SYLLABUS

MICROBIOLOGY

MEDICAL TECHNOLOGISTs and MEDICAL LABORATORY SCIENTISTS

PBMT approved in September 2022 for training implementation in 2023 for MT students who write from March 2024 onwards.

Effective from November 2023 for BHSc examinations

CONTENTS

1. INTRODUCTION		4
2. STATUTORY REGULATIONS AND ETHICS		5
3. TOTAL QUALITY MANAGEMENT		
	3.1 Laboratory Safety	6
	3.2 Specimens	6
	3.3 Laboratory Equipment	7
	3.4 Laboratory Reagents	8
	3.5 Stock control	9
	3.6 Quality Assurance / Accreditation	9
	3.7 Quality Control	10
	3.8 Method Validation	10
	3.9 Personnel	11
	3.10 Documentation	11
4. LABORATORY RELATED MATHEMATICS		12
5. MOLECULAR BIOLOGY		12
6. BASIC LABORATORY MANAGEMENT		14
	6.1 Quality Management System	14
	6.2 Laboratory Administration	14
	6.3 Infection Control	14
	6.4 Laboratory Safety	14
7. EQUIPMENT AND AUTOMATION		16
8. MICROSCOPY AND STAINING TECHNIQUES		17
9. PROCESSING OF SPECIMENS		18
10. STERILIZATION AND DISINFECTION		19
11. MEDIA		20

12. SYSTEMATIC BACTERIOLOGY	22
13. MYCOLOGY	31
14. ANTIMICROBIAL SUSCEPTIBILITY TESTING	33
15. PARASITOLOGY	36
16. PUBLIC HEALTH	38
17. SEROLOGY	39
18. CLINICAL APPLICATIONS	41
19. REFERENCE MATERIAL	42
20. NOMENCLATURE/ACRONYMS	43

1. INTRODUCTION

The objective of this syllabus is to provide the intern/student Medical Technologists or Medical Laboratory Scientists with a guideline on the essential aspects that must be covered in order to adequately prepare themselves for the HPCSA's Professional Board of Medical Technology / Final examination.

The examination will be based on the contents of this syllabus and related theoretical knowledge gained during study at the University of Technology.

Please refer to:

Nomenclature / Acronyms

- 19. Reference material
- 20. Nomenclature/acronyms

HPCSA regulations require that accredited training laboratories perform a minimum of 80% of the tests identified in this syllabus. Laboratories are required to ensure that Interns receive appropriate training in the tests contained within the syllabus but which are not routinely performed on site. (Where practical training at an alternate training facility is not feasible, minimum of theoretical and written assessments are compulsory)

Candidates must achieve a minimum mark of **50% for each paper,** to pass the examination.

Emphasis will be placed on problem solving and on practical application of theoretical knowledge, as expected from any competent technologist.

Candidates will not be expected to memorise specific details and quantities of reagent preparations. They will however be expected to know the principles on which tests are based and how to interpret the test results.

NB: Students are reminded that this document is merely a guideline intended to aid the study process. As specialists in a discipline, they are expected to keep their knowledge current and to have an in-depth understanding of their subject.

2. STATUTORY REGULATIONS AND ETHICS

Objective

Provide the Intern with information on the regulations and ethical principles which apply to the practice of medical laboratory technology.

Specified outcomes

On completion of this section the intern/student should be able to:

- Demonstrate knowledge of the structure and function of the Health Professions Council of South Africa.
- Demonstrate knowledge of the structure and function of the Professional Board for Medical Technology.
- Discuss the regulations relating to the scope of practice for Medical Technologists or Medical Laboratory scientists.
- Describe the legal and ethical standards related to the professional practice of medical technology.
- Demonstrate knowledge of the requirements for the acquisition of continual education units (CEUs).
- Demonstrate knowledge on how confidentiality in the workplace is obtained and maintained.
- Demonstrate knowledge of No. 61 of 2003: National Health Act, 2004.

3. TOTAL QUALITY MANAGEMENT SYSTEM

3.1 LABORATORY SAFETY

Objective

Provide knowledge of all safety procedures that must be applied in the workplace and an understanding of the relevant legislation.

Specified outcomes

On completion of this section the intern/student should be able to:

- Explain and apply the fundamental concepts of the relevant legislation pertaining to laboratory safety.
  RANGE: Occupational Health and Safety Act
  Hazardous Substances Act
  Compensation for Occupational Injuries and Diseases Act
- Demonstrate knowledge of the procedures to follow in the event of laboratory accident or emergency.
  RANGE: Chemical or bio-hazardous spill
  Fire, Flood, Bomb threat
- Describe the correct procedures for the storage, handling and disposal of laboratory waste.
- Describe the application of laboratory safety procedures to the collection, transport, storage and analysis of biological specimens including IATA regulations.
  RANGE: Biological specimens
  Human tissue
  Solid and liquid bio-hazardous waste
  Radioactive waste and sharps
- Describe the basic principles for the storage, handling and disposal of chemicals; poisons; flammable substances; gases and infectious material.
- Describe procedures to follow for the prevention, control and management of laboratory acquired infections including general housekeeping and decontamination of equipment.
- Describe the purpose and basic content of the material safety data sheets (MSDS).
- Demonstrate knowledge of the protocols to follow in the event of injuries on duty including needle-stick injury.
- Define the role of the designated safety personnel.
  RANGE: Fire marshal
  Safety representative
  First aid officer
- Recognize the international safety symbols used in the laboratory environment.
- Demonstrate the knowledge of **all** safety and emergency equipment.

3.2 SPECIMENS/PRE-ANALYTICAL REQUIREMENTS

Objective

Provide an understanding of the optimal specimen requirements for the maintenance of the integrity and suitability for ***all types*** of laboratory analysis with particular reference to the tests specified throughout this syllabus.

Specified Outcomes

On completion of this section the intern/student should be able to:

- Demonstrate knowledge of any required patient preparation for the collection of specimens for individual tests.
- Collect specimens as defined within current statutory requirements and limitations.
- Describe the optimal specimen requirements for the individual tests.
- Describe the conditions under which the specimens must be transported to the laboratory
- Display knowledge of the optimal storage conditions should testing be delayed and the stability of the specimen for the individual testing process.
- Capture the data and patient demographics that are required for the registration of the specimens at the laboratory accurately.
- Explain the principle of continuous identification of the specimen, aliquots and documentation.
- Describe the process for the rejection of unsuitable specimens.
- Conduct the pre-analytical processes required for specimen type and test requested.

3.3 LABORATORY EQUIPMENT

Objective

Explain the correct use, principle of operation, maintenance of laboratory equipment and the appropriate troubleshooting procedures to apply when indicated.

