

SYLLABUS

HAEMATOLOGY

TECHNICIANS

Effective from Feb 2019 for examinations from October 2020

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1. Introduction

Objective

The objective of this syllabus is to provide those student technicians with a guideline to the essential aspects that must be covered in order to adequately prepare them as a Haematology Technician candidate for the HPCSA's Professional Board Examination of Medical Laboratory Technician, who wish to register as Haematology Medical Technician at the end of their second year of training.

It is expected from them that they cover all the practical's included in this instruction manual. Their promoters must ensure that they are competent in all the prescribed laboratory procedures.

The student will be able to provide an adequate practical and theoretical knowledge of screening, quantitative and qualitative analytical process used in the testing of specimens in a haematology laboratory. In addition, they are required to have minimal understanding of the interpretation of the final results.

Range

Peripheral Blood and Bone Marrow

Body fluids for specific testing such as:

- Urine for haemosiderin and eosinophils.
- Sputum for eosinophils.
- CSF and other body fluids for cytopsin.

Specific Outcomes

At the end of the training period the student will sit an examination consisting of two, two hour papers. Both papers will be broadly based on the entire field of Haematology as covered in this syllabus up to, and including the final year. The students will be required to draw from all knowledge gained to date in order to answer these papers. The emphasis will be on laboratory techniques and concepts expected of a fully competent Medical Technician in Haematology. Specific details of methods, times and quantities will be asked. Students will however, be expected to know basic principles and expected results.

Laboratory Requirements

HPCSA regulations require that accredited training laboratories perform minimum of 80% of the tests identified in this syllabus. Laboratories are required to ensure that the interns receive appropriate training in the tests contained within the syllabus but which is not routinely performed on site.

1. Statutory Regulations and Ethics

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Objective

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

Specific Outcomes

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

- Demonstrate basic understanding of the structure and functions of the Health Professions Council of South Africa.
- Demonstrate basic knowledge of the structure and function of the South African Professional Board for Medical Technology.
- Understand the regulations relating to the scope of practice for Medical Technicians.
- A basic understanding of the legal and ethical standards related to the professional practice of medical technology/technicians.
- Demonstrate an understanding of the requirements for the acquisition of Continual Education Units (CEUs).

2. Total Quality Management

2.1. Laboratory Safety

Objective

Provide knowledge of all safety procedures in the workplace and the understanding of the relevant legislation.

Specific outcomes

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

- Explain and apply the basic fundamental concepts of the relevant legislation pertaining to laboratory safety. Occupational Health and Safety Act, Compensation for Occupational Injuries and Disease Act, Hazardous Substances Act.
- Demonstrate basic protocols to follow in the event of injuries on duty, including needle stick injury.
- Demonstrate basic knowledge of the procedures to follow in the event of a laboratory accident or emergency. Chemical or biohazard spills, fire, flood or bomb threat.
- Describe basic procedures to follow for the prevention, control and management of laboratory acquired infections including the prevention of blood borne viruses.
- Describe and apply good basic general housekeeping procedures including the demonstration of equipment.
- Describe the basic application of laboratory safety procedures in the collection, transport, storage and analysis of biological specimens.
- Describe the purpose and basic content of the Material Safety Data Sheets (MSDS).

- Describe the basic principles for the storage, handling and disposal of chemicals, poisonous substances, flammable substances, gases and infectious materials.
- Describe the correct procedures for the storage, handling and disposal of laboratory waste, as well as the disposal of biological specimens, human tissue, solid and liquid bio-hazardous waste, radioactive waste and sharps.
- Define the role of the designated safety personnel. First aid officer, fire marshal, and safety representative.
- Recognise the international safety symbols used in the laboratory environment.

2.2. Specimens/Pre Analytical Requirements

Objective

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

Specific outcomes

On completion of this section the 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 the current statutory requirements and limitations.
- Describe the mode of action of the various anticoagulants/preservatives. Including concentration, mode of action and uses of anticoagulants commonly used in Haematology.
- Select the correct anticoagulant/preservative for the analysis to be performed.
- Describe the optimal specimen requirements for the individual tests performed in Haematology
- Have an understanding of turnaround times including viability for all specific haematology tests.
- Describe the conditions under which the specimens must be transported to the laboratory including the use of appropriate transport media.
- 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.
- Describe the process for the rejection of unsuitable specimens.
- Conduct the pre-analytical process required for specimen type and test requested.

2.3. Laboratory Equipment

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Objective

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

Range

All glassware: – volumetric and graduated.

