physical education
7.00 - 7.45 a.m.	Tidying bedrooms, breakfast, sick parade (if necessary)
8.00 - 12.00 noon	Demonstration room : the lecture-demonstration and practical classes
12.00 - 1.00 p.m.	Lunch
1.00 - 2.30 p.m.	Rest
2.30 - 4.30 p.m.	Demonstration room
4.30 - 6.00 p.m.	Snack, recreation
6.00 - 7.30 p.m.	General instruction, supervised studies
7.30 - 8.30 p.m.	Dinner
8.30 - 10.00 p.m.	Common room, library
10.30 p.m.	Lights out

Saturday afternoon and Sunday : free

2. Subjects of instruction

	Hours
(*a*) Introduction	4
(*b*) General instruction	106

This general instruction is given outside the time of the practical laboratory work for three hours per week ; some sessions may entail only such

activities as drawing, editing of reports, problems, audio-visual instruction. It is broken down as follows :

	Hours
Mathematics	20
Chemistry and physics	12
Anatomy and physiology	12
Medical terminology, ethics and sociology	20
Administration and organization	12
Elements of hygiene	10
Supervised group discussions	20
	106

			Hours
(*c*)	Lecture-demonstrations		96
	(i) Techniques, general laboratory	20	
	(ii) Special laboratory testing techniques according to the following breakdown :		
	Haematology, blood grouping, histology	13	
	Parasitology	27	
	Bacteriology	12	
	Serology	5	
	Chemistry	12	
	Entomology	7	
		76	
(*d*)	Practical work and revision		1 064
(*e*)	Supervised studies		120

Résumé

Introduction	4
General instruction	106
Lecture-demonstrations	96
Practical work	1 064
Supervised studies	120
	1 390

3. Progression of studies : weekly division of work

Practical activities	*Lecture-demonstrations*
First week	
Division of the students into groups of three or four. Each week, in rotation, each group will be assigned certain duties such as cleaning the quarters, preparation of the common materials, preparation of solutions and stains, etc. Inventory of personal equipment : coat, microscope, pipettes, Bunsen burner, etc.	Opening session. Explanation of the role and duties of a certified assistant technician ; professional ethics ; prevention of accidents in the laboratory.
Design and names of equipment employed. Design and names of glassware. Cleaning of glassware. Glass-blowing (making Pasteur pipettes, sealing ampoules).	Laboratory material, enumeration, presentation. Glassware : cleaning and maintenance. Glass-blowing.

Practical activities	*Lecture-demonstrations*
First week (continued)	
Manipulation and regulation of heating devices : alcohol lamps, butane gas, blowlamps.	Weight measurements : units, balances.
Weighing.	Weighing techniques (two lectures).
The last three operations will be repeated throughout the course.	
Second week	
Use of the microscope, description of the various parts. Direct examination, drawing the cells observed (without naming them). Scales of butterfly wings, hay infusion, contents of the frog cloaca.	The microscope : optical principles.
Cultures of motile spore-forming bacteria, etc.	Micro-organisms : general discussion ; asepsis.
Opening of sterile broth flasks (subsequent check for contamination).	
Washing glassware, slides and cover slips.	Discussion of sample-taking.
Glass-blowing.	
Staining smears.	Procedures employed in microscopy.
Use of thermometers suitable for various types of measurement (boiling water, melting ice).	Temperature and its measurement.
Measurement of volumes. Use of the pipette. Filling and sealing ampoules.	Measures of volume : units, means, techniques.
Weighing. Preparation of normal (physiological) saline.	
Third week	
Every day : weighing, glass-blowing, cleaning glassware, measuring volumes.	Disinfection. Sterilization.
Dilution of disinfectants : demonstration by the tutor of the effects on microbial cultures.	Destruction of used materials. Fundamental definitions in chemistry : pure substances, molecules, atoms.
Sterilization : operation of autoclaves and of the hot air oven ; use and examination of controls.	Mixtures : separation of the constituents.
Centrifugation, practical study of the centrifuge, balancing, separation of the two phases of a suspension : blood.	Centrifugation, filtration, distillation.
Filtration by paper, by candle, by Seitz-type filter ; setting up each type of filter.	

