

MEDTECH 410 – Lecture 1

General Overview of the medical laboratory

Learning Objectives

- At the end of this lecture, learners should be able to:
- Define medical laboratory technology and other related terms
- Narrate the brief history of medical laboratory sciences
- Give an overview of the organisation and classification medical laboratory
- Understand the role of medical laboratory scientists

Introduction (i)

- Medical laboratory technology (MLT) is also known as medical laboratory science (MLS) or Biomedical science
- It is used to fall under the auxiliary or allied branch of medicine
- However nowadays, it is considered **fundamental part of modern medicine as it forms the basis of evidence based practice of medicine**
- Heinemann, defined MLT as...

“the application of principles of natural, physical and biological sciences to the performance of laboratory procedures which aid in the diagnosis and treatment of diseases”

Introduction (ii)

- Fagelson, defined MLT as..

“ The **branch of medicine** concerned with the **performance of laboratory determinations and analyses** used in the **diagnosis** and **treatment** of disease and the **maintenance of health**”.

- Walters, defined MLT as..

“ the health **profession** concerned with performing **laboratory analyses** in view of **obtaining information necessary** in the **diagnosis** and **treatment** of disease as well as in the **maintenance of good health**”.

Key elements of the definition

- Analyses, performance or testing of.....
- Samples (specimens – biological fluids or tissues)...
- Which provide....
- Results (information) which helps Doctors/Physicians to...
- i) Diagnose and treat a disease e.g. HIV test
- ii) Rule out presence of disease and need for treatment e.g. PAP smear
- iii) Monitor treatment e.g. HBA1C
- iv) Disease risk assessment e.g. Total cholesterol, Glucose, BMI and BP for metabolic disease risk assessment

History of medical laboratories

- It is difficult to exactly say when and where medical laboratory science was started.
- However, some early historical references have shown that there was examination of body fluid around the era of Hippocrates.
- The development of the profession was the pioneering work on microscopy by a Dutch businessman and scientist Antony Van Leeuwenhoek.
- Early laboratory practitioners were physicians, pathologists or both.
- Later medical laboratory profession was developed into a separate discipline having its own educational requirements and standards

The medical/clinical laboratory

It is a well **furnished** and **equipped** premise or facility that performs biochemical, microscopic, serologic physical and other examinations of various body fluids like blood and tissues by competent and licensed personnel



Different departments

- Medical Microbiology – Bacteriology, Mycology, Parasitology, Virology
- Medical Biochemistry/Clinical Chemistry – Fluids (urine, serum, CSF etc.), chemical and metabolic conditions e.g. Diabetes
- Haematology – Blood, blood components and blood disorders e.g. Leukaemia, anaemia etc.
- Blood Transfusion – Blood donors, recipients..
- Histology and cytology – Tissues, Cells, cancers e.g. Lung cancer, liver cancer, cervical cancer etc

Organisation and classification of medical laboratories (i)

- A laboratory:
 - A place that is equipped with different instruments and chemicals (reagents)
 - For performing experimental work, research activities and investigative procedures.
- Medical laboratory:
 - One part of the laboratory that is equipped with various biomedical instruments, materials and reagents (chemicals)
 - For performing different laboratory investigative activities
 - Using biological specimens (whole blood, serum, plasma, urine, stool, tissues etc.)
- The world Health Organization (WHO) lists four kinds of levels of laboratories based on their biosafety

Basic laboratory level I

- Basic laboratory level I is the simplest kind and adequate for work with organisms which have low risk to the individual laboratory personnel as well as to the members of the community.
- Such organisms are categorized under **Risk Group I** by WHO.
- These organisms are unlikely to cause human diseases.
- Examples include food spoilage bacteria, common moulds and yeasts.
- Food testing, industrial and some environmental testing laboratories fall in this category

Basic laboratory level II

- Basic laboratory level II is suitable for work with organisms that predispose to moderate risk to the laboratory worker and a limited risk to the members of the community.
- Such organisms are categorized under **Risk Group II** by WHO.
- They can cause serious human diseases but not serious hazards due to the availability of effective preventive measures and treatment.
- Example, staphylococci, streptococci, entero-bacteria
- Such laboratory should be clean, provide enough space, have adequate sanitary facilities and equipped with an autoclave.
- Most hospital laboratories fall in this category and should be fitted with a level I biosafety cabinet as a minimum

Containment laboratory (Level III)

