National Council For
Higher Education

MINIMUM STANDARDS FOR THE MASTER OF MEDICAL LABORATORY SCIENCE (MMLS/T) EDUCATION AND TRAINING IN UGANDA

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Preamble

The Curriculum introduces compulsory modules on non-technical cross cutting areas such as laboratory quality management systems (LQMS), concepts in procurement and logistics management, leadership and management, entrepreneurship, pedagogy, research methods and bioethics as well as scholarly writing relevant in addressing the increasing complexities in healthcare delivery.

Uganda and the East African region at large have made great strides in the provision of improved health care access and services for the population in pursuit of Universal Health Coverage (UHC). However, there is still a desperate lack of human resources for health (HRH) for the provision of specialist health care. This calls for more training and education of healthcare professionals at specialist level so as to provide a critical mass of specialists in the various disciplines.

We have the pleasure of presenting this first edition of Minimum Standards for the education and training of specialists at the Master of Medical Laboratory Sciences/ Technology level in several specialty areas including Medical and Diagnostic Microbiology (Bacteriology, Virology, Mycology, Parasitology and Entomology), Clinical Chemistry, Histopathology and Cytology, Hematology and Blood Transfusion Science, Molecular Biology and Immunology.

The Minimum Standards prescribed here are a result of a wide stakeholder consultative process spearheaded by the National Council for Higher Education (NCHE) and the Allied Health Professionals Council (AHPC), including the Uganda Medical Laboratory Technology associations (UMLTA) and experts in health professionals education as well as regional and international benchmarking of the knowledge, skills, competencies and attitudes required by a medical laboratory specialist graduate trainee in the various disciplines.

In this document, Minimum Standards for the education and training for the Master of Medical Laboratory Sciences Degree Programmes in Ugandan Higher Education Institutions

are prescribed. Specialist health care requires more than the technical clinical laboratory skills. The Curriculum introduces compulsory modules on non-technical cross cutting areas such as laboratory quality management systems (LQMS), concepts in procurement and logistics management, leadership and management, entrepreneurship, pedagogy, research methods and bioethics as well as scholarly writing relevant in addressing the increasing complexities in healthcare delivery. Institutions are expected to use these standards as the minimum guidelines in the innovative design, delivery and management of their own specific programmes. It is expected that the minimum standards as described here will enable higher education institutions channel out graduates who have sufficient theoretical and practical knowledge, skills and altitudes to deliver specialized clinical and research laboratory services through promotion of health, prevention of disease, diagnosis, prognostic monitoring and preventive services, and who can generally contribute to national medical advancement and be competitive in Uganda, the East African region as well the globalized environment

It is our hope that this effort will further improve the quality of specialist education and training at Master of Medical Laboratory Sciences level and strengthen the capacity of regulatory frameworks to monitor and enhance the quality of training and specialist practice. The success of implementation of these Minimum Standards will depend on the constructive collaboration of the leadership of the training institutions, education and training regulators, and the professional association.

I wish to pay a well-deserved tribute to the following persons who worked tirelessly in benchmarking, harmonizing, and drafting the minimum standards:

1.	Dr. Bernard S. Bagaya (BBLT, MSc., Ph.D.)	Chairperson
2.	Dr. Herbert Itabangi (BMLS, MSc, MRes, Ph.D.)	Member
3.	Mr. Lucas Ampaire (BMLS, MMLS)	Member
4.	Rev. Dr. Cyrus S. Ssebugenyi (BSc, MSc, Ph.D., MDiv)	Technical Officer
5.	Dr. Ovia Kyatuha Mwisaka	Technical Officer

Professor Mary J. N. Okwakol
Executive Director, NCHE

STANDARD 1: GOVERNANCE AND MANAGEMENT

Benchmark Standard

Master of Medical Laboratory Science / Technology (MMLS/T degree programmes shall be conducted under the governance and management framework of a School or Department of Medical Laboratory Sciences. This means that the governance and management standards set under the Minimum Standards for Bachelor of Medical Laboratory Science/Technology shall apply to Minimum Standards for Master of Medical Laboratory Sciences/Technology Degree Programmes as well. In addition, we provide the following guidelines.

Guidelines

i) There shall be in place the following policies/manuals to guide in graduate laboratory training.
   a. Research Policy
   b. Examination Policy specific to graduate examinations.
   c. Graduate Student Handbook
   d. Policy on graduate student supervision/mentorship
   e. Any other policy that may be needed for better running of graduate studies, conducting research and undertaking community services.

ii) The graduate supervision policy should emphasize the need to evaluate and appraise supervisors of graduate students on their research supervision capacity especially in compliance with the NCHE guidelines on graduate supervision.

iii) An institution running MMLS/T programmes without the undergraduate degree shall have those departments/units that are in line with all the specialties of MMLS/T they intend to offer.

iv) There shall be a clear and well-described admission and registration process for postgraduate students in MMLS/T.

STANDARD 2: FINANCIAL RESOURCES AND MANAGEMENT

The standards on financial resources and management listed under the Minimum Standards for Bachelor of Medical Laboratory Science/Technology shall apply to MMLS/T programmes as well. In particular, there is a need to have specific budgetary allocations for students' clinical/research laboratory attachments, hospital laboratory rotations, research, seminars and workshops, supervision as well as internal and external examination of students' dissertations. The academic departments shall be involved in the formulation and execution of budgets related to postgraduate activities.

STANDARD 3: TEACHING AND SUPERVISION REQUIREMENTS

Any institution intending to admit graduate students in Medical Laboratory Sciences/ Technology shall ensure that there is adequate capacity for running all taught and practical courses and ensure quality supervision for all students' dissertation research. The students' rights, responsibilities and obligations shall be clearly spelt out either in the graduate student's handbook or any other relevant policy documents. In addition, institutions shall spell out procedures for appointment of research supervisors, conditions for change of supervisors and submission and evaluation of progress reports. The institution shall also describe procedures for handling student-supervisor conflicts.

Under the minimum standards for the Bachelor of Medical Laboratory Science/Technology, the human resource requirements that were clearly articulated apply to MMLS/T as well. Here, aspects of teaching and supervision in respect of Master's degree students are provided.

3.1 Teaching Requirements

Benchmark Standards

1. The school/department/unit for medical laboratory science/technology shall at all time ensure availability of adequate, competent, experienced and qualified human resource to run all prescribed taught and practical courses in the MMLS/T programmes.
2. The following Full Time Academic Staff: Student Ratios shall apply
   - Ideal Practice 1:1
   - Good Practice: 1:3
   - Acceptable: 1:6
3. The teaching load per week for staff shall include didactic and clinical/practical hours as guided below.

i. **Didactic Hours**

- Ideal Practice 4 hours
- Good Practice: 5 hours
- Acceptable: 8 hours

ii. **Clinical/practical Hours**

- Ideal Practice 8 hours
- Good Practice: 10 hours
- Acceptable: 15 hours

NB: While computing these rations, consideration shall be made to the fact that the same teaching staff may be involved with undergraduate students as well as journal clubs, emergency calls, grand and mini rounds.

3.2 Supervision Requirements

The primary responsibility of a supervisor is to act as a mentor to the student. S/he is therefore required to:

i. Provide an environment that stimulates and encourages students to learn and work independently.
ii. Nurture the students' critical thinking abilities, oral and written science communication skills as well as grants manship
iii. Provide guidance on the planning and execution of research activities.
iv. Guide the student on professional code of conduct, ethical considerations and intellectual property rights.
v. Advise the student on relevant conferences and peer reviewed journals where the student can submit papers for presentation and or publication.
vi. Create an ethos of collegiality so that learning takes place within a community of scholars.
vii. Respect student's reasonable views and ideas on his/her research.

Benchmark Standards

a. The institution shall put in place a supervision policy that, among others;
   i. Outlines procedures for appointment of supervisors.
   ii. Defines duties and responsibilities of supervisors and those of the students.
   iii. Defines workload of supervisors and their remuneration
   iv. Defines procedures for change of supervisors
   v. Where institutional policy accommodates co-supervision of students, modalities should be defined especially if there is principal supervisor and a co-supervisor
   vi. Defines ethical considerations and dispute resolutions between graduate students and their supervisors.

b. Every MMLS/T student shall be allocated one or more supervisors. In case of more than one supervisor, a mechanism shall be put in place for effective supervision devoid of unnecessary conflicts.

c. Supervisors are expected to uphold professional etiquettes and moral principles at all times while relating with the students.

d. A supervisor shall not have any conflict of interest that might affect the quality of supervision.

e. A supervisor shall be allocated no more than four Master's Degree students at any one time. Where the supervisor also has on-going PhD students, s/he shall be allocated no more than two MMLS/T students for supervision.

STANDARD 4: PHYSICAL INFRASTRUCTURE AND RESOURCES

4.1 Didactic Resources

The minimum standards for Bachelor of Medical Laboratory Sciences/Technology lay down the necessary infrastructural requirements for Medical Laboratory Schools/Departments/ Units. These requirements will apply to MMLS/T programmes as well. It is however important to emphasize the need for graduate student study room(s), seminar/journal clubrooms and specialty-specific teaching laboratories as highlighted below.

Benchmark Standards

a. All buildings used for teaching and learning shall have adequate provisions to cater for the persons with physical disabilities.

b. **Lecture Rooms and Seminar Rooms:** There shall be adequate classrooms and seminar rooms dedicated to MMLS/T students. The following rations shall apply to lecture room/ seminar room space
   - Acceptable: 1.0 sqm per student
   - Good: 2.0 sqm per student
   - Ideal: 2.5 sqm per student

c. **Graduate students' self-study rooms:** There shall be in place adequate self-study offices for MMLS/T students. Self-study rooms may be shared but shall not be congested and should be well furnished with ICT facilities and Internet connectivity linking to electronic study resources.

d. **Library and Library Resources:** The library shall be equipped with relevant study materials and e-resources. The resources should be regularly updated.

e. **ICT Facilities:**

- Essential ICT facilities and services, including computer rooms and Internet, shall be in place to facilitate accessibility of e-resources and other learning materials through the Web.
- Institutions should strive to provide wireless hotspots in strategic areas on campus especially the graduate study and seminar rooms to enable easy connectivity and utilization of private mobile devices by students.

4.2 Graduate Student Welfare Services:

The students should have accessible and affordable services including an affordable cafeteria, on-call rooms, printing and photocopies services as well as counseling services.