Practical activities	*Lecture-demonstrations*
Fourth week	
Weighing, glass-blowing, measuring volumes, cleaning glassware.	Principles of concentration.
Dilution of coloured solutions (with colorimetric check by the instructor).	Dilutions ; serial dilutions.
Exercises in calculating dilutions.	
Sterilization.	
Preparation of staining solutions.	Human anatomy : systems, organs, tissues, cells (two lectures).
Examination of fresh cell cultures and of stained histological slides (drawing).	
Examination of fresh and of stained blood smears.	Blood : role, circulation composition, erythrocytes, cell counts.
May-Grünwald-Giemsa stain.	Stains, staining.
Cell counts.	
Sedimentation rate.	
Fifth week	
Measurements in weight and in volume.	Colorimetry.
Glass-blowing, cleaning glassware.	
Sterilization by group.	
Colorimetric measurement of pH.	Explanation of principle of pH.
Preparation of buffer solutions (weighing, dilution).	Acid-base mechanisms.
Establishment of dilution scales.	Blood : formed elements.
Making and staining of blood smears.	Blood, haemoglobin, differential white cell count.
Differential white cell counts.	
Red cell counts.	Materials used in haematology : cells, pipettes, haemoglobinometers, dilution liquids.
Colorimetric measurement of haemoglobin levels.	
Determination of colour index.	
First revision examination.	
Sixth week	
Measurement of weight and volume.	
Glass-blowing, cleaning glassware.	
Aseptic manipulations : dilution, sterilization.	
Making of blood smears : thin and thick smears.	

Practical activities	*Lecture-demonstrations*
Sixth week (continued)	
Withdrawal of capillary blood.	Examination of blood for parasites.
Staining of blood.	
Differential white cell counts.	
Red cell counts.	
Search for malaria parasites.	Malaria parasites (two lectures).

From this week on, the students are sent by groups to take samples of blood from patients for thin and thick blood smears.

Seventh week	
Revision.	
Measurement of weight and volume.	
Dilutions, preparation of solutions for haematology: Hayem's fluid, Marcano's solution, etc.	
Glass-blowing, etc.	Review of basic chemistry.
Aseptic manipulations. Sterilization.	Calculation of molecular weights.
Preparation of solutions of definite molarity.	
Cell counts, differential white cell counts. Search for malaria parasites.	Haematopoiesis.
Emmel's test.	Abnormal cells of the blood (two lectures).
Study and drawing of cells of the bone marrow.	
Observation of blood films from leukaemic patients.	Bone marrow and lymph-node punctures.
Study of smears of anaemic blood (poikilocytosis, anisocytosis, etc.).	

It is a question here of establishing at what point an apparently abnormal slide should be shown to the laboratory chief or sent to the central laboratory.

Eighth week	
Revision: see preceding weeks.	
Withdrawals of capillary blood and venepuncture; checking sterility of manipulations.	
Practice of triple centrifugation.	
Search for trypanosomes.	Human trypanosomes (two lectures).
Lymph-node puncture, examination of fresh specimens and of smears.	Lumbar puncture, lymph-node puncture.
Observation of trypanosomes in the fresh state and after staining.	

Practical activities	*Lecture-demonstrations*
Eighth week (continued)	
Red cell counts, differential white cell counts, etc.	The cerebrospinal fluid, cytochemical study : cells, proteins.
Counting cells in the cerebrospinal fluid.	
Determination of cerebrospinal fluid protein using the Sicard and Cantaloube tube.	
Ninth week	
Revision : see preceding weeks.	
Measurements, sterilization, red cell counts, differential white cell counts, haemoglobin, etc.	
Blood parasites ; preparation of blood smears.	
Platelet counts.	Blood coagulation.
Bleeding and coagulation times. Sedimentation rate (ESR).	Other blood examinations, ESR, and formol-gel test (Napier-Gaté).
Search for trypanosomes in infected animals, handling of animals.	Colloidal flocculation test.
Demonstration of the colloidal flocculation test.	
Second revision examination.	
Tenth week	
Revision : weighing, sterilization, dilution, etc.	
Red cell counts, differential counts, ESR, coagulation time, bleeding time, formol-gel test.	Blood microfilariae.
Blood parasites.	
Malaria parasites and trypanosomes.	General information on filariae and filariasis (three lectures).
Microfilariae : *Loa loa*, *Dipetalonema perstans*, *Wuchereria bancrofti*, *Onchocerca volvulus*.	Borrelia.
Smears for detection of microfilariae.	
Examination of *O. volvulus* cysts.	
Eleventh week	
Revision : see preceding weeks.	
All blood tests, calculation of dilutions, preparation of solutions, etc.	
Handling of guinea-pigs, rats, mice, rabbits, (from this date on, each group will be responsible for the care, feeding and observation of each type of animal in the animal house).	Laboratory animals (two lectures).