Specified outcomes – applicable to all equipment/instruments and analyzers

On completion of this section the intern/student should be able to:

- Describe the principle of operation where applicable.
- Operate all equipment optimally in accordance with recommended operating procedures.
- Apply the correct safety precautions during the operation and maintenance of equipment.
- Demonstrate full knowledge of, and apply, the correct maintenance, service and calibration requirements.
- Differentiate between calibration, validation and verification.
- Conduct applicable decontamination procedures.
- Apply the appropriate functional checks to ensure optimal operation.
- Describe and implement troubleshooting procedures when optimal operation is not demonstrated by the functional checks.
- Demonstrate an understanding of the approach to the validation and/or verification of new equipment, reagents and testing kits (Qualitative and Quantitative).
- Demonstrate full knowledge of the maintenance procedures, all equipment records and documentation required for good laboratory practice.

  RANGE: All glassware – volumetric and graduated
  Pipettes – glass, automated, air displacement and disposable
  Fridges
  Freezers
  Stopwatches/timers

Thermometers – min/max, electronic and mercury
Bio-hazardous safety cabinets – Class I and II
Fume cupboards
Pipette aids - rubber teats, pro-pipettes and dispensers
Centrifuges, safety centrifuges
Balances – top pan and fine analytical chemical
Stirrer
Hotplates
Water-baths
Spectrophotometers
pH meters
Rotators
Shakers
Flat bed and vortex mixers
Microscopes – light, phase contrast, inverted and fluorescent
Incubators – aerobic and CO2.
Equipment for sterilization –autoclaves, hot-air ovens, steamer, filtration and inspissation and tyndallisation.
Staining instruments
Microbiological automated identification/sensitivity systems
TB and blood culture semi-automated growth indicator equipment
Flow cytometry

Knowledge of the makes and models in use in the current workplace in all disciplines is required of the following:

- Laboratory instrumentation
- Staining instruments
- Automated blood culture systems
- Automated and semi-automated bacterial identification and susceptibility testing systems
- Automated TB culture and mycobacterial susceptibility systems
- Molecular biology amplification and detection systems
- Automated rapid detection of bacteria (including *Mycobacterium* spp.)

3.4 LABORATORY REAGENTS

Objective

Provide details of the correct preparation, storage and disposal of laboratory reagents.

Specified outcomes

On completion of this section the intern/student should be able to:

- Differentiate between controls and calibrators.
- Demonstrate knowledge of the objective, use and retention of package inserts.
- Prepare, store, and safely dispose of laboratory reagents.
  RANGE: Working reagents
  Controls
  Calibrators
  Reagent kits

- Define terms and solutions used in the laboratory:

RANGE: Physiologically normal saline
Buffer
Calibrators
Controls

Please refer to sections: 8. Microscopy and Staining techniques
10. Sterilization and Disinfection
11. Media

3.5 STOCK CONTROL

Objective

Outline the processes involved in good stock management**.**

Specified outcomes

On completion of this section the intern/student should be able to:

- Demonstrate knowledge of the basic principles to apply when managing stock.
- Demonstrate an understanding of the receipt of stock including the required records regarding condition of goods, expiry dates and lot numbers.
- Demonstrate an understanding of stock rotation with particular reference to expiry dates.
- Describe the correct storage conditions for all stock.
- Differentiate between open vail stability and expiry date.
- Demonstrate knowledge of company policy with regard to the use of expired reagents, controls and calibrators.

3.6 QUALITY ASSURANCE/ACCREDITATION

Objective

Expose the intern/student to all aspects of quality control.

Specified outcomes

On completion of this section the intern/student should be able to:

- Discuss quality assurance and quality control in the correct context.
- Define and apply the appropriate processes of quality assurance in the pre-analytical, analytical and post analytical areas.
- Demonstrate general knowledge on the terms accreditation and ISO.
- Demonstrate general knowledge on the use, performance and evaluation of RISK assessments.
- Define and explain all quality assurance terminology.

  RANGE: Non-conformance
  Corrective action
  Preventive action
  Root cause analysis
  Continual improvement
  Audits – Internal & External

3.7 QUALITY CONTROL

Objective

Expose the intern/student to all aspects of quality control.

Specified outcomes

On completion of this section the intern/student should be able to:

- Describe and apply the appropriate quality control processes which must be performed in the analysis of all analytes, organisms and parameters, equipment and analyzer operation, reagent as contained within this syllabus.
- Explain the principles of internal and external quality control procedures in the context of the tests performed.
- Apply a sound knowledge of all the principles, procedures, calculations and interpretation of all related internal and external, ***quantitative*** quality control data.
- Describe the potential causes and apply appropriate troubleshooting procedures in the event of failed Internal and external, quantitative and qualitative quality control.
- Define and explain all terminology used in the assessment of quality control results.

RANGE: Specificity
Sensitivity
Reference range
Biological variance

3.8 METHOD VALIDATION

Objective

Expose the student to all aspects of method validation.

Specified outcomes

On completion of this section the student should be able to:

- Differentiate between validation and verifications in terms of relevant ISO standards.

3.9 PERSONNEL

Objective

Provide knowledge of basic requirements for personnel in terms of relevant ISO standards.

Specified outcomes

On completion of this section the intern/student should be able to:

- Describe the personal documents and records which are required for all laboratory personnel.
- Demonstrate an understanding of the terms ‘competency’ and ongoing competency’ in terms of the training of all laboratory personnel.

3.10 DOCUMENTATION

Objective

Provide knowledge of basic requirements of documentation in terms of relevant ISO standards.

Specified outcomes

On completion of this section the intern/student should be able to:

- Demonstrate knowledge of document control requirements in terms of relevant ISO standards.
- Demonstrate knowledge of the required content of SOP's including the minimum content of the cover page.
- Know the process on how to make documents obsolete.
- Demonstrate knowledge on the retention and disposal of this documentation.
- Demonstrate knowledge on document control and review.
- Differentiate between a record and document.

RANGE: Policies
Procedures(SOPs)
Working instructions
Raw data
Equipment records
Quality control records
Personnel records
Package inserts

4. LABORATORY RELATED MATHEMATICS

Objective

Provide the intern/student with instruction on the application of the correct mathematical formulae to relevant calculations.

Specified outcomes

On completion of this section the intern/student should be able to:

Demonstrate proficiency in the calculations required for the preparation of solutions.

RANGE: Physiological saline, Percentage solutions

5. MOLECULAR BIOLOGY

Objective

Provide intern/student with an introductory knowledge of basic molecular biology as applied to techniques throughout the disciplines.