Pipettes: - glass, automated and disposable.

Balances: - top pan and fine chemical.

Small equipment: - Stirrers, hotplates, pH meters, rotators, shakers, rollers (flat bed and vortex), pro-pipettes, rubber teats, pipette aids, microscopes (light, phase contrasts, inverted and fluorescent), fume cupboards, bio hazardous safety cabinets (Class I and II), Centrifuges (micro haematocrit, safety, temperature controlled, ultra), water baths, stop watches/timers, spectrophotometers, thermometers, incubators (Haematology related 37°C).

Laboratory instrumentation: - Staining instruments and automated analysers are included in this range – knowledge of the makes and models in use in the current workplace.

Specific outcomes

(Applicable to all equipment/instrumentation and analysers in the Haematology department)

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

- Describe the principle of operation where applicable.
- Operate all equipment optimally in accordance with recommended procedures.
- Apply the correct safety precautions during the operation and maintenance of equipment.
- Demonstrate appropriate knowledge of, and apply the procedures to follow for the required routine maintenance thereof.
- Discuss the appropriate functional checks that are performed to ensure optimal preparations.
- Conduct applicable demonstration 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 a basic understanding of the approach to the validation of new equipment, reagents and testing kits.
- Demonstrate knowledge of, and maintain, all equipment records and documentation required for good laboratory practice.
- A basic knowledge of the working and standardisation of large apparatus used in haematology

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- Haematology analyser.
- Flow cytometer (CD4 counts).
- Coagulation instrument.

A working knowledge of reagent preparation, specifically related to Haematology.

2.4. Laboratory Reagents

Objective

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

Range

At the end of this section the student must be competent in making up: stock solutions, working solutions, working reagents, controls, calibrators, reagent kits as related to Haematology.

Specific outcomes

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

- Differentiate between standards, controls and calibrators.
- Prepare, store and safely dispose of laboratory reagents.
- Demonstrate knowledge of the objective, use and retention of package inserts.

2.5. Stock Control

Objective

Outline the processes involved in good stock management.

Specific outcomes

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

- Demonstrate an understanding of the receipt of stock including the required records regarding the condition of goods, expiry dates and lot numbers.
- Demonstrate knowledge of the basic principles to apply when managing stock of reagents.
- Describe the correct storage conditions of stock.
- Demonstrate knowledge of company policy with regard to the use of expired reagents, controls and calibrators.
- Must be able to perform batch to batch validations of reagents prior to use.

2.6. Quality Control/ Quality Assurance / Accreditation

Objective

The student needs an exposure to aspects of quality control.

Specific outcomes

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

- Discuss basic quality assurance and quality control in the correct context.
- Have sufficient understanding of the package inset with regards using the manufacturers mean and application within the 1, 2 and 3SD of the laboratories range.
- Define the process of quality assurance in the pre-analytical, analytical and post analytical areas.
- Define the appropriate quality control process performed in the analysis of all parameters, equipment and analyser operation, reagent preparation as contained in the syllabus.
- Explain the principles of internal and external quality control procedures in the context of the tests they can performed.
- Apply basic knowledge of all the principles, procedures and calculations and interpretation of internal and external, **quantitative** quality control data.
- Apply basic knowledge of all the procedures, principles and interpretation of internal and external **qualitative** quality control data.
- Demonstrate a basic understanding of the potential causes and apply appropriate troubleshooting procedures in the event of failed internal and external, quantitative and qualitative quality control.
- Define basic terminology used in the assessment of quality control results. Westgard rules, shift, trend, outlier, positive and negative bias, specificity, precision, sensitivity, systemic error, random error, delta difference, reference range, linearity, reportable range.
- Demonstrate a basic understanding of the term “Uncertainty of Measurement” and its’ application to the Haematology laboratory results.
- Describe and apply the appropriate quality control for all testing procedures included in this syllabus.

2.7. Personnel

Objective

Provide knowledge of basic requirements for personnel in terms of GLP.

Specific outcomes

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

- Describe the personal documents and records which are required for all personnel.

- Demonstrate an understanding of the terms “competency” and “ongoing competency” in terms of training laboratory personnel.
- Must understand the CPD requirement of the profession.

2.8. Documentation

Objective

Provide knowledge of basic requirements of documentation in terms of GLP.

Range

Policies, SOPs, equipment records, quality control records, personnel records, package inserts and archiving.