4.3 Teaching Laboratories

Benchmark Standard

The training of MMLS/T will require the following laboratories and diagnostic services

1. Anatomy Laboratory

Should be able to do the following;

i. Mortuary services (body treatment and storage facilities)
ii. Dissection services
iii. Specimen preparation and processing room
iv. Microscopy services

2. Microbiology Laboratory

The microbiology laboratory should be able to offer the following tests in high quality

i. Bacteriology
ii. Parasitology
iii. Microbiological Specimen analysis
iv. Body Fluid Analysis
v. Mycology
vi. Basic Serology
vii. Virological Tests

3. Molecular Biology Laboratory

The Molecular Biology Laboratory should have most of the capability below;

i. Physically separated rooms or engineering alternatives to handle separate Sample/ Nucleic Acid extraction, Reagent/Master Mix preparation and Post-Amplification processes, in accordance with international standards for clinical molecular testing.
ii. Conventional Polymerase Chain Reaction (PCR) machines with gel electrophoresis and detection equipment
iii. Real Time PCR (RT-PCR) machines, with computerized software to support detection and results output.
iv. There should be demonstrated capacity for molecular existing, either using in-house molecular tests or commercial reagents for some of the most common infectious agents and genetic/non-communicable diseases.
v. HIV Viral Loads
vi. Hepatitis B viral load
vii. Protein Biotechnology; expression, purification, western blotting, quantification methods
viii. Nucleic acid biotechnology

4. Histopathology Laboratory

Capacity in the Histopathology Laboratory should include;

i. Histological preparation of samples
ii. Basic staining of samples by Haematoxylin and Eosin

iii. Autopsies/ Post mortems
iv. Immuno-histochemical staining of tissues and cells
v. Histology
vi. PAS
vii. PAP Smear
viii. Histological Tissue analysis
ix. Cytology

5. Immunology Laboratory

i) CD3, CD4, CD8 Flow Cytometry
ii) CD4/CD8 Ratio Flow Cytometry
iii) Immunoagglutination / Immunoprecipitation tests for common immunological markers e.g. Rheumatoid Factor, C-reactive proteins
iv) Immunoglobulin fractional analysis
v) ELISA and related assays capabilities
vi) Immunoblots, Western blots
vii) TPHA
viii) O-H antigens

6. Hematology and Transfusion Science Laboratory

Should be able to do most of the following;

i. Complete blood count/Full haemogram analysis
ii. Peripheral film analysis
iii. Hemoglobin estimation
iv. Hemoglobin electrophoresis
v. Erythrocyte sedimentation rate
vi. Immunological tests: Comb's test
vii. Reticulocyte count

7. Clinical Chemistry Laboratory

The Clinical Chemistry Laboratory should be able to do the following;

i. Basic blood biochemistry
ii. Creatine kinase
iii. Inflammatory markers
iv. Arterial Blood Gas analysis
v. Cortisol and short Synacthen test
vi. HbA1C
vii. Lipid profile
viii. Organ/Tissue Function Profile tests; Liver Function Tests, Renal Function Tests, Lipid Profile, Cardiac Profile, Pancreatic Function Tests, Bone Profile, Thyroid Function Tests
ix. Electrolytes
x. Blood gasses
xi. Metabolic Profile

xii. Fertility Hormones
xiii. Urine Chemistry
xiv. Immunofluorescent chemistry tests for common Infectious Diseases and markers of inflammation tests; C-reactive protein,
xv. Amylase
xvi. Drug levels, including therapeutic and drugs of abuse
xvii. Fluid analysis: pleural, cerebro-spinal fluid, ascitic, Urine

4.4 Clinical Laboratories (for Clinical Practice Attachments)

While the School offering MMLS/T may operate a section or all of the laboratories in 4.3 above, it may not have adequate capacity to impart clinical experience to the learners. The school therefore is mandated to operate a program for practical clinical attachments to Clinical Laboratories. A Clinical Laboratory for the MMLS/T programmes shall demonstrate the following as capacity for training laboratory specialists:

A. Human resources:

- ✓ Specialist(s) in the areas; at least one of whom should have been in practice for at least three years.
- ✓ A Clinical Practical Attachment Programme coordinator
- ✓ Administrative support personnel for the program

B. Work Load

- ✓ The Clinical Laboratory should have a minimum of 25 test requests per week within the specialty of the attached learner(s). The exception is the Histopathology and Molecular Laboratories that shall at least have 10 requests per month.
- ✓ The Laboratory shall provide an opportunity for the trainee to progress through areas of increasing complexity.

C. Laboratories. Shall demonstrate laboratory capacity as described under Section 4.3. Clinical attachment Laboratories should have an appreciable level technological complexity in assays/equipment/procedures. Complimentary and or back-up procedures/assays should be available to enable learners appreciate procedures from first principles, through the more advanced or recent advances.

D. Other Facilities

An attachment laboratory shall have the following physical facilities appropriate to the number of students.

- ✓ Study rooms
- ✓ Call rooms
- ✓ Seminar rooms
- ✓ Staff Rooms

Note:
Where the proposed clinical laboratory is used by other medical laboratory training schools

for attachment programs, the laboratory capacity should be able to accommodate the programme in addition to the existing programmes. A School of Medical Laboratory Sciences proposing to use a laboratory it does not own should demonstrate written evidence of the existing collaboration, which should be explicit on its role in determining the suitability of the training environment for the programme.

STANDARD 5: STUDENTS' SUPPORT SERVICES

Benchmark standards

1. The institution shall ensure that students have access to resources to support their laboratory education, health and wellbeing. These shall include
   a. Academic support and Counseling services
   b. Mentorship
   c. Career Guidance and advise
   d. Recreational, sports, cultural and spiritual support.
   e. Health Care
   f. Occupation health services.
   g. Tutorial and duty rooms for the on-call students.
2. The institution shall support MLAB students to develop the professional values, knowledge, skills and behaviours required of all laboratory specialists working in East Africa
3. Mechanisms must be put in place to promote immunization and regular testing of students, academic staff and appropriate support against infectious diseases, such as mumps, measles, rubella and hepatitis B, prior to contact with patients and/or infectious objects or materials, in an effort to minimize the risk to patients and dental personnel.
4. The institution shall provide learning opportunities that allow MLAB students to meet the requirements of their curriculum and training programme
5. Institutions shall put in place systems and mechanisms to minimise the adverse effects of fatigue and workload among MLAB students.
6. Learners must receive timely and accurate information about their curriculum, assessment and clinical placements
7. Learners whose progress, performance, health or conduct gives rise to concerns must be supported where reasonable to overcome these concerns and, if needed, given advice on alternative career options.
8. The institution shall support every learner to be an effective member of the multi-professional team by promoting a culture of learning and collaboration between specialties and professions.
9. Students should have protected time for learning while undertaking academic training whether clinical or non-clinical activities in order to enable them meet the requirements of their curriculum.
10. In timetabled educational sessions, MLAB students should not be interrupted for service unless there is an exceptional and unanticipated clinical need to maintain patient safety

11. The students should have accessible and affordable services including affordable cafeteria, on-call rooms, printing and photocopies services as well as counseling services.
12. Institutional leaders shall ensure availability of a comprehensive student handbook that includes among others information on:
    a. Programme aims and objectives
    b. Learning outcomes
    c. Learning materials and resources
    d. Mechanisms for Feedback and supervision
    e. Assessment policies and guidelines
    f. Course requirements
    g. Examination guidelines
    h. Fees and bursaries
    i. Available faculty and staff for teaching and student administrative support
    j. Academic, personal and technical support for students.

STANDARD 6: RESEARCH AND INNOVATION

There must be evidence of scholarly activity among students and staff.

Benchmark Standard

1. Students and staff must be given the opportunity to participate in research.
2. There shall be a research coordinating office.
3. There shall be in place integrated research laboratories.
4. There shall be in place an institutional research policy
5. There must be in place an established research and ethical review committee

Guidelines

a. The School or Department offering Master of Medical Laboratory Sciences shall show evidence of promoting quality research and innovation in medical and related health sciences.
b. The Medical Laboratory Sciences School or Department shall have thematic research areas in line with its institutional research policy and aligned to the current national research policy.
c. The Medical Laboratory Sciences School or Department shall encourage, promote, and engage in innovative medical research consistent with its policies and strategic plans, and address national, regional, continental, and international needs.
d. The School or Department shall have a budget for research.
e. School or Department shall document and disseminate its research outputs.

STANDARD 7: COLLABORATION, PARTNERSHIPS AND COMMUNITY ENGAGEMENT

Standard

The School of Medical Laboratory Sciences shall have mechanisms that promote collaboration with other Schools of Medical Laboratory Sciences, Medical Schools, Institutions, professional bodies, research institutions and relevant social actors at national, regional, continental and international levels. The School o Medical Laboratory Sciences shall promote community engagement in all its activities.

Guidelines

The institution should have policies that promote the collaboration, partnerships as well as mobility of students and staff.

STANDARD 8: MASTER OF MEDICAL LABORATORY SCIENCE DEGREE PROGRAMMES

8.1 Modes of Conducting Master of Medical Laboratory Sciences Degree Programmes

The Master of Medical Laboratory Science/Technology Degree Programme shall be offered on full time and shall consist of taught courses, Clinical Laboratory apprenticeship and a dissertation arising out of a candidate's research undertaking. The dissertation shall be written in accordance with the institutional standards; which must conform to Benchmarks for Graduate Studies in Uganda. The dissertation shall be examined by both an internal and external examiner appointed in accordance with the institutional regulations.

8.2 Programme Name, Award, and Graduation Load

Programme Name(s)	Master of Medical Laboratory Science Degree Programme OR Master of Medical Laboratory Technology Programme
Award	Master of Medical Laboratory Science in short (MMLS) OR Master of Medical Laboratory Technology (MMLT)
Duration	A minimum of two years.

8.3 Programme Aim, Objectives and Learning Outcomes

8.3.1 MMLS/MMLT Programme Aims

Any MMLS/MMLT degree programme should be designed in order to produce specialists who will

1. Provide high quality diagnosis and care for patients in hospital and in the community;
2. Demonstrate independent practice, knowledge, clinical and technical skills in diagnostic services, professional behavior and leadership skills;
3. Have a basic understanding of health services management, quality improvement and patient safety in health care practice;
4. Demonstrate ability to pursue research and continuing learning and professional development.