Specified outcomes

At the end of this training the intern/student will be able to:

- Describe workflow dynamics in a molecular biology laboratory.
- Demonstrate and apply knowledge of the methods used for the prevention of contamination in a molecular laboratory.
- Demonstrate a fundamental knowledge of the function of DNA in terms of structure, replication, transcription and translation.
- Discuss the principle of the polymerase chain reaction (PCR) and the steps involved.
  RANGE: Denaturation
  Annealing
  Extension
- List the components of a PCR master mix and explain the purpose and action of each component.
- Discuss the role of primers used within a PCR lab.
- Demonstrate knowledge of the quality controls used in the testing procedure.
- Identify the potential causes of false positive and negative results.
- Identify potential causes of interference in the PCR process.
- A basic understanding of what probes are and how they are used in real-time PCR.
- An basic understanding of the PCR graph and Ct values (how the Ct values are used in quantitative and semi-quantitative PCR's).
- Understand the difference between conventional PCR and real-time PCR.
- Understand the principle and purpose of reverse transcription PCR (cDNA synthesis).
- Understand the difference between multiplex and single plex PCR's.
- Demonstrate basic practical knowledge of the techniques utilized for the automated extraction, amplification and detection.
- Describe Restriction enzyme analysis under the following headings:
  - Explain the use and function of restriction enzymes.
  - Basic principle and applications of Restriction Fragment Length Polymorphism (RFLP).
- Describe/discuss/explain/motivate the use of agarose gel electrophoresis by referring to the following:
  - Principle and applications
  - Preparation and loading of a gel
  - Quality control
  - Interpretation of test results including reasons for false positive and negative reactions.
- Describe real-time PCR under the following headings:
  - Principle and applications
  - Advantages and disadvantages
  - Advantages and disadvantages of the hydrolysis probes
  - Advantages and disadvantages of the hybridization probes
  - Advantages and disadvantages of using SYBR Green
  - List and explain alternative nucleic acid amplification techniques e.g. Loop Mediated Isothermal Amplification (LAMP), Nucleic Acid Sequence Based Amplification (NASBA), Ligase Chain Reaction (LCR)

6. BASIC LABORATORY MANAGEMENT

Objectives
To obtain a basic knowledge of the principles and practices involving laboratory safety, quality management systems and accreditation, basic laboratory administration and infection control & epidemiology.

Learning outcomes:
At the end of this section, the student should be able to:

6.1 QUALITY MANAGEMENT SYSTEM

- Describe/evaluate/formulate the components involved in a Quality Management System and Laboratory Accreditation (in keeping with the relevant ISO standards) under the headings as listed in 3.1 –3.10

- Discuss the concept of laboratory accreditation as defined by the specific standards relevant to medical and public health laboratories.

6.2 LABORATORY ADMINISTRATION

- Describe/evaluate/motivate/design the components of a good Inventory/Stock control system.
- Describe/identify/appraise the components of good data management system.

6.3 INFECTION CONTROL AND EPIDEMIOLOGY

- Discuss infection control procedures, epidemiology and surveillance of antibiotic resistance patterns in relation to the following resistance mechanisms and organisms:

  - MRSA
  - VRE
  - ESBL
  - IBL
  - CPE
  - Organisms commonly implicated in Intensive Care Units e.g. *S. maltophila, P. aeruginosa, A. baumannii*
  - *L. pneumophilia*

- Identify/categorize and discuss common types of nosocomial infections.
- Identify/discuss important components of the various isolation procedures utilized in hospitals.

6.4 LABORATORY SAFETY

- Describe the regulations relating to the transport of specimens referred to other centres.
- Describe the regulations relating to the handling of medico-legal specimens.
- Explain laboratory safety in relation to the Occupational Health and Safety Act (1993).
- List/state the responsibilities of safety representatives and first aiders as required by the OHS Act (1993).
- Describe/summarize the procedures for the storage, handling and disposal of laboratory waste including chemicals, biohazardous waste, radioactive waste, human tissue, solid contaminated waste, liquid contaminated waste, sharps and gases.
- Describe/motivate and demonstrate the proper safety precautions while handling and disposing of infectious material including those potentially containing organisms like M. tuberculosis, HIV or Hepatitis virus.
- Explain/describe the Safety protocols involved in event of a needle-stick injury and exposure to blood-borne pathogens.
- Motivate/explain the various biosafety level requirements when working with infectious material.

7. EQUIPMENT AND AUTOMATION

Objective

To obtain a basic knowledge of basic laboratory equipment and other automated systems in use in a Microbiology environment.

Learning outcomes

At the end of this section, the student should be able to:

Describe/discuss/ the use of the following types of laboratory equipment / instrumentation under the following headings:

- Principles of use
- Operation, Maintenance and Trouble-shooting
- Quality Control
- Record-keeping
- Calibration, where applicable

a) Standard laboratory equipment:

- Centrifuges
- Biosafety cabinets
- Incubators (aerobic and CO_2)
- Analytical balances
- Automated pipettes
- Water baths
- Anaerobic systems
- pH meters
- Microscopes
- Adjustable & fixed volume pipettes
- Plate pourer
- Thermometers

b) Automated and semi-automated equipment:

- Automated blood culture systems
- Automated and semi-automated bacterial identification and susceptibility testing systems
- Automated TB culture and mycobacterial susceptibility systems
- Molecular biology amplification and detection systems
- Automated rapid detection of bacteria (including *Mycobacterium* spp.)

(The systems have been listed generically, to allow for inter-laboratory differences between specific types/makes of instruments used. The student is expected to have a basic understanding **of *one example of each*).**

8. MICROSCOPY AND STAINING TECHNIQUES

Objective

To describe the methods, use and application of microscopy techniques in a clinical laboratory setting.

Learning Outcomes

At the end of this section, the student should be able to:

- Explain/state the basic principles of the following types of microscopes:
    - Light
    - Phase-contrast
    - Fluorescent
- Describe with the aid of a diagram, the components and light path of each of these microscopes.
- Discuss the use and application in a clinical laboratory setting of each of these microscopes.
- Explain/describe the basic maintenance of each type of microscope.

- Describe the methods of preparation and use of wet preparations of faeces, urine and vaginal swabs in the identification of microorganisms.

- Describe the concentration methods for parasites in faeces and urine specimens.

- Demonstrate a sound knowledge of the following staining techniques (including quality control)commonly employed in a clinical laboratory:

Describe the procedures, interpret the results and motivate/explain/justify/quality control procedures for the following stains.

- Cell counts on CSF specimens and other body fluids, e.g. pleural and synovial fluids
- Gram's stain
- Ziehl-Neelsen's stain (standard and modified- for detection of *Actinomyces, Nocardia and M.leprae*)
- Auramine stain TB
- Acid-fast (Kinyoun) stain for parasites (e.g. *Cryptosporidium*.)
- Capsular stain (e.g. India Ink)
- Schaeffer-Fulton stain to demonstrate the presence of spores
- Methylene blue stain
- Calcofluor White stain for demonstration of fungal elements
- 10% KOH preparation for fungal elements.
- Lactophenol Cotton Blue mount (sticky tape mount) for microscopic morphology of fungi

9. PROCESSING OF SPECIMENS

Objective

- Describe proper specimen collection, transportation, and processing of bacterial (aerobic, micro-aerophylic, capnophylic, mesophilic, psychrophilic, thermophilic and anaerobic) cultures.
- Select appropriate procedures for identifying the pathogens present in cultures, perform these procedures, and interpret the results accurately.