Laboratory Policies on: Issue of new documents, review process, process for obsolete documentation, document retention and disposal.

Specific outcomes

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

- Demonstrate a basic knowledge of the management of laboratory documentation in terms of GLP and in terms of relevant ISO standards.
- Basic knowledge of issuing new documents, frequency of review, process of obsolete documentation, documentation retention and disposal.
- Demonstrate a basic knowledge of required content for SOPs.

3. Laboratory Related Mathematics

Objective

Provide and instruct on the application of the correct mathematical formulae to relevant calculations used in Haematology.

Specific outcome

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

- Demonstrate the proficiency in the use of the correct formula used in the calculation of their patients’ haematological results. Red Cell Parameters (MCV, MCH, MCHC, HCT/PCV and RDW), absolute and relative differential white cell counts, correction for the presence of nucleated red cell parameters, percentage haemolysis, mean corpuscular fragility, INR, absolute reticulocyte count, RMI/RPI, reticulocyte percentage and corrected reticulocyte count, Prothrombin Ratio PR and Prothrombin Index PI. Calculation of CD4 counts.
- Demonstrate an ability to apply the calculations required for the preparation of solutions or patients samples. Normal solutions, percentage solutions, molar solutions, titrations/dilutions, serial and doubling dilutions.

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- Apply the correct formula used in the assessment of quality control results. SD, CV, mean, median, reference range.

4. Haematology Theory

5.1 Anatomy and Physiology of the Bone Marrow

Objective

The objective is to provide the student with working knowledge, and understanding of basic aspects of haemopoiesis.

Specific Outcome

On completion of this section the student:

- Will be able to define haemopoiesis.
- Understand the function of bone marrow relevant haemopoiesis.
- Understand, and be able to illustrate the origin and normal development of the following haemopoietic elements:
 1. Erythrocytes
 2. Leucocytes
 3. Platelets

5.2 Erythrocytes

Objective

The objective is to supply the student with sufficient understanding of normal and abnormal erythrocytes pertaining to the syllabus.

Specific Outcome

- They must demonstrate sufficient knowledge outlining normal red cell life span, both theory and illustration of maturation from blast to mature erythrocyte.
- To demonstrate a basic understanding of Extravascular and Intravascular Haemolysis.
- The structure, appearance and function of normal circulating reticulocytes and red blood cells.
- A general description and knowledge of anaemia.
- A basic knowledge of the laboratory findings in the following, including full blood count parameters and morphological findings:
 - Iron deficiency anaemia.
 - Megaloblastic anaemia.
 - Haemolytic anaemia

- Aplastic Anaemia.
- Normocytic Normochromic Anaemia.

5.3 Leukocytes

Objective

The objective is to supply the student with sufficient understanding of normal and abnormal leukocytes pertaining to the syllabus.

Specific Outcome

- They demonstrate sufficient knowledge outlining normal leukocyte life span, including the granulocyte maturation sequence from blast to mature granulocyte, both theory and illustration.
- Basic knowledge of morphological variations and their significance.
- The student must be provided with sufficient knowledge to identify morphological features, written and illustrated of:
 - Neutrophils
 - Eosinophils
 - Basophils
 - Lymphocytes
 - Monocytes
- The significance of raised and reduced numbers (absolute and percentage).
- Basic knowledge of morphological variations and their significance of each.
- Outline the basic function of each of the following cells:
 - Neutrophils and band cells
 - Eosinophils
 - Basophils
 - Lymphocytes
 - Monocytes
- Understand the meaning of: leukocytosis, neutrophilia, eosinophilia, basophilia, lymphocytosis and monocytosis. Including a basic understanding of each of their applications.
- Understand the meaning of: Leukopaenia, neutropaenia and lymphopaenia. Including a basic knowledge of their application.
- Identify the following white cell morphological changes:
 - Toxic granulation
 - Hypersegmentation
 - Smear Cells
 - Atypical/reactive lymphocyte
 - Inclusions such as: dohle body, vacuolation.
- Infection: Both bacterial and viral.
- Differentiated between a leukaemoid reaction and a leukaemia.

5.4 Platelets

Objective

The objective is to supply the student with a basic understanding of normal platelet function and maturation sequence and a basic working knowledge of the abnormalities listed below.

Specific Outcome

When the student has completed this section they will have basic understanding of the following:

- Must be able to provide sufficient knowledge outlining the normal platelet maturation and life span, including the platelet maturation sequence, theory and illustrated.
 - A basic knowledge of platelet abnormalities:
 - Definition of Thrombocytopenia.
 - Definition of Thrombocytosis.