8.3.2 Expected Learning Outcomes

At the end of the MMLS/T programme, the graduate specialist should be able to:

1. Perform thorough and efficient Laboratory diagnostic examinations and communicate effectively with the clinicians, patients and colleagues in a logical, organized and thorough manner;
2. Integrate clinical notes and results of laboratory investigations to appropriately interpret and use laboratory investigations and other data to support clinicians in arriving at accurate assessments and management decisions for the patient;
3. Seek appropriate consultation with colleagues and seniors in the provision of comprehensive high quality of diagnosis and care to the patient;
4. Perform with proficiency both routine and advanced laboratory procedures relevant to the specialty;
5. Observe medical- ethical principles and legal issues and their application in practice;
6. Critically review of literature to inform their practice;
7. Assess the unique health care needs, Laboratory presentations, key management strategies and the importance of an interdisciplinary approach to specific patient populations and clinical problems.
8. Conceptualize and conduct hypothesis-driven basic and operational research that adds scientific knowledge in the field as well as better patients' outcomes.

8.4 Admission Requirements

8.4.1 Minimum Admission Requirements

Benchmark Standards

a. Be a holder of a Bachelor of Medical Laboratory Science/Technology or its equivalent recognized by the National Council for Higher Education (NCHE)
b. The candidate must have at least 1 year of post-graduation laboratory work experience.

c. The candidate must be registered with or registrable by the Allied Health Professionals Council (AHPC) or equivalent body of another country, with a current practicing license or Gazetted or possessing an official waiver from AHPC or equivalent body from another country.
d. If the applicant's language of instruction was not English, s/he shall demonstrate evidence of English language proficiency appropriate for medical education.

8.4.2 Credit Accumulation and Transfer and Exemptions

Benchmark Standard

Credit transfers and exemptions shall be accepted for purposes of student mobility and recognition of prior learning.

Guidelines

a. The School of Medical Laboratory Sciences/Technology shall have an approved credit transfer and exemptions policy, which is in line with NCHE requirements.
b. Transfer students shall meet the minimum admission criteria as set up in this standard/document.

8.4.3 Student Enrollments

Benchmark Standard

The NCHE shall, at accreditation, determine the number of students to be enrolled per year. While determining annual enrollment, consideration shall be given to a full cycle period when students would use human and physical resources in all years.

Guidelines

a. The programme document should indicate the proposed number of students the School of Medical Laboratory Sciences/Technology intends to enroll every year.
b. The enrollments shall match with the infrastructure, human resource requirements, placements and other requirements.

9.5 Duration of Candidature

Benchmark Standards

a. The minimum duration of candidature for any specialty in Medical Laboratory Sciences/Technology shall be 2 years.
b. The maximum duration of candidature for a student shall be (n+2) years where n is the duration of the specialty as provided for in the accredited programme document.

8.6 Programme Structure

8.6.1 The Curriculum

The programme curriculum document informs students and other stakeholders about the full programme content which includes the goal, full curriculum content, examination and quality assurance processes. Programme designers are therefore required to ensure that the proposed programme

- is broad-based or integrated
- is practical oriented;
- is diversified;
- does not compromise the standards of excellence expected of the medical laboratory profession.
- contributes to the overall national human resource development and requirements as well as the national development plan.

The level of content of the Master's Degree programme shall show a progression beyond the bachelors' degree level and not a mere repetition or just a wider coverage of concepts at the undergraduate level.

The chosen teaching approaches shall be commensurate with the expected master's standards. It is also necessary that every programme embed mechanisms to ensure continuous quality of standards.

Benchmark Standards

a. The institution shall consult with all relevant internal and external stakeholders when designing and revising MMLS/T graduate programmes.
b. The programme goals, objectives and learning outcomes shall be consistent with the vision and mission of the School of Medical Laboratory Sciences
c. The programme aims, objectives and learning outcomes shall encompass provisions for medical training or support to enable MMLS/T students acquire skills in problem identification, problem solving, Laboratory bench procedures, multi-tasking and publication of research outcomes.
d. The programme goals, objectives and learning outcomes shall encompass creativity in the application of knowledge and skills in the practice of the profession of Medical Laboratory Science/Technology.
e. The programme shall be benchmarked against professional medical laboratory science/technology standards in the country, the region and internationally.
f. The programmes shall be reviewed and submitted to NCHE for re-accreditation every after seven years. In this period, the School of Medical Laboratory Science shall undertake self-assessment and peer assessment before application for re-accreditation. The peer review team shall be nominated by NCHE at the cost of the institution.

8.7 Cross-Cutting Courses

Benchmark Standards

a. Every institution offering MMLS/T programmes shall have common/cross-cutting courses as indicated in Table 1 below.
b. The common/cross-cutting courses offered in combination with other topics/courses should be allocated adequate time to impart skills and achieve desirable outcomes in the learners.

Table 1: Cross-cutting courses for MMLS/T Programme

A. COMMOM/CROSS-CUTTING COURSES
1. Principles of Epidemiology & Public Health
2. Biostatistics
3. Research Methods and Scholarly Writing
4. Bio-Ethics and Professionalism
5. Principles of Procurement and Laboratory Management
6. Laboratory Quality Management Systems
7. Principles of Entrepreneurship
8. Pedagogy

8.8 Specialty Tracks for the Mmls/T Programme

Benchmark standards

a. Every institution offering MMLS/t programme, depending on the infrastructure and human resources capacity shall offer any one or more of the specialty tracks as indicated in Table 2 below.

NOTE: This minimum standard is cognizant of the evolving nature and maturation of the profession of Medical Laboratory Science/Technology. Particularly the Medical/Clinical Microbiology specialty has sub-specialties that are transitioning into fledged specialties of their own; Parasitology and Entomology, Virology and Medical Mycology. Equally the Specialty of Molecular Biology has the Medical Genetics, Bioinformatics, and Histopathology has cytology (cytotechnology) in transition.

b. Institutions that wish to offer any of the emerging sub-specialties of Medical Laboratory Science/technology as stand-alone specialty tracks within their MMLS/T programmes may do so. In such a case strong and demonstrated gap in the national or regional market for such a specialist, informed by relevant stakeholders must be convincing.
c. Where the MMLS/T programme being offered is multi-track, the institution shall define within the curriculum the time-point at which learners shall chose their preferred specialty track.
d. The qualification awarded to the learner upon graduation (see 9.2) shall bear a suffix indicating the specialty of the graduate.

Table 2: Specialty Tracks for the MMLS/T Programme

B. SPECIALTY TRACKS FOR MMLS/T
1. MEDICAL/CLINICAL MICROBIOLOGY
Sub-Specializations
i. Bacteriology
ii. Parasitology and Entomology
iii. Virology
iv. Medical Mycology
2. MOLECULAR BOLOGY
Sub-Specializations
i. Cell Biology
ii. Biotechnology
iii. Bioinformatics
iv. Medical Genetics
3. IMMUNOLOGY
4. HAEMATOLOGY AND TRANSFUSION SCIENCE
5. CLINICAL CHEMISTRY
6. HISTOPATHOLOGY AND CYTOLOGY

8.9 Elective/Other Courses

This minimum standard does not give courses to be offered as electives within the MMLS/T programmes. Training institutions have the liberty to formulate/innovate courses of their own that make their MMLS/T programmes competitive and novel.

8.10. Indicative Content and Brief Description of Courses

This standard provides mostly the expected learning outcomes for each course, and the indicative content. Minimal description of the course is provided where necessary. The learning outcomes and the indicative content should give training institutions enough room to develop competitive, innovative MMLS/T programmes unique to their institutions, but within the confines of this standard.

9.1 COMMON/CROSS-CUTTING COURSES

i. Principles of Epidemiology & Public Health

Learning Outcomes

By the end of the module, students should be able to:

1. Describe and discuss the application and scope of epidemiological research
2. Define, calculate and interpret epidemiological measures, including measures of disease frequency, measures of association and measures of population impact
3. Plan, discuss and evaluate epidemiological study designs and analytical strategies
4. Describe the uses and limitations of different data sources in the context of epidemiological and public health measures
5. Express and describe the key concepts, implications and approaches to address random error, bias, and confounding in the context of epidemiological and public health research and study design
6. Discuss the concepts of reliability and validity
7. Evaluate the results and interpretation of published epidemiological research
8. Describe strategies for causal inference in epidemiological research
9. Critically discuss the nature and scope of the public health approach
10. Describe the influence that social and environmental factors can have on health and disease
11. Distinguish a number of different approaches to management of public health problems and determine when each might be most appropriate
12. Calculate measures of population impact and understand the strengths and limitations of these measures
13. Assess a proposed early detection or screening programme against appropriate criteria
14. Understand the principles of healthcare, public health financing and healthcare organization
15. Demonstrate an understanding of the core influences on public health and healthcare policy
16. Discuss the ethical implications of different public health approaches

Indicative Content;

This course should cover the major concepts in Epidemiology and Public Health. The coverage should include;

1. **Epidemiology**
   - Epidemiologic Terms and Concepts
   - Descriptive Epidemiology
   - Analytical Epidemiology
   - Observational Studies:
   - Interventional Studies:
   - Bias
   - Error

- Variable Associations and Causality
- Sensitivity and Specificity
- Disease surveillance/monitoring
- Disease Outbreak Investigation

2. **Public Health specific**
   - Environmental risks and impact on public health
   - Concepts in environment health
   - Climate change, impact on populations and community resilience
   - Nutrition and food safety
   - Management of Health Systems
   - Public health programming and evaluation
   - Survival analysis
   - Diseases of public health importance in Uganda and East African region
   - Health promotion
   - Disease control
   - Health Economics
   - Occupation Health Safety
   - Health promotion. Health education, health advocacy
   - Emergency medicine and first aid

ii. Biostatistics

Learning Outcomes

At completion of this course, learners will be able to;

1. Understand sampling variation in the context of population health studies
2. Select, perform and interpret appropriate descriptive and regression data analyses of population health data
3. Perform standard sample size and power calculations
4. Develop capacity to use most common data analysis tools such as R and STATA.