Practical activities	*Lecture-demonstrations*
Eleventh week (continued)	
Rearing, restraint, autopsy, blood withdrawals, cardiac puncture, examination of stools.	Antigens and antibodies, principles of immunology.
Blood groups. Identification of red cell antigens and serum agglutinins.	Blood groups A, B, O, Rh (three lectures).
Establish the blood group of each student (A, B, O and Rh).	
Storage of blood in plastic bags.	

Twelfth week

At the beginning of the week : revision of blood examinations, including blood grouping.

Haematology examination : covering the theory and practice of haematology taught during the trimester.

This will serve as a probationary examination ; marks given will take into account the candidate's general practical ability and his intellectual aptitudes.

Thirteenth week

Revision : weighing, pipetting, sterilization, etc.	
Preparation of staining solutions.	Revision of bacteriology.
Gram stain.	
Fontana's stain (demonstration), Vago's stain, dark field examination, detection of treponemes.	Pus, remarks on their examination (two lectures).
Pick's stain and Jacobson's stain.	Genital ulceration, treponemes, Ducrey's bacillus.
Ducrey's bacillus, soft chancres (sample-taking and examination).	
Urethral discharge, detection of gonococci.	Urethral discharge, the gonococcus.
Preparation of sera for despatch to the serological laboratory.	Principles of immunology, serological diagnosis.
Demonstration of various agglutination tests (Widal) and flocculation reactions (Kline).	Agglutination, precipitation and complement-fixation reactions (two lectures).

Fourteenth week

Revision : basic procedures, blood examinations, bacteriological stains.

Demonstration of the serological diagnosis of syphilis.

Training in the use of the pipette.

Practical activities	*Lecture-demonstrations*
Fifteenth week	
Revision : haemoglobin, red cell counts, differential white cell counts, clotting time, bleeding time, sedimentation rate.	
Blood parasites.	
Preparation and examination of pus smears.	
Collection of specimens from animals, draining abscesses.	
Demonstration of the inoculation of culture medium with pus.	Review of principal pathogenic organisms (simple nomenclature, bacteria, fungi, etc.).
Examination of organisms isolated.	
Examination of smears from throat swabs (inoculation of guinea-pigs with cultures of diphtheria bacilli).	Buccopharyngeal exudates.
Obtaining specimens from the throat to be sent to the bacteriological laboratory.	
Third revision examination.	
Sixteenth week	
Revision : blood and pus.	
Examination of sputum (fungi, parasites), detection of tubercle bacilli : Ziehl-Neelsen stain.	Sputum, elementary cytology.
Homogenization.	Laboratory diagnosis of tuberculosis.
Presentation of lepers.	Diagnosis of leprosy.
Obtaining specimens from the nose and skin for detection of Hansen's lepra bacilli.	
Seventeenth week	
General revision, particularly of bacteriological techniques.	
Bacteriology examination.	
Eighteenth week	
Revision : daily blood examinations and search for blood parasites. Emphasis on proper organization of work and use of spare time (staining, ESR, etc.).	
Weighing, measurement of volume, sterilization.	
Examination of stools. Note and draw the constituents (food residues, bacterial flora, parasites).	The stools ; principles of the physiology of digestion ; parasitological examination of stools.

Practical activities	*Lecture-demonstrations*
Eighteenth week (continued)	
Entamoeba, Trichomonas, Chilomastix, Enteromonas, Giardia.	Intestinal protozoa.
Examination of cultures of these parasites.	
Measurement of the pH of stools with indicator paper.	
Nineteenth week	
Revision : see preceding weeks.	
Examination of stools : demonstration of specimens rich in parasites and stools obtained at random.	Discussion of helminths ; diagnosis, epidemiology (two lectures).
Protozoan cysts.	
Eggs of ancylostoma (hookworms), of ascaris, of trichocephalus (whipworms) ; observation of the adult worms. Attention is drawn to the size of the egg of trichocephalus (unit of measurement).	Nematodes.
Twentieth week	
Revision : blood, pus, basic techniques.	
Study of nematode eggs.	Nematodes (continued) (two lectures).
Fourth revision examination.	
Twenty-first week	
Revision : blood and pus, examinations of stools.	
Examination of adult trematodes, eggs of trematodes, schistosoma and liver flukes ; examination of urinary deposits of persons with bilharziasis.	Trematodes (two lectures). Rudiments of malacology.
In the field : collection and examination of molluscs.	
Twenty-second week	
Revision : daily blood examinations, including differential counts, search for eosinophilia, blood parasites, etc. ; examination of adult cestodes.	Cestodes (two lectures).
Examination of stools (all eggs, compare the sizes).	General picture of the diagnosis of intestinal helminthiases.
Twenty-third week	
Revision : parasitology of the blood, the stools, the urine, the cerebrospinal fluid, etc.	
Parasitology examination.	