5.5 Haematological Malignancies

Objective

To provide training for the student to recognise and have a sufficient knowledge of laboratory findings of the morphological and working haematologic parameters to identify the malignancies listed below.

Specific outcomes

On completion the student should have an understanding of the following malignancies including: morphologically and the full blood count related parameters of:

- Acute leukaemia: Differentiation between a myeloid and lymphoid blast.
- Chronic myeloid leukaemia.
- Chronic lymphoid leukaemia.

5.6 Haemostasis

Objective

The objective is to provide sufficient training for the student, to recognise, and exhibit sufficient knowledge basic coagulation.

Specific Outcome

On completion of this section the student should have a basic knowledge in the theory of normal blood coagulation, including the role of platelets and clotting factors.

- List the main components in maintaining haemostasis.

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- Platelets
- Vascular Integrity /System
- Coagulation Factors
- Fibrinolysis/Fibrinolytic system
- Define the term haemostasis.
- Have knowledge of the principles behind coagulation testing:
 - PT and the relevance of the INR and warfarin therapy.
 - APTT and effect of heparin therapy on prolonged results.
 - Have an understanding of specific coagulation anticoagulants and the affect on results, including overfilling and under filling of tubes.
- Platelets:
 - Basic structure/production
 - Function
 - Plug formation
- Coagulation system
 - Cascade pathway
 - Coagulation factors
 - Demonstrate the effect of liver disease on coagulation.
 - Demonstrate knowledge of Vitamin K dependant factors.

5.7 Blood Parasites

Objective

To provide sufficient training for the student to recognise and understand laboratory findings for the blood parasites listed below.

Specific Outcome

When the student has completed this section they need to demonstrate sufficient knowledge of the following:

- An understanding of the life cycle and appearance in the peripheral blood of the following parasites:
 - Malaria
- Should have an understanding of the malarial antigen kit method, and have knowledge to perform the test antigen.

5.8 Basic Haematology Values

Objective

The objective is to supply the student with sufficient training to calculate specific haematological parameters, and understand the importance thereof.

Specific Outcome

On completion of this section the student is expected to know, calculate and interpret the following haematological ranges (In addition to Section 4 on haematological related mathematics):

Normal haematological parameters:

- WBC, RBC, Hb, HCT/PCV, MCV, MCH, MCHC, RDW, Platelets, MPV.
- Neutrophil, lymphocyte, monocyte, eosinophil, basophil.
- Calculation and significance of indices and all commonly determined haematological values.

Red cell parameters:

- MCV, MCH, MCHC

White cell parameters:

- Correction for the presence of nucleated red blood cells.
- Absolute differential white cell count.

Reticulocyte count:

- Reticulocyte count percentage
- Uncorrected reticulocyte count percentage
- Reticulocyte production index RPI.
- Absolute Reticulocyte calculation.

6. Haematology Practical

Objective

The objective of this section is to award the student a thorough knowledge of the principles and methods of the following procedures, including standardisation and calculations.

6.1 Slide Preparation

Specific outcome

The student must have a practical understanding of the following methods, pertaining to routine morphology, including bone marrow aspirate slide preparation, bone marrow crush and imprints, reticulocyte preparations and preparations for malaria examination. They need to know carry out the practice below and sufficiently understand what they are used for:

- Preparation of wedge, for peripheral blood and bone marrow aspirates.
- Spinner preparation.
- Buffy layer smears.
- Cytospin preparation.

6.2 Stain Preparation

Specific outcome

The student must have a practical working knowledge of haematological stains and procedures, at the end of this section they must know stain preparation and principles including uses for the following stains.

- Romanowsky stains.
- Supravital stains.
- Malaria parasite staining thick and wedge preparation.
- Cytochemical staining MPO and Esterase.

6.3 White Cell Differentiation

Specific Outcome

On completion of this section the student must demonstrate sufficient knowledge to:

- Evaluate a **normal** white cell differential and assess the red cell, white cell and platelet morphology.
- They need to have sufficient knowledge to **identify** the following conditions:
 - **Infections:** As covered in 5.3 Leukocytes
 - **Anaemias:** As covered in 5.2 Erythrocytes
 - **Leukaemias:** As covered in 5.5 Haematological Malignancies
 - **Leukaemoid Reactions:** As covered in 5.3 Leukocytes.
 - **Blood parasites:** As covered in 5.7 Blood Parasites

6.4 Coagulation

Specific Outcome

At the end of this section the student must have sufficient knowledge to explain the principle, procedure and perform the following coagulation tests. In addition, reference range, anticoagulant therapeutic effects on these tests:

- Manual and automated Prothrombin Time PT and INR
- Manual and automated Activated Partial Thromboplastin Time (APTT)
- Bleeding Times.