Indicative Content;

- **Introduction to Biostatistics**
  - √ Scales of measurement
  - √ Frequency distribution and other data presentation
  - √ Measures of Central Tendency, Variation, Position Probability
  - √ Distributions: Normal Distribution

- **Standard Normal Distribution**
  - √ z values and tables
  - √ Introduction to Hypothesis testing
  - √ Introduction to Statistical inference

- **Sampling Distribution**
  - √ Confidence interval for proportion and mean,
  - √ One/Two sample inference,

- √ Independent samples /paired test, Sample size calculation,
- √ Analysis of categorical data: Chi square/Fishers

- **Data analysis**
  - √ Presenting baseline characteristics
  - √ Introduction to Correlation and Linear regression,
  - √ Assessment of the linearity, independence, normality and equality of variances assumptions, Multiple linear regression, assessment of multi-collinearity

iii. Research Methods and Scholarly Writing

Learning outcomes

By the end of this module, learners shall be able to;

1. Plan a research project, including development of a research question, implementation of a systematic search strategy and production of a research protocol and analysis plan
2. Critically review published research papers/literature using appropriate methods
3. Demonstrate awareness and understanding of the regulatory frameworks and ethical issues related to health research
4. Understand the publication, peer review and funding processes
5. Communicate research findings clearly to different audiences, and design an appropriate strategy for achieving impact from population health research findings

Indicative Content

- **Research Methodology**
  - √ Theoretical and Philosophical Orientations
  - √ Clarifying The Research Topic
  - √ Critical Review of Existing Literature
  - √ Defining a problem of study
  - √ Hypothesis generation
  - √ Research Designs
  - √ Measurements and Scaling Techniques
  - √ Questionnaire and research Forms/tools Design and development
  - √ Sampling Designs and Procedures
  - √ Selecting a study population
  - √ Data Collection and Analysis

- **Scholarly Writing**
  - √ Reading and writing Skills
  - √ Technical aids to assist in scientific writing
  - √ Styles and types of writing
  - √ Referencing
  - √ Dissertation Production at Masters Level
  - √ PowerPoint preparation
  - √ Presentation skills

- **Publication Skills**
  - √ What is 'scholarly activity'? What is 'publishing'?
  - √ Structuring Journal Articles.
  - √ Abstract writing for reports and conferences
  - √ The journal submission process
  - √ Data presentation for publication;
    - tables, charts, images/pictures, figures
  - √ Selection of a journal
  - √ Journal article Peer-review process.
  - √ Peer review of conference papers.

IV. Bioethics and Professionalism

The course will address issues of medical ethics and professionalism encountered during clinical training, practice and research.

Learning outcomes

By the end of this module, learners will be able to;

1. Know and abide by the codes of conduct for Medical Laboratory profession as well as the AHPC regulatory statutes.
2. Appreciate the international and national bioethics for conducting research
3. Appreciate cultural differences and health practice
4. Practice their profession in and alongside other professions
5. Work on patients with special needs

Indicative Content

The course should cover the following areas:

- √ Code of professional practice
- √ Ethical obligations
- √ Standards of professional practice
- √ End of life issues including withholding life sustaining treatment
- √ Cross-cultural and religious issues that affect health, ethics and human rights.
- √ Ethical dilemmas encountered in clinical practice
- √ Research ethics
- √ Inter-professional and multi-disciplinary relationships
- √ Rights of patients
- √ Roles and responsibilities of medical councils and Associations.
- √ Mentorship
- √ Human rights
- √ Communication
- √ Child rights
- √ Teaching ethics
- √ Incompetent and vulnerable patients

V. Principles of Procurement and Laboratory Management

Learning Outcomes

By end of this module, learners should be able to;

1. Draw periodic plans for the laboratory or contribute to their institutional planning cycle.
2. Chose and apply different leadership and management skills in their work environments
3. Set up, promote and manage effective teams in the laboratory
4. Optimize operations in the laboratory to achieve organizational goals in a timely manner.
5. Draw and follow a procurement plan
6. Manage and evaluate the laboratory's supply chain, including periodic evaluation of suppliers.
7. Source for various equipment and consumables that provide value or money to the laboratory.
8. Identify tools and resources that are most suitable for each stage of contract management.
9. Appreciate national and international procurement best practices, governing laws/ policies such as PPDA guidelines.

Indicative Content

- **Operations and Processes Management**
  - √ Strategy Development
  - √ Planning and Control
  - √ Operational Improvement
  - √ Objective Setting
  - √ Organization of Work

- **Leadership and Change Management**
  - √ Performance Management
  - √ Effective Teams
  - √ Leadership
  - √ Change Management

- **Managing Teams and Human Resources in the laboratory**
  - √ Principles of human resource management
  - √ Organizational behavior
  - √ Communication skills for manager
  - √ Group dynamics
  - √ stress management
  - √ Entrepreneurial development
  - √ HR information systems

- **Finance Management in the Laboratory**
  - √ Financial Management
  - √ Financial Statements
  - √ Budgets
  - √ Controlling Costs
  - √ Making Financial Decisions

- **Introduction to procurement**
  - √ Legal framework of organizations
  - √ Fundamentals of accounting
  - √ Quantitative methods for business
  - √ Development economics

- **Management theory and practice**
  - √ Supplies management
  - √ Risks management
  - √ Managerial economics
  - √ Operation management
  - √ Marketing management
  - √ Business computing.

- **Logistics management**
  - √ Introduction to supply chain management
  - √ The management component of supply chain management
  - √ Electronically linking the supply chain
  - √ Supply chain performance measurement
  - √ Developing and implementing partnership in the supply chain
  - √ Implementing supply chain management

VI. Laboratory Quality Management and Systems

Learning Outcomes

By end of this module, Learners shall be able to;

1. Develop and implement a laboratory quality management system for their institutions
2. Create, implement and evaluate a quality control and quality assurance program for the laboratory
3. Conduct internal audits/assessments of their laboratory quality systems
4. Perform root-cause-analysis and address nonconformities identifies in their laboratory quality management system.
5. Appreciate the importance and implement an effective equipment management system for the laboratory.
6. Implement good clinical laboratory practices.
7. Appreciate and implement good documentation practices in the laboratory.

Indicative Content

- **Introduction to quality**
  - √ The importance of laboratory quality
  - √ Overview of the quality management systems
  - √ The quality management system model
  - √ International laboratory standards

- **Facilities and safety**
  - √ Laboratory design and geographical and spatial organization
  - √ Physical aspects of premises and rooms
  - √ Safety management programme and risks identification
  - √ Personal protective equipment, emergency management and first aid

- **Equipment**
  - √ Selection, acquisition and calibration of equipment
  - √ Implantation and maintenance programme
  - √ Troubleshooting, service, repair and retiring equipment

- **Purchase and inventory**
  - √ Implementing purchase and an inventory programme
  - √ Quantification, forms and logs
  - √ Receipt and storage of supplies
  - √ Monitoring inventories

- **Process control and sample management**
  - √ The laboratory handbook
  - √ Sample collection, transport, preservation, processing, storage, and disposal

- **Introduction to quality control**
  - √ Control materials
  - √ Establishing the value range for control material
  - √ Graphical representation of control ranges
  - √ Interpreting quality control data and using quality information
  - √ Control strains
  - √ Quality control materials

- **Assessment Audits**
  - √ Internal and external audit programmes
  - √ Proficiency testing
  - √ Managing external quality assessment in the laboratory
  - √ Assessment norms and accreditation

- **Personnel**
  - √ Recruitment and orientation
  - √ Competency and competency assessment
  - √ Training and continuing education
  - √ Employee performance appraisal

- √ Personnel records

- **Customer service**
  - √ The laboratory clients
  - √ Assessing and monitoring customer satisfaction

- **Documents and records**
  - √ Documents overview
  - √ The quality manual
  - √ Standard operating procedures (SOPs)
  - √ Document control, overview and storage of records

- **Information management**
  - √ Elements of information management
  - √ Manual paper-based systems
  - √ Computerized laboratory information systems
  - √ Investigations of occurrences
  - √ Rectifying and managing occurrences

- **Organization**
  - √ Organizational requirements for a quality management system
  - √ Organizational structure and functions (planning and implementation)
  - √ Management role
  - √ The laboratory quality manual

VII. Entrepreneurship

Learning Outcomes

By the end of this module, the learner should be able to;

1. Draw an effective business plan
2. Appreciate concepts entrepreneurship including business types and wealth creation
3. Understand the importance of best practice, opportunities, constraints in setting up and managing an enterprise.
4. Do feasibility studies and market surveys to inform decision making for investments.
5. Implement entrepreneurial activities in the most socially acceptable ethical mindset.

Evaluate current and emerging opportunities in the laboratory sector and manage competently manage all aspects of a laboratory enterprise.

Indicative Content

- **Introduction to entrepreneurship**
  - √ Definitions (Entrepreneurship, Business, Investment, Success, Entrepreneur,)
  - √ The concept of wealth
  - √ The entrepreneurial mindset

- √ Pathways to entrepreneurial ventures
- √ Entrepreneurial business types (Franchises, buy-outs, family businesses; SMEs,)
- √ Self-employment, from formal to self-employment
- √ Entrepreneurship within organizations

- **Ideas and opportunities**
  - √ Identifying need and opportunity
  - √ Generating a business idea, locating a business idea, expanding the idea
  - √ Feasibility analysis and Environmental scan
  - √ Competitive assessment
  - √ Design thinking
  - √ Opening a new business/setting up a business
  - √ Profitability
  - √ Conducting internal external analyses
  - √ Traditional and emerging business and investment fields/ventures

- **The Business plan**
  - √ Business models
  - √ Purpose, Components, Presentation, pitching,
  - √ Matching a business plan to the needs of the firm

- **Capital**
  - √ Sources of capital, Borrowing and interest rates
  - √ Sources of financial information
  - √ Savings in starting and maintaining business
  - √ Financial planning and management
  - √ Budgeting
  - √ Inventory
  - √ Portfolio investments – shares, bonds, debentures
  - √ Balance sheets, income and expenditure sheets

- **Legal/Regulatory environment for businesses**
  - √ Business ownership (Sole proprietorship, partnerships, joint ventures, companies)
  - √ Starting and registering a business
  - √ Taxes and taxation
  - √ Overview of Company law
  - √ International business laws
  - √ Contracts, property rights
  - √ Laws governing credit

- **Managing a business**
  - √ A successful manager
  - √ Goal setting and strategic planning
  - √ Entrepreneurial activities and management functions
  - √ Reporting, monitoring and evaluation in business
  - √ Decision making, Management meetings
  - √ Building a viable product
  - √ Public relations

- √ Succession
- √ Organizational chart, structure and hierarchy
- √ Financial statements
- √ Support networks and networking
- √ Risk management and resilience, reacting to hardships and setbacks, overcoming obstacles
- √ Human Resource Management (Recruiting, job descriptions, training, appraising, motivation, retreats and team building)
- √ Growing a business; Managing growth and expansion
- √ Important documents
- √ Tenders and tendering; Preparation and use of tender documents

- **Marketing**
  - √ Selecting a market strategy
  - √ Conducting a market survey
  - √ Customer identification
  - √ Assessing product demand
  - √ Promoting the business, Advertising
  - √ Understanding and reaching the target market
  - √ Pricing strategies
  - √ Promotional campaigns, branding
  - √ Establishing and strengthening culture

- **Personal evaluation**
  - √ Characteristics, traits and skills of a successful entrepreneur
  - √ Learned entrepreneurial traits
  - √ Personal/self-assessment
  - √ Personal potential as an entrepreneur
  - √ Personal development plans

- **ICT in entrepreneurship**
  - √ Financial management systems
  - √ Payrolls
  - √ Money transfers and payment systems
  - √ Matching skills and resources to changing technology
  - √ Business websites and Social media in business

- **Social impact and entrepreneurship**
  - √ Social and ethical entrepreneurship
  - √ Sustainable entrepreneurship
  - √ Women entrepreneurs
  - √ Environmental impact assessment

- **Innovation**
  - √ Corporate innovation
  - √ Successful corporate innovators
  - √ Innovation through acquisition
  - √ Business incubation

VIII. Pedagogy

Learning outcomes

At the end of this module, the learner will be able to;

1. To prepare a lesson plan appropriate for the type of audience
2. Chose teaching techniques and teaching aids appropriate for the audience.
3. Gather and meet student's expectations.
4. To chose an appropriate method of assessing learning and knowledge transfer.