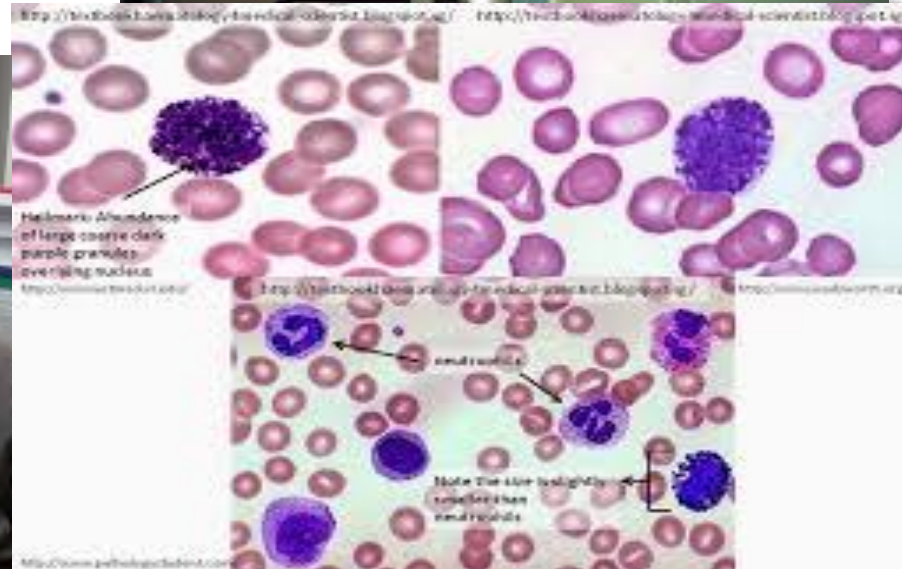
- A containment laboratory is more advanced and is used for work with infectious organisms that present a high risk to the laboratory personnel but a lower risk to the community.
- Such organisms are categorized under **Risk Group III** by WHO.
- Example, Tubercle bacilli, *Salmonella typhi*, Yersina and others that are easily transmitted through the air, ingestion of contaminated food or water and paranterally.
- Such laboratory should be a separate room with controlled access by authorized staff.
- It should also be fitted with a level II biosafety cabinet
- An example the National TB Reference Laboratory (NTRL)

Maximum containment laboratory (Level IV)

- Maximum containment laboratory is intended for work with viruses, which predispose to a high risk for both laboratory personnel and the community.
- Such organisms are categorized under **Risk Group IV** by WHO.
- Examples include *Small pox*, Ebola, Lassa fever and others.
- Most of these organisms cause serious disease and readily transmitted from one person to another.
- These laboratories are usually in a separate building with strictly controlled access.
- They are also fitted with a level III biosafety cabinet and a suit room

Personnel in the medical laboratory (i)

- The Pathologists
 - Histology/cytology
 - Chemical
 - Microbiology
 - Haematology
 - Virology



Personnel in the medical laboratory (ii)

- Medical laboratory scientists
- Medical laboratory technicians
- Phlebotomists



The role of medical laboratory scientists

- Some of the major roles of medical laboratory scientists include:
- Carry out routine and advanced laboratory tests using standard laboratory methods;
- Apply problem-solving strategies to administrative, technical and research problems;
- Conduct community – based researches in collaboration with other categories of health professionals;
- Provide professional consultancy on matters related to the establishment, renovation, upgrading and reorganization of medical laboratories of intermediate levels

Attributes of medical laboratory scientists (i)

- To succeed in the medical sciences profession a person needs:
 - Stamina
 - Good eye sight
 - A normal color vision
 - Manual dexterity
 - Good intellect and an aptitude for the biological sciences
 - Caring attitude
 - Good communication skills and ability to relate well to fellow workers

Attributes of medical laboratory scientists (ii)

- Observant
- Motivated
- Able to perform precise manipulations and calculations
- Good organizational skills
- Service oriented
- Patience
- Honesty, accuracy
- Dedication
- Emotional maturity

Job opportunities for Medical Laboratory Scientists (i)



Job opportunities for Medical Laboratory Scientists (ii)

1. Clinical / medical laboratories

- a) Medical technology generalist in a hospital government or private, clinical laboratories
- b) Medical technology specialist (microbiology, hematology, blood banking, clinical chemistry, etc.)
- c) Clinical laboratory supervisors, chief medical technologist and laboratory owners

Job opportunities for Medical Laboratory Scientists (iii)

2. Universities, Medical Schools, Research Institutes

- a) Specialists can work in universities and colleges as lecturers e.g. DDTCOM, UB, BIUST, BUAN
- b) Specialists can also work in research institutes as Research Scientists e.g. BITRI, NAFTEC, Botswana Harvard
- c) Research specialists for different government departments e.g. Health Research, Nutrition, Veterinary etc.

Job opportunities for Medical Laboratory Scientists (iv)

3. Industry

- a) Research and development scientists for biotechnology manufacturing companies e.g. GSK, Merck
- b) Sales representatives, Scientific Liaison Officers, Application Specialists, diversify to become biomedical service specialists etc.
- c) Industrial laboratory scientists in water, microbiology and environment laboratories e.g. BMC, WUC, BPC, Mines
- d) Quality and Regulatory Scientists in manufacturing e.g. Pharmaceuticals, Chemicals, Beverages etc.

Job opportunities for Medical Laboratory Scientists (v)

4. Public Health Specialists

- a) Laboratory Scientists can specialise in public health related course and become program managers for different public health institutes e.g. The National Public Health Laboratory
- b) Respond to public health emergencies around the world e.g. Ebola, Zika virus, Cholera etc.
- c) Work for WHO, Africa-CDC etc.

Summary

- Defined Medical Laboratory Technology
- History of the medical laboratory
- Different departments in the laboratory
- Organisation and classification of laboratories
 - Levels I – IV
- Personnel in the laboratory
 - Pathologists, Medical Laboratory Scientists, Medical Laboratory Technicians, Phlebotomists
- Attributes of Medical Laboratory Scientists
- Job opportunities