Practical activities	*Lecture-demonstrations*
Twenty-fourth week	
Revision of all knowledge acquired. One day is reserved for a complete test involving five different types of examination, e.g. : 1. Blood count and haemoglobin. 2. Detection of blood parasites. 3. Examination of stools for eggs of five different parasites. 4. Preparation of a solution of a given concentration. 5. Serial dilution of a solution of stain.	
Cytoparasitological examination of urine.	Urine cytoparasitological examination ; aseptic collection of urine (mid-stream).
Detection of sugar and albumin in urine.	Chemical study of urine (two lectures).
Detection of bile salts and pigments in urine. *Fifth revision examination.*	
Twenty-fifth week	
Revision : daily repetition of several of the tests already learned.	
Entomology : materials, dissecting microscope, etc.	Introduction to medical entomology ; role of arthropods as vectors.
Stages of development of mosquitos, differential characters, demonstration of dissection, search for sporozoites.	Culicine and anopheline mosquitos. Biting flies.
Glossina and Stomoxys, identification, demonstration of dissection.	Glossina and Stomoxys.
Observation of mounted preparation of various arthropods.	Fleas, lice, bed-bugs, ticks ; biting and vesicant arthropods.
Twenty-sixth week	
Revision : see preceding weeks (stress identification of microfilariae).	
Observation of arthropods presented during the course (Phlebotomus, Heleidae, Chrysops, Simuliidae).	Phlebotomus and Heleidae.
Flies that cause myiasis and their larvae.	Sensitivity and resistance of arthropods to insecticides.
Techniques of collection, labelling and transmission of arthropods of medical or veterinary importance.	

Practical activities	*Lecture-demonstrations*
Twenty-seventh week	
Revision of medical entomology.	
Entomology examination.	
Twenty-eighth week	
Revision : complete blood counts, blood groups, examination of pus, stools, urine, etc.	Further discussion of professional ethics.
Preparation of specimens for despatch to the laboratory.	General remarks about despatch of specimens to the laboratory.
Writing requests for examination of specimens.	
Demonstration of blood cultures (precautions required).	Despatch of stools, urine, sera.
Demonstration of stool and urine cultures.	Techniques used for blood, stool and urine cultures.
Preparation of anticoagulant or preservative solutions.	Despatch of blood and urine for chemical tests.
Twenty-ninth week	
Revision : blood (haematology and parasitology), chemistry of urine.	
Presentation of histological techniques.	Despatch of specimens for histological examination.
Importance of fixation : show the results of an insufficient preparation of a specimen before despatch.	
Preparation of fixatives in current use.	Drinking water ; the importance of organized control ; laboratory methods.
Water samples (in the field).	Despatch of samples (two lectures).
Presentation of bacteriological and chemical techniques for analysis of drinking water.	
Thirtieth week	
Revision of chemistry : atoms, molecules, pure substances, separation of constituents, dilution, pH, chemical analysis of urine, etc., including the precautions to be taken in preparing specimens for despatch to the laboratory.	
Chemistry examination.	

Practical activities	*Lecture-demonstrations*

Thirty-first week

Revision of all knowledge acquired.

Autopsies on dogs, cats, guinea-pigs, rats and mice; collection of specimens with particular reference to the brain.	Specimens to be taken, in order to confirm the diagnosis of certain viral diseases: *rabies*, smallpox, yellow fever, poliomyelitis, influenza, etc.

Thirty-second week

Revision of techniques learned.

Inventory of laboratory supplies.	Laboratory administration. Equipping of laboratory premises. Maintenance of registers.
Presentation of orders for reagents and supplies.	Reports and orders. Technical and operational integration.

Thirty-third to thirty-ninth week

Revision of techniques taught, so that each day every student will have to make at least one complete blood count, one direct bacteriological and one stool examination, with occasionally an entomological examination. Preparation of specimens and request forms for transmission to another laboratory. Frequent preparation of reagents, with calculation of the concentrations, and making dilutions and distribution by pipette and drops.

Sterilization and disinfection every day.

Fourtieth week

Final examination

The marks already obtained in the intermediate examinations are added to those of this examination, which should entail a series of tests including the principles not covered in the intermediate examinations. This examination should test whether the candidate is capable of passing from one discipline to another and whether he is able to organize his work efficiently and to give satisfactory service when alone in a peripheral laboratory.

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