Indicative content

- **Learning**
  - √ Lesson planning
  - √ Theories of learning
  - √ Principles of adult learning
  - √ Learning styles

- **Teaching techniques**
  - √ Small group teaching
  - √ Large group teaching
  - √ Presentation techniques
  - √ Special needs teaching

- **Assessment**
  - √ Types of assessment
  - √ Methods of assessment
  - √ Assessment planning
  - √ Validity and reliability
  - √ Workplace based assessment

- **Skills training**
  - √ Inter professional skills training
  - √ Effective clinical supervision

9.2 Specialty Tracks and Courses

I. MEDICAL/CLINICAL MICROBIOLOGY

Sub-Specialties and Indicative Content

i. Bacteriology

Learning outcomes

This course will enable learners to;

1. Analyze specimens for microorganisms
2. Identify microorganisms such as bacteria up to species, types, strain level
3. Discuss the epidemiology and control of bacterial infections in the community and environment.
4. Describe the pathogenesis, pathogenicity and laboratory diagnosis of common pathogenic bacteria.
5. Prepare specimen containers for bacteriological analysis.
6. Interpret results of microbiological investigations
7. Prepare quality control strains
8. Prepare and quality control various stains and perform different staining techniques for identification of microorganisms.
9. Prepare and quality control culture media
10. Culture specimens on appropriate culture media and conditions
11. Make choice of culture media for different samples and procedures
12. Describe the principles and methods of various laboratory procedures used in the analysis of samples plus how to interpret the results correctly

Indicative content

- **Basic principles of bacteriology**
  - √ Introduction to microbiology, historical development of microbiology and scope of bacteriology
  - √ Major groups of pathogenic microorganism
  - √ Bacterial Pathogenicity and virulence, host defense mechanisms
  - √ Bacterial Genetics, Nutrition and Growth
  - √ Principles and staining theories of basic and special bacteriological stain
  - √ Bacteriological Culture media; properties and preparation
  - √ Bacterial culture methods; types, performance and application
  - √ Incubation methods of bacteria; Types, performance and applications
  - √ Routine bacteriological examinations of specimens: Collection, transportation and examination
  - √ Safety precautions in bacteriology
  - √ Sterilization and disinfection; Principles, Preparation, application

- **Systemic bacteriology**
  - √ Biological Classification of bacteria of medical importance
  - √ Clinical diseases of bacteria of medical importance
  - √ Morphology and Physiology of bacteria of medical importance
  - √ Pathogenesis and pathogenicity, Infection, spread and symptoms, diagnosis, treatment and management of bacteria of medical importance;
    - o Gram positive cocci: Staphylococcus, Streptococcus
    - o Gram positive rods: Clostridia, Bacillus, Corynebacteria, Listeria, Gardnerella
    - o Gram negative cocci: Neisseria species
    - o Gram negative rods: Pseudomonas, Enterobacteriaceae, Brucella, Haemophilus, Yersinia, Legionella
    - o non grammable bacteria: Mycobacteria spp, Treponema
  - √ Laboratory diagnosis of bacteria of medical importance
  - √ Epidemiology and control of bacterial infection in the community and the

environment.

- **Diagnostics in bacteriology (contemporary and advanced Methods)**

Learning outcomes

This course will enable learners to;

1. Perform and interpret blood/other bodily fluid culture using automated and semi-automated culture systems
2. Perform drug susceptibility/resistance testing using automated systems
3. Perform microbial detection using Probe based assays
4. Perform and interpret biochemical and phenotypic profile based identification tests
5. Perform and interpret microarray based microbial identification assays
6. Perform the MALDI-TOF assay for rapid bacterial identification
7. Perform PCR and its variations for microbial detection and characterization

Indicative concepts

√ Safety aspects of microbiology lab and handling of microbiology equipment & tools
√ Biochemical and phenotypic profile based microbial identification and detection
√ Conventional and Automated culture and identification
√ Conventional and Automated drug susceptibility testing
√ Advanced Rapid Bacterial Characterization and Identification: MALDI-TOF Mass Spectrometry, Probe based, PFGE
√ Application of Real-Time PCR Based on FRET Technology
√ non PCR targeted amplification techniques
√ Rapid Screening and Identification of MRSA, Mycobacteria

- **Antibiotic and Chemotherapeutic agents**

Learning outcomes

This course will enable learners to;

1. Perform and interpret antibiotic susceptibility assays using automated and non automated methods
2. Apply molecular techniques in detection of resistance genes
3. Perform drug residue testing using advanced techniques such Enzyme Immunoassays and high Performance Liquid Chromatography (HPLC) and Radioimmunoassay.
4. Prepare and standardize local antibiotic discs
5. Establish antibiotic policy in a hospital setting laboratory
6. Conduct Laboratory Quality Audit of antibiotic policy

Indicative concepts

√ Introduction to antibiotics and chemotherapeutic agents; definitions and classification of antimicrobial agents.
√ Origin and modes of action of antibiotics and chemotherapeutic agents and their

application
- √ The problem of resistance, definition of resistance, mechanisms of antibiotic resistance (Genetic and non genetic basis)
- √ Antibiotic Combination therapy; Performance and its application
- √ Role of laboratory in diagnosis, treatment and control of AMR
- √ Internal quality control and External Quality Assessment schemes in the management of antibiogram utilization
- √ Antibiotic policies; stimuli for introduction of antibiotic policies, methods for implementation of antibiotic policies, methods for evaluation of interventions to improve professional practice
- √ Preparation and QC of local antibiotics

- **Advanced public health bacteriology**

Learning outcomes

This course will enable learners to;

1. Prepare containers for sample (milk, water, sewage and sewage effluents, foodstuffs and beverages) collection appropriately.
2. Carryout the sampling of different samples for bacteriological examination correctly.
3. Perform and interpret the bacteriological examinations accurately of water, sewage, milk, canned food, ice-cream, air, foodstuffs of food poisoning)
4. Perform Viable counts and interpret the findings appropriately
5. Perform Quantitative examination of water using Compartment Bag Test and INDEX Colilert methods
6. Carryout laboratory investigations in outbreaks of diseases of public health importance
7. Perform the isolation and identification of specific pathogens in Water, Milk and foodstuff samples.
   - √ Bacterial pathogens of public health importance: Transmission, spread, prevention and control
   - √ Principles of Biosecurity and Biosafety
   - √ Investing an epidemic
   - √ Laboratory Preparedness in in epidemic response
   - √ Collection, transportation and examination of Epidemic samples
   - √ Bacteriological Examination Methods, Principles, Performance, interpretation of:
     - o Water and effluents:
     - o Milk and its products
     - o Air
     - o Food (solid, liquid, canned)
     - o Environment

ii. Parasitology and Entomology

Learning outcomes

This course will enable learners to;

1. Identify, describe and contrast unicellular parasites and parasitic worms
2. Describe specific human and non-human parasitic diseases
3. Prepare and observe live parasitic specimens and test students ' own sero-positivity for a particular parasitic infection
4. Report on observations of biological specimens such as parasites
5. Appraise the impacts of parasitic diseases on human societies
6. Evaluate the complexity of the parasite/host relationship (parasite evasion mechanisms vs. host defensive mechanisms)
7. Assemble presentation on a current topic in parasitology (literature search, selection of relevant sources of information, evaluation of the information/data , formulation of the research's results)

Indicative content

- **Introduction to parasitology**
  - √ Definitions and terminologies of parasitology
  - √ History of parasitology
  - √ General characteristics of parasites
  - √ Medical importance of parasitology
  - √ Branches of parasitology
  - √ Type of hosts
  - √ Source of infection
  - √ Modes of infection
  - √ Host-parasite relationship

- **Study of parasites**
  - √ Morphology
  - √ Life cycle
  - √ Pathogenesis of parasites
  - √ Diagnosis
  - √ Treatment
  - √ Transmission
  - √ Prevention and control

- **Parasitology of helminthes**
  - √ Study of Nematodes (structure, classification, growth and development)
  - √ Study of Cestodes (structure, classification, growth and development)
  - √ Study of Trematodes (structure, classification, growth and development)

- **Parasitology of protozoa**
  - √ Study of Mastigophora or Flagellated protozoans (structure, classification, growth and development)
  - √ Study of sarcodina or Amoeboids (structure, classification, growth and development)
  - √ Study of sporozoans (structure, classification, growth and development)
  - √ Study of Ciliophora or Ciliated protozoans (structure, classification, growth and development)

- **Parasitology of arthropods (entomology)**
  - √ Study of Arachnid (structure, classification, growth and development
  - √ Study of Chilopoda (structure, classification, growth and development
  - √ Study of Collembola (structure, classification, growth and development
  - √ Study of Crustaceans (structure, classification, growth and development
  - √ Study of Diplopoda (structure, classification, growth and development
  - √ Study of Diplura (structure, classification, growth and development
  - √ Study of Myriapoda (structure, classification, growth and development

- **Immunology of parasites**
  - √ Parasitic infection biology
  - √ Innate immune responses against parasitic infections
  - √ Adaptive immune responses against parasitic infections
  - √ Pathogen-host interactions

- **Practical parasitology**
  - √ Diagnosis of parasitological diseases
  - √ Clinical diagnosis of parasitic infections
  - √ Sample collection, transport and processing
  - √ Direct examination techniques (direct microscope)
  - √ Parasitological Serology
  - √ Molecular techniques

- **Treatment, management and prevention**

√ Anti-parasite targets
√ Anti-parasite formulation and modes of action
√ Anti-parasite drug resistance development
√ Control and prevention of parasitological infections

iii. Virology

Learning outcomes

This course will enable learners to;