Learning Outcomes

At the end of this section, the student should be able to:

- Describe/discuss/give an outline/illustrate the standard operating procedures (SOPs) used for the examination of the following types of specimens for the presence of pathogenic organisms:
    - Aspirates from normally sterile sites
    - Blood cultures
    - CSF
    - Pus/pus swabs (eye, ear, nose, throat, genital, wound, burn)
    - Respiratory samples
    - Stool, rectal swab
    - Tissue
    - Urine
    - Skin, hair and nails
    - Catheter tips
    - IUCD (Intra-uterine contraceptive device)
- State/name/list/identify the organisms commonly implicated in each of these specimen types.
- Differentiate between normal flora, commensals and pathogens where relevant, and have an approach to deciding which organisms to follow up based on specimen type and clinical information.
- Determine the suitability of specimens for processing.
- Discuss/explain sterile techniques that are employed.
- Explain/motivate/justify/identify safety precautions to be observed.
- Collect specimens as defined within current statutory requirements and limitations.

10. STERILIZATION AND DISINFECTION

Objective

To obtain a basic knowledge of the principles and applications of sterilization and disinfection procedures in a clinical laboratory setting.

Learning outcomes

At the end of this section, the student should be able to:

- Discuss the principles and applications of sterilization used in a laboratory under the following headings:
  - Autoclaves
  - Hot-air oven
  - Steam
  - Gas sterilisation (ethylene oxide)
  - Filtration
  - Tyndallisation
  - Inspissation
  - Radiation (ionising and non-ionising)

- Describe the use and action of disinfectants commonly employed in a laboratory and critically evaluate their application in relevant laboratory environments. The following list of disinfectants is compulsory.

  - Alcohols
  - Phenolics
  - Peroxygen compounds (oxidising agents)
  - Aldehydes
  - Halogens
  - Ethylene oxides (gas sterilisation)
  - Quaternary ammonium compounds

- Describe the methods employed when testing the bacteriocidal or bacteriostatic activity of disinfectants.

11. MEDIA

Objective

To enable the student to select appropriate media for isolation of various pathogenic microorganisms from various body areas.

Learning Outcomes

At the end of this section, the student should be able to:

Discuss the preparation and sterilization of solid, semi-solid and liquid culture media necessary for the isolation, identification and sensitivity testing of all the micro-organisms listed in this study guide. This will vary from laboratory to laboratory. Basic microbiology media to be included for study.

- Primary isolation media:
  - Blood agar
  - Chocolate agar (Boiled Blood agar)
  - MacConkey agar & MacConkey with crystal violet
  - Salmonella Shigella agar/ XLD
  - Sabouraud dextrose agar & Sabouraud dextrose agar with Chloramphenicol/Gentamycin
  - New York City/Thayer Martin agar
  - Lowenstein & Jensen medium / Middlebrooks
  - Thiosulfate-Citrate-Bile Salts-Sucrose TCBS agar
  - Cooked meat broth / Thioglycolate broth
  - Egg yolk agar (EYA)
  - The principle and example of chromogenic agar
  - Isolation media for *Campylobacter spp.*
- Identification media:
  - Glucose
  - Lactose/ONPG
  - Urea
  - Nutrient Agar
  - Decarboxylases (e.g. lysine, ornithine)
  - H2S
  - Citrate
  - DNAse
  - Oxidation/Fermentation (OF) media
  - Mannitol salt agar
  - Bile aesculin agar
  - 5%NaCl
  - CTA sugars
  - Motility
  - Nitrate
  - Arginine
- Susceptibility testing media:
  - Mueller Hinton agar
  - Haemophilus test medium
  - Gonococcus testing Media

MHA with sheep blood/MHF with horse blood
Mechanically defibrinated blood agar

- Isolation of Anaerobic organisms: e.g. Brucella Agar + Vitamin K and Haemin / Anaerobic Colstin Nalidixic Acid Agar (selective agar) / Nalidixic Acid Agar (selective)

- Media used in Public health testing:
  Baird Parker agar (BPA)
  Tryptone Glucose Extract agar (TGEA).
  Peptone water

Discuss the media relevant to the organisms listed in this study guide with regard to:

- Application
- Knowledge of the main ingredients and their function
- Performance and interpretation of quality control procedures for all media studied

Recognize/identify potential problems occurring while performing tests or quality control procedures and take corrective action.
Discuss/distinguish between the concepts of selective, non-selective, enriched, indicator and differential (including chromogenic) culture media.

12. SYSTEMATIC BACTERIOLOGY

Objective

To provide the student with a systematic study of the bacteria that are parasitic to man with special reference to:

Classification
Epidemiology
Isolation
Identification- phenotypic and genotypic where relevant

For examination purposes, the species listed under each genus are merely the most common representative organisms in that genus. However, as specialists, students are encouraged to gain knowledge and insight beyond the basic requirements.

The following codes have been assigned to represent the extent of knowledge required for each organism:

T - *thorough* knowledge

B - *basic* knowledge

S - knowledge of the *serological confirmation* of the identity of the organisms.

G - knowledge to *genus level only*

Learning outcomes

At the end of this section, the student should be able to:

- Describe in detail the techniques and media used for the primary isolation of the organisms listed below – including cultural morphology, growth requirements, incubation and temperature. **(T)**
- Describe in detail the techniques used in the microscopic identification of the organisms listed below. **(T)**
- Describe in detail the principles, methods, reagents and results obtained for the biochemical identification of the organisms listed below and demonstration of presence of toxins and/or enzymes– including growth requirements, incubation and temperature.**(T)**
- Discuss the molecular identification of organisms. **(T)**
- Know and explain the isolation and biochemical identification of the organism and demonstration of presence of toxins and/or enzymes – including growth requirements, incubation and temperature. **(B)**
- Know, describe and interpret the methods used for serological confirmation of the identity of the organism. **(S)**
- Know the isolation and biochemical identification of the organism to genus level only – including growth requirements, incubation and temperature. **(G)**

12.1 AEROBIC AND FACULTATIVE ANAEROBIC ORGANISMS

12.1.1 GRAM NEGATIVE ORGANISMS:

- **ENTEROBACTERIACEAE**

Fermenters:

Tests: oxidase, glucose, ONPG, urea, H2S, citrate, motility, indole, Methyl Red, Voges-Proskauer (VP broth) for Enterobacteriaceae, decarboxylase tests