6.5 Miscellaneous Tests

Specific outcome

On completion of this section the student should demonstrate sufficient knowledge and understanding of preparation, expected ranges and influencing factors on the following tests:

- ESR manual and semi automated
- Reticulocyte count manual and automated.
- Iron stain on bone marrow and urine.
- Malaria stain (thick and thin preparations) and antigen test.
- Cytochemical staining for MPO and Esterase.

6.6 Immunohaematology

Specific outcome

On completion of this section the student is required sufficiently understand and perform the following tests. They must have a basic knowledge of the principles, methodology and expected results.

- Coombs direct and indirect
- ABO and Rh.

6.7 Bone Marrows

Specific Outcome

On completion of this section, the student should have a basic knowledge of the following:

- How to make a bone marrow aspirate wedge preparation.

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- Prepare aspirates for cytogenetic and molecular studies.
- Other slide preparations required from bone marrow aspirates, such as: crush and imprints.
- Safety precautions required for all procedures in the bone marrow room.

6.8 Flow Cytometry: CD4 Counts and CrAg LFA

Specific Outcome

On completion of this section the student will have sufficient knowledge to:

- Perform daily instrument maintenance.
- Prepare CD4 counts for flow cytometric analysis (automated and manual).
- Plot daily controls.
- Enter results on the LIS.
- Set up, perform and enter the results in the LIS for the CrAg LFA.

6.9 Laboratory Equipment

Specific Outcome

On completion of this section the student must have working knowledge of the following pieces of laboratory equipment (*In addition, to section 3.3 Equipment.*)

- They must be able to use and understand the principle of the following equipment:
 - PH meter
 - Centrifuge
 - Chemical balance
 - Microscope
 - Water bath
 - Automated pipette
 - Heating blocks

6.10 Molecular Biology

Objective

Provide the student with an introductory knowledge of basic molecular biology.

Specific Outcome

At the end of the training the student will be able to:

- Describe the flow dynamics in a molecular laboratory.
- Define and apply the methods used for the control of contamination in a molecular laboratory.
- Demonstrate a fundamental knowledge of the function of **DNA ONLY** in terms of structure, transcription and translocation.
- Demonstrate a basic understanding of the steps involved in the polymerase chain reaction (**PCR**). Demonstrate a basic knowledge of DNA extraction.

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- **Range:** Extraction, pour gels prepare buffers, prepare master mix.
- **Extract DNA** in preparation for storage and analysis in accordance with laboratory procedures.
- List the components of **PCR** master mix and explain the purpose and action of each component.
- Demonstrate knowledge of the quality controls used in the testing procedure.

7. Reference Material

Practical Haematology Tenth edition (2008)

S.M. Lewis and John V. Dacie

ISBN—978-0-44306660-3

Churchill Livingstone

8. Nomenclature / Acronyms

APTT – Activated Partial Thromboplastin Time

CEUs – Continual Education Units

CrAg LFA – Cryptococcal Antigen Lateral Flow Assay

CSF – Cerebral Spinal Fluid

CV – Coefficient Variant

DNA - Deoxy Ribonucleic Acid

GLP – Good Laboratory Practice

Hb/HGB - Haemoglobin

HCT - Haematocrit

HPCSA – Health Professions Council of South Africa

INR – International Standard Ratio

ISO – International Standard Organisation/International Organisation Standard

LIS – Laboratory Information System

MCH – Mean Cell Haemoglobin

MCHC – Mean Cell Haemoglobin Concentration

MCV – Mean Cell Volume

MPO – Myeloperoxidase

MPV – Mean Platelet Volume

PCR – Polymerase Chain Reaction.

PCV – Packed Cell Volume

PR – Prothrombin Ratio

PI – Prothrombin Index

PT – Prothrombin Time

RBC – Red Blood Cell

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RCC – Red Cell Count
RDW – Red Cell Distribution Width
RMI – Reticulocyte Maturation Index
RPI – Reticulocyte Production Index
SD – Standard Deviation
SOP – Standard Operating Procedure
WBC – White Blood Count
WCC – White Cell Count

Appendices

None

APPROVED