1. Describe and review the elements of the viral life cycle
2. Explain the rationale behind the Baltimore classification system of viruses and present example viruses for each Baltimore group
3. Explain viral replication strategies; and compare and contrast replication mechanisms used by viruses relevant for human disease
4. Explain host antiviral immune mechanisms at a cellular and molecular level d
5. Describe viral strategies to evade host immune and cellular factors (by use of examples of viruses relevant for human disease)
6. Discuss principles of virus pathogenesis
7. Compare and contrast methods used for laboratory diagnosis of viral infections
8. Explain vaccine strategies and mechanisms of antiviral drugs
9. Coherently analyze and report outcomes of virological research in oral and written output

Indicative Content

- **The general structure and composition of viruses**
  - √ Helical
  - √ Icosahedral
  - √ Enveloped
  - √ Complex structure

- **Classification and nomenclature of human viruses**
  - √ The Baltimore Classification of Viruses
  - √ Class I - to - Class VII
  - √ Taxonomic classification
  - √ Virus Families,
  - √ Subfamilies and
  - √ Genera
  - √ Virus families of medical importance;
  - √ Parvoviridae (Parvovirus B19,)
  - √ Papovaviridae (HPV, SV40, BK, JC)
  - √ Adenoviridae (A-F)
  - √ Herpesviridae (Human herpes viruses 1-8, herpesvirus saimiri)
  - √ Poxviridae (Orthopox, Parapox, Molluscipox and Yatapox)
  - √ Hepdnaviridae and Deltavirus (Hepatitis B virus, Hepatitis D virus)
  - √ Retroviridae (HTLV 1 and 2, HIV-1, HIV-2)
  - √ Picornaviridae (enteroviruses, rhioviruses, hepatovirus)
  - √ Paramyxoviridae (RSV, measles, parainfluenza)
  - √ Rhabdoviridae (Rabies, vesicular stomatitis)
  - √ Filoviridae (Ebola, Marburg)
  - √ Orthomyxoviridae (Influenza A, B, C, Thogoto, Dhori viruses)
  - √ Flaviviridae (Hepatitis C, Yellow fever, Dengue, West Nile, Associated haemorrhagic fevers and encephalitis)
  - √ Calciviridae and astroviridae (Hepatitis E, diarrhea associated calciviruses/ astroviruses)
  - √ Reoviridae (Rotavirus, Coltivirus, orbivirus)
  - √ Arenaviridae (Lassa, LCMV, Junin, Machupo Guanarito)
  - √ Togaviridae (Rubella, arboviruses)
  - √ Coronaviridae (SARS, others)
  - √ Bunyaviridae (Rift valley fever, Crimean Congo, Oropouche, Hantaan, others)

- **Viral replication**
  - √ The one step growth curve
  - √ Attachment.
  - √ Penetration.
  - √ Uncoating.
  - √ Replication.
  - √ Assembly.
  - √ Maturation.
  - √ Release.

- **Virus induced changes in cells**
  - √ Cytopathic effects

- **Viral genetics and evolution**
  - √ Viral genomes and gene organization
  - √ Causes of viral genetic evolution
  - √ (Dis)Advantages of viral evolution to the virus
  - √ Viral evolution on diagnostics, pathogenesis and epidemiology

- **Viral Pathogenesis**
  - √ Systemic spread
  - √ Host-virus interactions
  - √ Host resistance to viral infections
  - √ Determinants of virulence
  - √ Mechanisms of disease production
  - √ Viral persistence/Latency mechanisms
  - √ Major viruses of medical importance; Infection, spread, pathogenesis and symptoms, diagnosis, treatment and management
    - o HIV
    - o Measles
    - o SARS CoV-2
    - o Polio
    - o Hepatitis B, C
    - o EBV

- **Immune responses to viral infections**
  - √ Cellular immunity to viral infections
  - √ Humoral/Antibody responses to viral infections
  - √ Systemic inflammation to viruses/Cytokine storms
  - √ Viral immune evasion mechanisms

- **Viral oncogenesis**
  - √ Transforming viruses and associated cancers
  - √ Oncogenic viral proteins and mechanisms of transformation

- **Laboratory diagnosis of viral infections**
  - √ Types of specimens for viral diagnosis
  - √ Specimen collection techniques and containers
  - √ Specimen packaging and transportation,
  - √ Viral culture and isolation systems
  - √ Electron microscopy,
  - √ Specific viral antigen detection tools
  - √ Serological tests
  - √ Molecular techniques for viral diagnosis

iv. Medical Mycology

Learning Outcomes

This course will enable learners to;

1. Describe the basic structure and classification of pathogenic fungi
2. Demonstrate knowledge and understanding of the pathogenesis of various mycoses, their clinical manifestations, diagnosis and management
3. Apply relevant identification techniques and skills in any laboratory settings using moulds or yeasts
4. Demonstrate antifungal susceptibility testing and interpretation
5. Describe fungal-host infection biology and; immunity to fungal infections
6. Describe the WHO fungal pathogens priority list and its impact

Indicative content

- **Introduction**
  - √ Definitions and Terminology in medical mycology
  - √ History of mycology
  - √ Fungi and their general properties
  - √ Beneficial and harmful effects of fungi
  - √ Natural ecology of fungi
  - √ Reproduction in fungi
  - √ Classification of fungi
  - √ Pathogenicity and virulence attributes of fungi
  - √ Fungal diseases
  - √ Fungal diagnostics
  - √ Antifungal chemotherapeutics

- **Fungal Taxonomy**
  - √ Fungal structure
  - √ Medically important fungi
  - √ Systematic mycology

- **Fungal diseases**
  - √ Superficial fungal infections
  - √ Cutaneous and subcutaneous fungal infections
  - √ Deep seated mycoses
  - √ Opportunistic fungal infections
  - √ Mycotoxicosis
  - √ Infectious mycology
  - √ Public health mycology

- **Fungal immunology**
  - √ Fungal infection biology
  - √ Innate immune responses against fungal diseases
  - √ Adaptive immune responses against fungal diseases
  - √ Pathogen-host interactions

- **Practical mycology (fungal diagnostics)**
  - √ Fungal diagnostics
  - √ Clinical diagnosis of fungal infections
  - √ Sample collection, transport and processing
  - √ Direct examination techniques (direct microscope)
  - √ Fungal Serology
  - √ Molecular techniques

- **Treatment, management and prevention**
  - √ Antifungal targets
  - √ Antifungals based on mode of action
  - √ Antifungals based on structure
  - √ Antifungal drug resistance development
  - √ Control and prevention of fungal infections

II. MOLECULAR BOLOGY

Learning outcomes

This course will enable learners to;

1. Demonstrate understanding of core patterns and principles of biology
2. Integrate and apply Knowledge across other scientific disciplines
3. Incorporate contemporary research into existing conceptual framework
4. Synthesize data and draw appropriate inferences
5. Analyze and interpret data and scientific literature
6. Understand how genetic, genomic and microbial techniques are combined to produce products and treatments in industrial, medical and agricultural settings
7. Use electrophoresis, blotting, chromatography and centrifugation equipment
8. Employ nucleic acid hybridization in a range of formats
9. Purify, modify and analyze DNA, RNA and proteins
10. Use microscopy with in situ hybridization, immunocytochemistry and fluorescent protein technologies to analyze gene and protein expression and function
11. Prepare and dispense precisely formulated solutions, even at microliter quantities
12. Conduct, design and troubleshoot experiments
13. Observe and make measurements on organisms
14. Write literature reviews and scientific reports
15. Chart the development of complex microorganisms
16. Collect analyze, interpret and make projections from data
17. Utilize statistical tests in data analysis

Indicative content

- **Introduction to molecular biology**
  - √ An overview of Nucleic acid chemistry, Structure and functions

- √ Extraction of Nucleic acid.
- √ Nucleic acid blotting techniques

- **Polymerase Chain Reaction**
  - √ Basic principle and methods of PCR
  - √ The common PCR types
  - √ PCR contamination control
  - √ PCR diagnostic applications; PCR based methods for mutation detection and alternative method for amplified Nucleic acid Testing

Sub-Specialties and Indicative Content

- **Cell Biology**

Learning outcomes

This course will enable learners to;

1. Describe different types of cells, especially eukaryotic cells; functional and structural similarities and dissimilarities between them.
2. Describe structure and function of important biomolecules, organelles and other cellular components.
3. Understand fundamental facts regarding cellular metabolism, energy transformations and means of communication with other cells.
4. Understand fundamental facts about cellular processes such as intracellular transports, cellular growth and division and programmed death.
5. Use common methods to study cells and organelles in the laboratory.
6. Independently use databases and scientific literature for evaluating information about cellular processes
7. Compile and evaluate cell biological data in writing, suitable for a scientific content
8. Reason about ethical aspects related to animal testing

Indicative content

- √ An introduction to cell theory
- √ The four main types of cells
- √ The chemical composition of the cells
- √ Cellular functions and cell signaling
- √ Cellular reproduction
- √ Cell genetics
- √ Cell metabolism
- √ The cell cycle
- √ The cellular biochemistry

- **Biotechnology**

Learning outcomes

This course will enable learners to;

1. Describe the science of biotechnology and identify its product domains
2. Outline the steps in producing and delivering a product made through recombinant DNA technology
3. Describe how scientific methodologies are used to conduct experiments and develop products
4. Identify the levels of biological organization and explain their relationships
5. Describe cell structure and its significance in biotechnology research and product development
6. Define genetic engineering and identify products created with technology
7. Explain the central dogma of biology and its importance in genetic engineering
8. Explain and give examples of key nutrients, nutrient cycles, photosynthesis and cellular respiration
9. Identify various eating disorders and their causes, as well as the social, cultural and influences on diet
10. Discuss the scope and role of medical biotechnology in the healthcare industry
11. Explain the function of drugs and discuss how they may be created using combinatorial chemistry
12. Explain the methods for synthesizing peptides and oligonucleotides and discuss the uses of each
13. Students will demonstrate an understanding of the commonly used terms in the biotechnology

Indicative content

- √ Introduction to biotechnology
- √ The raw materials of biotechnology
- √ Molecular biology application in Biotechnology
- √ From molecules to cells
- √ Introduction to experimental biology molecular and cellular biology
- √ Microbe, human kind and the environment
- √ Writing and referencing skills
- √ Genome maintenance and regulation
- √ Omic technologies and resources
- √ Fundamentals of microbiology
- √ Science communication
- √ Proteins and the dynamic cell
- √ Post genome biology
- √ Bioethics, contemporary issues in science and Biomedicine
- √ Toxins, toxicants ant toxicity
- √ Molecular biology of cancers
- √ Green biotechnology
- √ Gene regulation and disease

- √ Biotechnology in medicine
- √ Biotechnology techniques
- √ Medical Terminology

- **Bioinformatics**

Learning outcomes

This course will enable learners to;

1. Demonstrate knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
2. Demonstrate knowledge of existing software effectively to extract information from large databases and to use this information in computer modeling
3. Demonstrate problem solving skills, including the ability to develop new algorithms and analysis methods
4. Demonstrate an understanding of the intersection of life and information sciences, the core or shared concepts, language and skills the ability to speak the language of structure –function relationships, information theory, gene expression, and database queries

Indicative content

- Bioinformatics (Computer-Based Approaches to Gene Analysis)
  - √ Introduction to bioinformatics, the human genome project and bioinformatics tools (Sequence data base, MAP viewer, local alignment search tools, and expressed sequence tags database and Unigene).
  - √ Mapping of candidate disease gene and identification of candidate gene hrs.
  - √ Clinical application of Bioinformatics hrs.