*Citrobacter (C. freundii*and*C. koseri)***(T)**
*Enterobacter (E. cloacae*and*E. aerogenes E. sakazakii)* **(T)**
Escherichia (E. coli, including enteropathogenic *E.coli* eg*. 0157:H7)***(T&S)**
Klebsiella (K. pneumoniae and *K. oxytoca)* **(T)**
Morganella (M. morganii) **(T)**
*Pantoea (P. agglomerans)***(T)**
Proteus (P. mirabilis and *P. vulgaris)* **(T)**
*Providencia (P. rettgeri)***(T)**
Serratia (S. marcescens) **(T)**
Shigella (S. flexneri, S. boydii, S. sonnei and *S. dysenteriae)* **(T&S)**
Salmonella enterica subsp*. Enterica* serTyphi **(T&S)**
Salmonella enterica subsp*. Enterica* serParatyphi**(T&S)**
Non-typhoidal*Salmonellae (S. enterocolitica, S. enteritidis and S. typhimurium)* **(T&S)**
Yersinia (Y. enterocolitica and *Y. pestis)***(T&S)**

Non-fermenters:

Tests: oxidase, citrate, O/F media, motility, pigment production, growth temperature requirements

Acinetobacter (A. baumannii and *A. lwoffii)* **(T)**
Brucella (B. abortus and *B. melitensis)***(T)**
Burkholderia (B. cepacia) **(T)**
Pseudomonas (P. aeruginosa) **(T)**
Stenotrophomonas (S. maltophilia) **(T)**
*Chryseomonas luteola***(B)**
Chryseobacterium sp. **(B)**
Alcaligenes (A. faecalis) **(B)**
Bordetella (B. pertussis, B. parapertussis and *B. bronchiseptica)* **(T)**
Pasteurella (P. multocida) **(T) (classified under Fastidious GNBs)**

- **MISCELLANEOUS GRAM NEGATIVE ORGANISMS:**

NB*: The organisms below have been grouped according to the approach to identification. This was done for the sake of convenience and is not a formally accepted system (with the exception of the HACEK group).*

Group 1

Tests: oxidase, glucose, ONPG, urea, H_2S, citrate, motility, indole, mannite, DNAse.

Aeromonas (A. hydrophilia) **(T)**
Plesiomonas (P. shigelloides) **(T)**
*Vibrio parahaemolyticus***(T)**
Vibrio cholerae **(T&S)**

Group 2

Tests: oxidase, CTA sugars (glucose, lactose, maltose, sucrose), DNAse, nitrate reduction, growth factor and special media requirements.

Haemophilus (H. influenzae, H. parainfluenzae and *H. ducreyi)* **(T)**
Moraxella (M. catarrhalis) **(T)**
*Neisseria gonorrhoeae***(T)**
Neisseria meningitidis **(T&S)**

Group 3

Tests: growth requirements including temperature and atmospheric conditions, oxidase, hippurate, catalase, arylsulphatase.

Campylobacter sp. (C. jejuni, C. coli, C. concisus, C. upsaliensis) **(B)**
Helicobacter (H. pylori) **(B)**

Group 4

Tests: media of choice

Capnocytophaga (C. canimorsus) **(B)**
Gardnerella (G. vaginalis) **(B)**
Legionella (L. pneumophilia) **(B)**

HACEK group

Tests: basic approach to identification i.e epidemiology, spectrum of disease, media of choice.

Haemophilus aphrophilus and *H. paraphrophilus***(B)**
*Aggregatibacter actinomycetemcomitans***(B)** (previously *Actinobacillus*)
*Cardiobacterium hominis***(B)**
*Eikenella corrodens***(B)**
Kingella kingae **(B)**

12.1.2 GRAM POSITIVE COCCI:

Staphylococcus spp.
Tests: catalase, DNAse, coagulase, mannitol agar, novobiocin susceptibility
*S. aureus***(T)**
Coagulase negative staphylococci **(T)**
*S. saprophyticus***(T)**
*Micrococcus luteum***(B)**

Beta HaemolyticStreptococci (T&S)
Tests: **catalase, bacitracin and trimethoprim susceptibility, latex test for Lancefield grouping, CAMP**

Lancefield groups:
Group A - *Streptococcus pyogenes*
Group B - *Streptococcus agalactiae*
Group C - *Streptococcus dysgalactiae subsp. Equisimilis* and *subsp.dysgalactiae*
Group D - *Streptococcus bovis* and *S. equinus*
Group F - *Streptococcus anginosus group*
Group G - *Streptococcus dysgalactiae subsp. equisimilis*

Alpha Haemolytic and Non-haemolytic Streptococci
Tests: growth requirements, colony morphology, Optochin susceptibility, bile solubility

Streptococcus pneumoniae **(T&S)**

Tests: bile aesculin agar, salt tolerance, tellurite agar, acid formation in carbohydrate broths, Voges-Proskauer (VP broth) for Streptococci, arginine, aesculin hydrolysis.

Viridans Group Streptococci **(B)** (group level only)

S. mitis group
S. mutans group
S. sanguis group
S. salivaris group
S. bovis group

Tests: bile aesculin agar, salt tolerance, tellurite agar, acid formation in carbohydrate broths, Voges-Proskauer (VP broth) for Streptococci, arginine, aesculin hydrolysis

Enterococci **(T)**

Enterococcus faecalis
Enterococcus faecium
Enterococcus gallinarum and casseliflavus

Tests: bile aesculin agar, salt tolerance, PYR

Nutrition variant Streptococcus (B)

Abiotrophia defectiva

Abiotrophiaadaciens

Agar: Cystein-containing media

"*Streptococcus*- like" bacteria(B)

Tests: vancomycin resistance, MRS broth (Man - Rogosa -Sharpe broth)

Leuconostoc sp.

12.1.3 GRAM POSITIVE BACILLI:

Spore-forming Gram positive bacilli:
Tests: catalase, haemolysis on sheep blood agar, lecithinase, motility, capsule stain, spore stain, API 32A®

B. cereus **(T),**
*B. anthracis***(WHO harbour control)(T)**
B. subtilus **(B)**

Non spore-forming Gram positive bacilli:
Tests: catalase, haemolysis, bile aesculin agar, tumbling motility, cold enrichment, CAMP test, Coryne API®, growth on MacConkey

*Listeria monocytogenes***(T)**

Tests: catalase, motility, metachromatic granules, Elek test

Corynebacterium species

C. diphtheria **(T)**
C. ulcerans **(B)**
C. jeikeium **(B)**
C. pseudodiphtheriticum **(B)**
C. urealyticum **(B)**
C. xerosis **(B)**

*Rhodococcus equi***(T)**
Arcanobacterium spp. **(B&G)**
Lactobacillus spp. **(B&G)**

Gram positive branching bacilli:

Tests: growth requirements, colony morphology, Kinyoun stain (modified ZN), identification by molecular method.