- Electrophoretic Methods for Mutation Detection and DNA Sequencing.
  - √ The fundamentals of electrophoresis, the gel matrix agarose, the gel matrix polyacrylamide, capillary electrophoresis and applications of electrophoresis in the DNA diagnostic laboratory.
  - √ DNA sequencing, enzymes used for DNA sequencing, labeling of DDNTP fragments, capillary array instruments, software for data analysis and application of DNA sequencing in the clinical laboratory.

- Single-Nucleotide Polymorphisms
- Microarray approaches to gene expression analysis
- Fluorescence In Situ Hybridization

- **Medical Genetics**

Learning outcomes

This course will enable learners to

1. Carry out molecular diagnosis to establish genetic disorders and diseases accurately
2. Perform chromosomal typing (karyotyping) accurately
3. Perform genetic assessment and offer counseling services for genetic cancer diseases
4. Perform genetic population screening services
5. Detect chromosomal and Mitochondrial disorders
6. Perform DNA analysis for tracking of Indirect mutant gene , for demonstrations of DNA polymorphisms and for direct mutant gene analysis
7. Perform Sex determination and differentiation
8. Carry out Genomic and parental imprinting

Indicative content

- **Principles of Genetics**
  - √ Mendel's theory
  - √ Structure and organization of genome and non mendelian's inheritance
  - √ Nucleic acid stricture and DNA analysis
  - √ Spermatogenesis
  - √ Genomic and Parental imprinting
  - √ Chromosome aberrations
  - √ Multifactorial disorders
  - √ Medical genetics in population

Applied Genetics

- Immunogenetics(Geneticsofthenormalimmunesystem,Inheritedimmunodeficiency)
- Blood groups (ABO and Rhesus groups), Haemolytic Disease of the New born (HDN), Neonatal Alloimune thrombocytopenia, Major Histocompatibility Complex (MHC), Transplantation, Blood Transfusion
- Genetic aspects of cancer and common Diseases
- Congenital malformation
- Prenatal diagnosis (fetal sexing, fetal karyotyping , genetic disorder carrier detection, chordocentesis)
- Prevention and treatment of genetic disorders

III. IMMUNOLOGY

Learning outcomes

This course will enable learners to;

1. Demonstrate knowledge of the structure and function of the immune system
2. Demonstrate knowledge of innate and adaptive immunity
3. Demonstrate knowledge of antibodies in response to stimulation
4. Demonstrate knowledge of how antigen from bacteria and viruses is processed and presented to lymphocytes
5. Demonstrate knowledge of effector mechanisms in response to stimulation
6. Demonstrate knowledge of the regulation of the immune response
7. Demonstrate knowledge of vaccines
8. Demonstrate knowledge of research and development in immunology

- Introduction to the immune system
  - √ History of Immunology as a specialty
  - √ Properties of immune responses

- Arms of the Immune System;
  - √ Innate immunity
  - √ Adaptive immunity

- Molecules, Cells, tissues and organs of the immune system
  - √ Primary Lymphoid organs
  - √ Secondary Lymphoid Organs
  - √ Mucosa-Associated Lymphoid Tissues
  - √ Hematopoiesis and generation of Cells of Immune System
  - √ Immune Cells and functions
  - √ Molecules of the Immune system; CRPs, Complement Proteins, Defensins

- Development and maturation of cells of the adaptive immune system
  - √ Development and Selection of B cells
  - √ Somatic maturation of B cells
  - √ Development, selection and maturation of T cells

- Antigens, immunogens, immunogenicity and antigenicity
  - √ Key definitions
  - √ Properties of antigens, immunogens, haptens

- Immune Antigen Recognition Receptors, structure and function;
  - √ T Cell receptor (TCR)
  - √ B cell Receptor (BCR)
  - √ Other Pathogen Recognition Receptors (PRRs e.g. TLRs)

- Immunoglobulin superfamily
  - √ Immunoglobulin structure,
  - √ Immunoglobulin gene families,
  - √ function and generation of diversity;
  - √ Antibodies;
    - o Classes,
    - o Structure,
    - o Function
    - o Antigen-Antibody interactions
  - √ Major Histocompatibility Complex (MHC) molecules
  - √ TCR alpha & beta chains
  - √ CD4
  - √ CD8

- Generation of an Immune Response
  - √ Innate Immune mechanism
  - √ Inflammation
  - √ PRRs and PAMPs

- √ Phagocytosis
- √ Autophagy
- √ Chemotaxis and immune cell migration
- √ B and T cell antigen recognition, activation and response to infection

- Humoral/Antibody mediated Immunity
  - √ Immune effector mechanisms
  - √ Immune complexes, advantages and clinical disadvantages

- Cell Mediated Immunity; Immune effector mechanisms
  - √ Th1 and Th2 responses
  - √ Immune regulatory responses (Tregs etc.)
  - √ Other inflammatory responses
  - √ Cytotoxicity
  - √ NK cells; activation, cytotoxicity mechanisms, ADCC

- Tolerance and autoimmunity
  - √ Mechanisms of Immune tolerance
  - √ Immunological disorders/diseases: Allergy and hypersensitivity; Immunodeficiencies

- Cytokines and cytokine receptors
  - √ Cytokine Receptors and Types
  - √ Cytokines and their Functions
  - √ Properties of cytokines

- Immune Signal transduction mechanisms and signaling pathways
  - √ Transmission of signals across the cell membrane
  - √ Cytoplasmic receptors and adaptor signaling molecules
  - √ Signaling pathways
  - √ Transcription factors

- Tumor immunology
  - √ Tumor antigens and immune recognition
  - √ Tumor Immune-suppression responses
  - √ NK cells and role in tumor immunity

- Transplantation Immunology
  - √ The HLA and tissue/organ cross-matching
  - √ Tissue/Organ rejection immunology
  - √ Management of tissue/organ recipients

- Diagnostic and Research Immunology Techniques
- Overview of antigen-Antibody Interactions
  - √ Specificity, affinity, avidity of antigen-antibody binding
  - √ Overview of epitopes, antigen, immunogen, haptens
  - √ Systems for visualization of antigen-antibody reactions

- Routine Serological Techniques, principles and applications, advantages and disadvantages
  - √ Agglutination tests
  - √ Precipitation tests
  - √ Radial Immunoassays
  - √ Coagulation tests
  - √ Lateral Flow cassette/Strip-based Rapid Diagnostic tests

- Advanced Serological Techniques
  - √ Multiplex serology assays e.g. Lumina
  - √ Multiplex serology machines/equipment; principle, use and maintenance
  - √ Analysis of large serology multiplex datasets
  - √ Advantages, challenges/Disadvantages

- Enzyme-Linked Immunosorbent Assays (ELISAs or EIAs)
  - √ Types of ELISAs
  - √ Qualitative and Quantitative application of ELISAs
  - √ 4th Generation ELISA principles
  - √ ELISA detection systems
  - √ Principles, use and maintenance of Equipment used in ELISA

- Immunology techniques in protein biotechnology, histology, cytology and pathology
    - Immunohistochemistry
    - Immunoelectron microscopy
    - Western Blotting
    - ELISPOT
    - Dot-Blot Assays
    - Immunofluorescence applications
  - √ Localization microscopy
  - √ Live cell imaging
  - √ Lateral flow Immunoassay point of care tests and fluorescent readers

    - **Flow cytometry**
    - Principles of flow cytometry
    - The flow cytometer; principle, use and maintenance
    - Automated Cell counters and Complete Blood Counter machines
    - CD4/CD8 cytometers and POC machines e.g. PIMA, BD FACSPresto
    - Immuno-phenotyping and Cell counting
    - Intracellular cytokine staining

IV. HAEMATOLOGY AND TRANSFUSION SCIENCE

Learning outcomes

This course will enable learners to;

1. Describe stem cells, Hematopoiesis and marrow failure

2. Describe leukocyte function
3. Describe RBC function and metabolism
4. Describe cellular and plasma components
5. Describe the hemostatic plug (Platelets)
6. Describe formation and regulation of hemostasis
7. Demonstrate tests of hemostasis and thrombosis
8. Describe blood groups and compatibility testing
9. Describe non-malignant Disorders
10. Describe malignant disorders

Indicative content

- Introduction
  - √ Definitions and terminologies
  - √ Hematopoiesis and hemopoietic stem cells
  - √ Blood and its components
  - √ Blood vessels and blood
  - √ Erythropoiesis
  - √ Haemoglobin synthesis
  - √ Iron cycle
  - √ Anaemias
  - √ White blood cell production and break down
  - √ Platelet production and breakdown
  - √ Reticulo-endothelial systems
  - √ Code of conduct in hematology lab
  - √ Phlebotomy
  - √ Anticoagulants
  - √ Preparations of blood smears

- Blood grouping systems
  - √ ABO blood grouping system
  - √ Bombay groups
  - √ ABO phenotypes banking and frequencies

- Rhesus (CDE and other blood group systems and their genetics
  - √ Rhesus system
  - √ Rhesus antigens and antibodies
  - √ Fisher's and Race's wieners and Prokop unlenbruk
  - √ Subdivisions of rhesus
  - √ Difference between rhesus antigen and LW antigen
  - √ Blood transfusion procedures
  - √ Preparation of standard control cells

- Blood transfusion procedures
  - √ History and blood groups
  - √ Types of blood transfusions
  - √ Transfusion reactions
  - √ Risks and complications

√ Blood transfusion for cancer patients
√ Cross matching

- Hematological parameters

√ Enumeration of blood cells
√ Hematological, indices and packed cell volume
√ Erythrocyte sedimentation rate (ESR)
√ Comprehensive blood thin film reporting
√ Cell blood count (CBC)
√ Automation and computerization in hematology principles
√ Hemoglobin estimation