N. asteroides group **(T)**
*N. brasiliensis***(T)**

12.2 ANAEROBIC ORGANISMS

Non-pigmented Gram negative bacilli:
Tests: anaerobic aesculin, spot indole, catalase, lipase, motility, urease, oxidase

Identification using special potency disks- colistin; erythromycin; vancomycin; rifampicin; penicillin G and kanamycin

Bacteroides (B. fragilis group only) **(T)**
Fusobacterium (F. nucleatum and *F. necrophorum)* **(T)**
Eggerthella lenta(formerly *Eubacterium lentum*) (**T)**

Pigmented Gram negative bacilli:
Tests: anaerobic aesculin, spot indole, catalase, lipase, motility, urease, oxidase

Porphyromonas spp. (**G)**
*Prevotella*spp. **(T&G)**

Gram negative cocci:
Test: nitrate reduction

Veillonella (V. parvula) **(G)**

Gram positive cocci:
Tests: sodium polyanetholsulphate (SPS), urea, nitrate reduction, aesculin for anaerobes, indole for anaerobes

Peptococcus (P. niger) **(B)**
Peptostreptococcus (*P. anaerobius)***(T)**
Peptostreptococcus spp. **(T&G)**

Spore-forming Gram positive bacilli:
Test: reverse CAMP test, Lecithinase

Clostridium sp. **(T)**

C. perfringens
C. bifermentans
C. sordellii
C. tetani
C. botulinum
C. difficile (*C. difficile* toxin test including the tissue culture method; as well as molecular tests for C. difficile).

Non-spore-forming Gram positive bacilli:
Tests: anaerobic aesculin, indole, catalase, motility, nitrate reduction

*Actinomyces israellii***(T)**
Propionibacterium:
*P. acnes***(T)**
*P. propionicus***(T)**

12.3 MYCOBACTERIA

Objective
To enable the student to acquire a thorough knowledge of the microscopy, culture and identification and susceptibility testing of Mycobacteria.

Learning Outcomes
On completion of this section, the student will be able to:
discuss/describe/explain/motivate/illustrate/interpret the following:

-Decontamination-liquefaction of specimens before TB culture.

Reasons for the procedure and selection of specimens for decontamination.

Principle and one method for decontamination-liquefaction of sputa.

-Staining.

Methods (see section on MICROSCOPY AND STAINING TECHNIQUES)

The International Union Against Tuberculosis and Lung Disease (IUATLD) and World Health Organisation (WHO) guidelines for the reading and reporting of TB sputum direct smears.

Isolation (culture) of Mycobacteria.

Conventional (solid + liquid media-Lowenstein Jensen and Middlebrook's)

Automated systems (e.g. Mycobacteria Growth Indicator Tube (MGIT)/Omnimed/Versatrek)

- **Mycobacterium tuberculosis complex.**

Identification: conventional, Niacin and molecular

Basic knowledge of species within the complex**.**

Theoretical difference between *M. tuberculosis* complex and the Bacillus Calmette-Guerin (BCG) (*M. bovis*) intended as vaccine strain.

Non-tuberculous Mycobacteria (NTM's) previously known as Mycobacteria Other Than Tuberculosis (MOTT's)

Basic identification of NTM's: conventional OR molecular (and understand when to identify and when not to identify these organisms, in principle)

Classification (Runyon classification) of NTM's and differentiation using biochemical tests, growth temperature and other growth requirements (one example from each group):

Nonchromogens: *M. avium*- intracellulare group

Photochromogens: *M. kansasii*

Rapid growers: M. fortuitum group and *M. chelonei*

Scrotochromogens: *M. scrofulaceum*

- ***M. leprae***

Specimens required for detection.

Staining and reporting.

Susceptibility testing.

Knowledge of first (Isoniazid, Rifampicin, Ethambutol) and second line (Ofloxacin, Kanamycin,/Gentamycin) antibiotics (see section on Antimicrobial susceptibility testing).

Methods of sensitivity testing: conventional, automated and molecular

Knowledge of molecular mechanisms involved in antibiotic susceptibility and resistance and how this relates to the molecular methods for antibiotic susceptibility (also see ANTIBIOTICS)

-Definition of MDR (Multi Drug Resistant) and XDR (Extensively Drug Resistant) TB.

Knowledge of the South African national protocol for diagnosis and treatment of Mycobacterium tuberculosis, with specific reference to section 4.1 XPERT diagnostic algorithm.

12.4 MYCOPLASMA AND UREAPLASMA

Objective

To enable the student to acquire a basic knowledge of the culture and identification of Mycoplasmas and Ureaplasmas.

Learning Outcomes

At the end of this section, the student should be able to describe/discuss/explain the cultural and identification methods employed to distinguish between Mycoplasmas and Ureaplasmas with regard to:

- Specimen types
- Principles of test methods
- Interpretation of tests
- Quality Control

13. MYCOLOGY

Objective

To enable the student to understand microscopy and culture methods used for the detection and identification of yeasts, fungi and moulds.

Learning Outcomes

At the end of this section, the student should be able to discuss/describe/motivate the following:

- Selection of appropriate microscopy and culture methods (staining, media, incubation conditions) for detection of yeasts and fungi in the following specimens:
    - Blood
    - CSF and body fluids
    - Skin, hair and nails
    - Sputum, and tracheal aspirates
    - Tissue and pus
    - Urine and stool
- Identification of the following yeasts, fungi and moulds using microscopic, colonial, germ tube teat, commercial identification morphology, as well as media and growth temperature requirements:

Yeasts

- *Candida albicans* and *Candida. tropicalis*
- *Candida glabrata*
- *Candida krusei*
- *Candida parapsilosis*
- *Candida auris*
- *Cryptococcus neoformans*
- *Malassezia furfur*

Hyphomycetes

- *Aspergillus niger and Aspergillus. fumigatus*
- *Penicillium sp.*

Mucorales

- *Mucor spp. (to genus level)*
- *Rhizopus spp.* (to genus level)

Dermatophytes

- *Epidermophyton floccosum*
- *Microsporum canis* and *Microsporum. gypseum*
- *Trichophyton mentagrophytes, Trichophyton rubrum* and *Trichophyton violaceum*

Dimorphic fungi

- *Histoplasma capsulatum*
- *Sporothrix schenckii*
- *Emmonesia spp*

Pneumocystis jiroveci: direct fluorescent antibody test (DFAT), polymerase chain reaction(PCR)

14. ANTIMICROBIAL SUSCEPTIBILITY TESTING

Objective

To obtain an understanding of antimicrobial susceptibility testing principles and procedures in a clinical setting.