- Hemostasis

√ Sub-endothelial exposure and vascular spasm
√ Platelet adhesion
√ Platelet activation
√ Platelet aggregation
√ Platelet plug (clot formation)
√ Clot retraction and clot dissolution

- Blood clotting pathways

√ Intrinsic pathway
√ Extrinsic pathway
√ Final common pathway
√ The clotting cascade
√ Clotting and hypercoagulability conditions
√ Bleeding and decreased clotting conditions

- Blood disorders

√ Anemia
√ Hemophilia
√ Leukocytosis
√ Polycythemia Vera
√ Sickle cell disease
√ Thalassemia
√ Von Willebrand disease
√ Lymphomas
√ Idiopathic thrombocytopenic purpura
√ Disseminated intravascular coagulation
√ Deep venous thrombosis

- Practical hematology (diagnostics)

√ Laboratory tests for red blood cells (red cell count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), Hemoglobin determination, Hematocrit determination, Reticulocyte count, Erythrocyte Osmotic fragility test, Hemoglobin electrophoresis, sickle cell test.
√ Laboratory tests for hemoglobin (serum ferritin determination, total iron-binding capacity (TIBC), transferrin saturation, Porphyrin analysis, Direct anti-globulin test

(DAT) antibody screen (indirect Coombs test)
- √ Laboratory tests for white blood cells (differential white cell count, neutrophil count, Lymphocyte count, monocyte count, Eosinophil count and Basophil count.
- √ Laboratory tests for platelet (platelet count, Bleeding time, Clot retraction test, platelet adhesion studies, platelet aggregation tests)

- Treatment and management of blood disorders

V. CLINICAL CHEMISTRY

Learning out comes

This course will enable learners to;

1. Identify and explain the relationship between normal physiological function and the pathological changes that occur in the different clinical conditions
2. Diagnose based on the biochemical results and clinical information
3. Compare analytical methods for analytes
4. Formulate differential diagnoses based on the biochemical results and clinical information
5. Interpret laboratory results, taking into account clinical information and the preanalytical and analytical issues in relation to the different analytes
6. Suggest further investigations based on the clinical question being asked and the results currently available
7. Appreciate the applications of micro-array technology and proteomics in diagnosis
8. Describe the Changes that occur during pregnancy and how these changes affect biochemical investigations
9. Understand and be able to apply the principles of neonatal and paediatric screening in the clinical environment.
10. Understand the Circadian rhythm and heterogeneity of hormones, biological and analytical variation
11. Understand Aging from the physiological and pathological point of view and the ability to advise on appropriate biochemical investigations
12. Have a detailed understanding of the pathophysiology of in born errors of metabolism
13. Demonstrate knowledge of the various methodologies and investigation protocols used to identify inborn errors of metabolism.
14. Identify commonly monitored drugs and drugs of abuse
15. Carry out testing of therapeutic drugs and drugs of abuse/poisons in serum
16. Interpret results from tests on therapeutic drugs and drugs of abuse/poisons in serum

Indicative content

- Fluid and Electrolyte Homoeostasis and Disturbance
  - √ Acid-Base Balance and Disturbance
  - √ Renal Function and Disease
  - √ Gastrointestinal and Exocrine Pancreatic Function and Disease
  - √ Liver Function and its Disorders
  - √ Enzymology

- √ Cardiovascular Biomarkers in Relation to Cardiovascular Disease
- √ Biochemical Aspects of Nutrition and Nutritional Support
- √ Tumor Markers

- GENERAL, PAEDIATRIC AND GERIATRIC BIOCHEMISTRY
  - √ The metabolic diseases that occur most commonly in the elderly: thyroid disease, diabetes mellitus, renal disease, pituitary disease, impaired gonadal function and bone disease.
  - √ Prenatal and Postnatal Diagnosis and Screening
  - √ Cystic Fibrosis and Sweat Tests
  - √ Pregnancy and Pre-eclampsia
  - √ Calculations in Clinical Chemistry
  - √ Molecular Diagnostics and Genetics
  - √ Proteomics
  - √ Trace Elements
  - √ Cytokines and the Inflammatory Responses
  - √ Clinical chemistry of Immunodeficiency and Allergy
  - √ Multiple Myeloma and Para-proteinaemia

VI. HISTOPATHOLOGY AND CYTOLOGY

Learning outcomes

This course will enable learners to;

1. Demonstrates a strong knowledge in gross and microscopic anatomy.
2. Understands and applies the concepts of general pathology.
3. Demonstrates the ability to review and extract appropriate information from the clinical history prior to diagnosis.
4. Demonstrate knowledge of how common cytopathology specimens are screened
5. Explain the general procedure in cytology
6. Explain the use of special and advanced pathology techniques.
7. Perform special and advanced pathology techniques.
8. Carryout and interpret routine techniques employed in pathology.
9. Utilize cytopathology as a non-invasive modality of diagnosis.
10. Evaluate common cytopathology specimens comprehensively
11. Apply ancillary techniques including image analysis, immunocytochemistry, flow cytometry, Cytogenetics, electron microscopy, and molecular studies (FISH; PCR).
12. Rapidly evaluate common FNA biopsy specimens
13. Explain the general cytological pitfalls.
14. Explain basic aspects of thyroid gland cytology
15. Interpret kidney cytology.
16. Interpret adrenal gland cytology.
17. Interpret cytology of fluid (urinary and effusion of cavity).
18. Explain basic aspects in respiratory cytopathology
19. Interpret gastrointestinal cytology

Indicative content

- Introduction
  - √ Anatomic pathology
  - √ Historical perspective
  - √ Methods for study pathology. Biopsy. Cytology.
  - √ Frozen section.
  - √ Surgical pathology and the pathologist
  - √ Surgical pathology report
  - √ Slide review and consultation
  - √ Limitations of the histological diagnosis
  - √ Legal aspects of surgical pathology
  - √ Initial handling of specimens
  - √ Fixation
  - √ General principles of gross examination
  - √ Specimen photography
  - √ Specimen radiography.
  - √ Lymph node dissection
  - √ Sampling for histological examination
  - √ Gastrointestinal cytology
  - √ Salivary gland aspiration cytopathology
  - √ Fine needle aspiration biopsy of the liver and pancreas
  - √ Thyroid aspiration cytopathology
  - √ Fine needle aspiration of the kidney, adrenal gland and retro-peritoneum
  - √ Urinary cytopathology
  - √ Fine needle aspiration of female genital tract and peritoneal washings
  - √ Fine needle aspiration biopsy of breast
  - √ Fine needle aspiration biopsy of musculoskeletal system
  - √ Cell adaptation, cell injury and cell death (necrosis and apoptosis)
  - √ Acute inflammation
  - √ Chronic inflammation
  - √ Tissue renewal and repair: Regeneration, healing and fibrosis
  - √ Hemodynamic disorders, thromboembolic disease, and shock.
  - √ Immunology disorders
  - √ Anemia
  - √ Cervical cytology
  - √ Malignancy in the tropic
  - √ Kaposi's sarcoma

9.3. Instructional/Teaching Methods

Benchmark Standard

The Methods of instruction shall be stated for every course unit. Medical schools are encouraged to adopt instruction methods that support innovation, student-centered learning, mentorship and use of evidence-based training methodologies.

9.4. Assessment of Student Performance

10.4.1. General Requirements

Benchmark Standard

a. There shall be in place appropriate assessment procedures for graduate students.
b. Evaluation and assessment of graduate students shall meet the objectives and learning outcomes of the MMLS programmes.
c. There shall be in place well documented examination policy and regulations specific to graduate students.

Guidelines

While assessing graduate students, holistic assessment is expected in the following six core competency areas adapted from the Accreditation Council for Graduate Medical Education (ACGME) \ Progressive (Formative) and summative, Continuous.

Common Assessment Methods for the Six Core Competency Areas adapted from ACGME

Core Competency Area	Common Assessment Methods
Patient diagnostic Care	• Direct observation • Rating scales/evaluation forms • Audit of clinical and diagnostic practice • Simulation • Case logs/registries
Medical Knowledge	• In-training examinations • Oral questioning methods • Direct observation • Assessment of Reasoning Tool
Professionalism	• Multi-source feedback • Patient surveys • Direct observation
Interpersonal and Communication Skills	• Multi-source feedback • Patient surveys • Direct observation • Simulation

Practice-based Learning and Improvement	• Audit of diagnostic practice • Evidence-based medicine logs • Case logs • Rating scales/evaluation forms • Reflective practice rubrics
Systems-based practice	• Quality improvement knowledge assessment test • Audit of clinical practice • Multi-source feedback • Rating scales/evaluation forms

9.4.2. Grading of Taught Courses

All taught courses shall be graded out of 100% in accordance with institutional standards and procedures. Pass mark shall be 60%. A candidate who gets the 60% and above in any given course shall be allocated the entire credit units allocated for that course while one who scores below 60% gets no credit units and is required to repeat the course. The number of times required to repeat a failed course or subject shall depend on each institution's policies and regulations.

9.4.3. Medical Assessments

1. All MMLS Master Degree students shall undertake continuous and summative medical and diagnostic assessments.
2. Every institution should demonstrate evidence of continuous and summative clinical assessment in the specialty area.

9.4.4. Examination of MMLS Dissertations

MMLS student dissertations shall be assessed in accordance with the institution graduate regulations which must be in conformity with Benchmarks for Graduate Studies in Uganda [See Sec. 3.10& 3.11 of Benchmarks for Conducting Postgraduate Programmes in Uganda]

9.5. Programme Monitoring and Evaluation

Every institution shall have and implement an M&E framework for quality monitoring and evaluation of the programme.

9.6. Annual Reporting

Benchmark Standards

Every medical School shall prepare and submit to the Allied Health professionals and the National Council for Higher Education an annual report on the operations and progress of the medical school giving a detailed evaluation of its academic activities and the extent to which the prescribed institutional standards are met.

Guidelines

a) The annual report shall indicate admitted students as well as progression trends.
b) It should also show achievements in research, collaborations, etc.

References

East African Community Medical and Dental Boards/Councils, Regional Guidelines for Inspection and Recognition of Medical Schools and Teaching Hospitals in EAC Partner States, May 2015.

National Council for Higher Education, 2015; Benchmarks for Conducting Postgraduate Programmes in Uganda.

National Council for Higher Education, 2019. Minimum Standards for the Bachelor of Medicine and Bachelor of Surgery Degree Programme in Uganda

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