Learning Outcomes

At the end of this section, the student should be able to:

- Disk (Kirby Bauer) and breakpoint sensitivity testing
- Minimum Inhibitory Concentration (MIC) testing by broth dilution and gradient diffusion (e.g. ETest®)
- Minimum Bactericidal Concentration (MBC) test.
- Testing for the presence of the ß-lactamase enzyme (chromogenic cephalosporin test)

- Describe/discuss/explain/demonstrate the following mechanisms as well as methods and principles involved in demonstrating them in vitro:

  - synergism – principle only
  - antagonism - principle only
  - induction - principle only
  - extended spectrum ß-lactamases (ESBL)
  - inducible and derepressed chromosomal β-lactamases (IBL)
  - inducible clindamycin resistance
  - vancomycin resistant Enterococci (VRE)
  - carbapenem resistant Enterobacteriaceae
  - Methicillin resistant Staphylococcus aureus (MRSA)

Discuss quality control of antibiotic susceptibility testing, in keeping with the accepted international standards (Clinical Laboratory Standards institute – CLSI, European committee on Antimicrobial sensitivity testing - EUCAST)

  - Procedures/protocols.
  - Media (application only).
  - Interpretation of results and reporting.
  - Use and storage of control strains of organisms.
  - Use and storage of antibiotic discs/solutions/gradient diffusion strips.

- Describe the susceptibility testing methods for *Mycobacterium tuberculosis.*

  - Radiometric (Basic knowledge only) and non-radiometric
  - Agar proportion
  - Understand molecular methods of TB susceptibility testing i.e. molecular probe, PCR and sequencing (usually for INH and/or RIF)
- Discuss the following antimicrobials with regard to**:**
  - bacterial target and clinical application
  - mechanisms of action
  - spectrum of activity
  - mechanisms of resistance**.**

B-lactams
Penicillins (penicillin, ampicillin, synthetic:e.g. cloxacillin).
Cephalosporins (one example of each generation).
Carbapenems (imipenem, meropenem, ertapenem).
ß-lactamase inhibitors (co-amoxiclav acid, piperacillin/tazobactam).

Aminoglycosides
gentamicin
amikacin
tobramycin

MLS group (**m**acrolides, **l**incosamides and **s**treptogramins):
erythromycin / azithromycin/clarithromycin
clindamycin
quinupristin/dalfopristin

Quinolones/Fluoroquinolones
naladixic acid
ciprofloxacin
ofloxacin
moxifloxacin
gatifloxacin

Glycopeptides
vancomycin
teicoplanin

Phenicols
chloramphenicol

Sulphonamides
Trimethroprim-sulphamethoxazole (co-trimoxazole)

Imidazoles
Metronidazole

Cyclines
Tetracycline

Oxazolidinones
linezolid
cyclic lipopeptide
daptomycin

Antimycobacterials:
streptomycin (STR)
isoniazid (INH)
rifampicin (RIF)
ethambutol (ETH)
pyrazinamide (PZA)

Antifungal drugs:
amphotericin B
fluconazole
echinocandins

- Discuss the classification of the generations of cephalosporins.
- Discuss the recognition of “impossible phenotypes” and typical antibiogram patterns**.**

15. PARASITOLOGY

Objective

To enable the student to recognize and identify parasites at various stages of their life-cycles through the selection of appropriate microscopy and staining techniques

Learning Outcomes

At the end of this section, the student should be able to:

- Describe the life cycles and basic epidemiology of the parasites listed below.
- Discuss sample preparation to optimize detection e.g. stool concentration (see section on MICROSCOPY AND STAINING).
- Select and describe appropriate microscopy and staining techniques (see section on MICROSCOPY AND STAINING).
- Perform visual (micro – and macroscopic) recognition and identification of the parasites at various stages of their life-cycles, as well as demonstration of the most important morphological features of each, with an aid of a simple, labeled sketch.

Use the following as a key:
ova **(O),** oocysts**(OO),** cysts **(C),** hooklets & scolices**(H&S),** larvae **(L),** trophozoites**(T)** and adult forms **(A).**

Cestodes:

- *Echinococcus granulosus***(H&S)**
- *Hymenolepis nana* **(O)**
- *Taenias aginata and T.solium***(O & A)**
-

Nematodes:

- *Ascaris lumbricoides***(O & A)**
- *Enterobius vermicularis (O & A)*
- *Hookworms: Necator americanus, Ancylostoma duodenale***(O)**
- *Strongyloides stercoralis***(L)**
- *Trichuris trichiura***(O & A)**

Trematodes:

- *Schistosoma haematobium***(O)**
- *Schistosoma mansonii* **(O)**

Protozoa:

- *Balantidium coli* **(C & T)**
- *Blastocystis hominis* **(C&T)**
- *Chilomastix mesnili***(C & T)**
- *Entamoeba histolytica* and *Entamoeba coli***(C & T)**
- *Giardia lamblia***(C & T)**

- *Trichomonas vaginalis***(T)**

Coccidia:

- *Isospora belli***(C)**
- *Cryptosporidium parvum***(OO)**
- *Cyclospora cayetanensis***(OO)**
- *Microsporidium spp.* **(spores)**

16. PUBLIC HEALTH

Objective

To obtain comprehensive knowledge of testing procedures and their application in a Public health laboratory.

Learning Outcomes

Upon completion of this section, candidates should be able to describe/explain and interpret the following tests:

- **POTABLE (DRINKING) WATER**
  - Filtration procedure for presence of coliform organisms.
  - Confirmatory procedure for presence of *E.coli*.
  - Interpretation and reporting of above results according to the SABS standards.

- **MILK**

  - Method for determining the mesophilic aerobic count.
  - Interpretation and reporting of above results according to the milk regulations.
  - Methods to detect the presence of coliform organisms and *E.coli* in pasteurised milk.
  - Method of the phosphatase test and the interpretation of results.
  - Brucella ring test
  - Detection of pathogenic organisms i.e. *Stapylococcus aureus* and *Salmonellae*.

- **FOODSTUFFS**

  - Know the "Indicator organisms".
  - Be able to explain the laboratory procedures that demonstrate the presence of the following food-borne pathogens and the interpretation of positive results.
  - Know the pathogenesis of the following food-borne pathogens and the significance of their presence in foodstuffs:

    Bacillus cereus
    Campylobacter spp.
    Clostridium perfringens
    Listeria monocytogenes
    Salmonella spp.
    Staphylococcus aureus
    Vibrio cholera, Vibrio parahaemolyticus
    Enterobacter sakazakii

17. SEROLOGY

Objective

To obtain knowledge and understanding of serological tests employed by the bacteriology laboratory in the diagnosis of disease.

Learning Outcomes

Upon completion of this section, candidates should be able to:

- Describe the principles, procedures and troubleshooting for the following tests:

  - Agglutination
  - Enzyme linked immunosorbent assay (ELISA)
  - Haemagglutination, direct and indirect
  - Immunofluorescence, direct antigen detection.
  - Immunofluorescence, indirect antibody detection.
  - Neutralization reactions
  - Precipitation
  - Lateral flow assay (LFA)

- Know which of the above serological tests to use, interpret the results and any influencing factors to consider when performing the tests to detect infections due to:

  Brucella abortus
  Chlamydia trachomatis, C. pneumoniae and C.psittaci
  Cryptococcus neoformans
  Echinococcus granulosus
  Entamoeba histolytica
  Epstein Barr virus (screening test only)
  S. pyogenes
  Human Immunodeficiency Virus (screening test only)
  Legionella pneumophilia
  Mycoplasma pneumoniae
  Pneumocystis jiroveci
  Rickettsia conorii
  Salmonella typhi and *paratyphi*
  Schistosoma haematobium
  Taenia solium
  Toxoplasma gondii
  Treponema pallidum
  Yersinia enterocolitica
  Helicobacter pylori
  Rotavirus
  Adenovirus
  Respiratory Syncytial virus

- Discuss the interpretation of results including IgG, IgM and IgA levels where relevant.

18. CLINICAL APPLICATIONS

Objective

To enable the student to integrate data derived from an understanding of the factors underlying a clinical problem, assessment of the clinical picture and laboratory results.

Learning outcomes

Using the following headings, the candidate should be able to discuss/describe the clinical conditions listed below:

- Introduction/Background
- Epidemiology
- Predisposing factors
- Pathophysiology
- Clinical picture and causative organisms
- Laboratory diagnosis, expected results and interpretation of testing

a) Burns, bedsores and chronic ulcers
b) Diarrhoea/gastro-enteritis/enterocolitis
c) Ear, nose and throat infections
d) Fungal diseases
e) Meningitis
f) Nosocomial infections
g) Post-operative sepsis
h) Pyrexia of Unknown Origin (PUO)
i) Respiratory diseases
j) Septicaemia
k) Sexually transmitted infections (STI's):
l) Tuberculosis
m) Urinary tract infections (UTI)
n) Diseases of the immuno-compromised host, especially HIV/AIDS and related diseases
o) Parasitic infections

19. REFERENCE MATERIAL

The following list of books is included merely as a guide; there are many other suitable textbooks available.

Murray PR, Rosenthal KS &Pfaller MA, 2013. Medical Microbiology, 7th Ed. Elsevier.

Atlas of Clinical Fungi. (Eds) G.S. de Hoog and J.Guarro.
Atlas of Medical Helminthology and Protozoology. (Eds) Jeffrey and Leach.
Bailey & Scott's Diagnostic Microbiology , Betty A Forbes Daniel F Sahm and Alice S Weissfeld
Bergey's Manual of Determinative Bacteriology. (Eds.) John.G.Holt, Noel.R. Krieg *et al*.
Colour Atlas Textbook of Diagnostic Microbiology, 5th Edition-1997. (Eds.) E.W. Koneman, S.B.Allen*et al*. Lippencott, New York.
Health Professions Council of South Africa (HPCSA):www.hpcsa.co.za
Manual of Clinical Microbiology. (Eds) Albert Balows, William Hausler*et al*.American Society of Microbiology.
Medical Mycology-The Pathogenic Fungi and the Pathogenic Actinomycetes. (Eds) John Willard Rippon.
Microbiology with Diseases and Taxonomy: International Edition, Robert W. Bauman (Pearson Education).
Parasites: A guide to Laboratory procedures and identification. (Eds) Lawrence R. Ash and Thomas C. Onhel.
Quality control and accreditation references: www.iso.org , www.clsi.org, www.sanas.co.za.
Williams and Wilkens
National TB Management Guidelines 2014
https://www.tbonline.info/media/uploads/documents/national_tuberculosis_management_guidelines_%282014%29.pdf

20. NOMENCLATURE/ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
BPA	Baird Parker Agar
BSAC	British Society for Antimicrobial Chemotherapy
CLSI	Clinical and Laboratory Standards Institute
CO_2	Carbon Dioxide
CPE	*Clostridium perfringens* enterotoxin
CSF	Cerebrospinal Fluid
CTA	Cystine Tryptic Agar
CVP	Central Venous Pressure
DFAT	Direct Fluorescent Antibody Test
DNA	Deoxyribonucleic Acid
ELISA	Enzyme Linked Immunosorbent Assay
ESBL	Extended Spectrum Beta Lactamases
ETH	Ethambutol
EUCAST	European Committee on Antimicrobial Susceptibility Testing
EQC	External quality control
H_2S	Hydrogen Sulphide
HIV	Human Immunodeficiency Virus
HPCSA	Health Professions Council of South Africa
IBL	Inducible Beta Lactamases
IgA	Immunoglobulin A
IgG	Immunoglobulin G
IgM	Immunoglobulin M
INH	Isoniazid
ISO	International Organisation for Standardisation
IUATLD	The International Union Against Tuberculosis and Lung Disease
IQC	Internal quality control
KOH	Potassium Hydroxide
LFA	Lateral Flow Assay
MBC	Minimum Bactericidal Concentration
MDR	Multi Drug Resistant
MGIT	Mycobacteria Growth Indicator Tube
MIC	Minimum Inhibitory Concentration
MLS	**M**acrolides; **L**incosamides; **S**treptogramins
MOTT	Mycobacteria Other Than Tuberculosis
MRS	Man-Rogosa-Sharpe broth
MRSA	Methicillin-resistant *Staphylococcus aureus*
NaCl	Sodium Chloride
NTM	Non-tuberculous Mycobacterium
OF	Oxidation/Fermentation
OHSA	Occupational Health and Safety Act
ONPG	ortho-Nitrophenyl -β-galactoside
PCR	Polymerase Chain Reaction
PUO	Pyrexia of Unknown Origin
PZA	Pyrazinamide

RFLP	Restriction Fragment Length Polymorphism
RIF	Rifampicin
RNA	Ribonucleic Acid
SABS	South African Bureau of Standards
SOP	Standard Operating Procedure
SPS	Sodium Polyanethol Sulphonate
STI	Sexually Transmitted Infection
STR	Streptomycin
TB	Tuberculosis
TCBS	Thiosulphate Citrate Bile Salts Sucrose agar
TGEA	Tryptone Glucose Extract Agar
UTI	Urinary Tract Infections
VP	Voges-Proskauer
VRE	Vancomycin-resistant Enterococcus
WHO	World Health Organisation
XDR	Extensively Drug Resistant
XLD	Xylose-Lysine-Deoxycholate Agar
ZN	Ziehl Neelsen