Health Professions Council of Zambia

CORE COMPETENCIES REFERENCE MANUAL FOR SCIENCE LABORATORY TECHNOLOGIST
TO PRACTISE IN ZAMBIA

CORE COMPETENCIES & MINIMUM STANDARDS

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QUALIFICATION AND RESPONSIBILITIES:

Title of the programme: Diploma in Science Laboratory Technology.

Key accountability for the job: Protect the general public from health hazards associated with food and other artifacts offered for sale, import/or export for food safety and provide clinical and forensic toxicology.

Primary roles and responsibilities:

1. Microbiological and chemical analysis of food, water and natural products
2. Analyse clinical toxicology specimens
3. Analyse forensic toxicology samples in nature

1.0 INTRODUCTION

The Health Professions Council of Zambia (HPCZ) is a statutory body that was established by the Health Professions Act No. 24 of 2009. The Act renames and continues the existence of the Medical Council of Zambia established by the Medical and Allied Professions Act of 1977. The Health Professions Act No. 24 provides for the registration of health and regulation of their professional conduct; provides for the licensing of health facilities and the accreditation of health care services provided by health facilities; and provides for the recognition and approval of training programmes for health practitioners

Following the issuance of the guidelines for introduction of licensing examinations for health professionals to be registered with the Health Professions Council of Zambia, this bulletin provides an outline of the core competencies and minimum standards for registrants who have completed the Diploma in Science Laboratory Technology seeking registration as Science Laboratory Technology in Zambia.

2.0 EXIT EXAMINATIONS AND AWARD OF THE DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY

Training institutions, private or public(local and foreign) approved /recognised by the Health Professions Council of Zambia are mandated to examine and graduate their students under their own seal and authority as prescribed by the HPCZ act number 24 of 2009. The Diploma in Science Laboratory Technology award is designated the primary qualification of the practitioner and it is a pre-requisite requirement for eligibility for a Science Laboratory Technologist licensing examinations. Accordingly, a holder of the Diploma in Science Laboratory Technology award will be required to take and pass the HPCZ licensing examination to qualify for registration with the Council as a Science Laboratory Technologist.

3.0 LICENSURE EXAMINATIONS BY THE HEALTH PROFESSIONS COUNCIL OF ZAMBIA

A person shall not practise as a health practitioner, unless that person is registered as a health practitioner in accordance with the Health Professions Act No. 24 of 2009. In the exercise of its functions under this Act, the 2nd and the 3rd Council of the Health Professions Council of Zambia instituted Licensure Examinations to help maintain standards given the emergence of multiple private and public training institutions. This “Bulletin provide Core Competencies and Minimum Standards for the Licensing Examinations for Science Laboratory Technologist to Work in Zambia” binds all parties regulated under this Act. Examination fees for licensure examinations, as prescribed by the Council, are payable to the Health Professions Council of Zambia as part of the eligibility to sit licensing examination.

The HPCZ Licensing Examination assesses a laboratory technologist’s ability to apply knowledge, concepts, and principles, and to demonstrate fundamental research and analytical skills, that are important in public health, clinical toxicology, forensic toxicology and medical research. The HPCZ Licensing Examination includes, but is not limited to, theoretical and practical examinations

which complement each and the other components. No component is a stand-alone in the assessment of readiness for Science Laboratory Technologists in Zambia.
The candidates will be assessed under three domains namely

1. Knowledge
2. Skill
3. Attitudes

Three domains will be assessed by means of a theory exams comprising of multiples choice questions followed by composite objective structured laboratory techniques
The three domains will be from professional Courses which give the graduates the theory and practical skills.

The four main **subject areas** (assessed under all three learning domains**)** for Science laboratory technologist are:

1. Microbiology techniques
2. Analytical chemistry techniques
3. Instrumentations
4. Laboratory Management

Other subject areas prescribed by the curriculum such as Communication skills, entrepreneurship will only be assessed as cognitive domain in the theory paper. The overall expected outcomes of science laboratory technologist licensure examination is to ensure that the candidate will meet the minimum standards for the role as a laboratory technologist in public health

4.0 COMPETENCE OUTCOME GUIDELINES

The curriculum must have hard identified attributes in each educational domain (knowledge, skills and attitude) and present them to guide Science laboratory technologist graduate learning profession and assessment by examiners.

OVERALL OUTCOMES

Knowledge, Skills and Performance

1. Carry out chemical analysis and quality control of food for Food borne pathogens, mycotoxins, pesticide residues, metallic and nonmetallic contaminants, and nutritional value of food constituents and presence of allergens
2. Isolating, identifying and measuring toxic substances or radiation and any harmful effect they have on humans, animals, plants or ecosystems.
3. Understand the principles techniques of Instrumentations and Quality Control

SAFETY AND QUALITY

1. Treat all specimens as health hazards and should be handled with care,
2. Treat all service users and colleagues respectfully and equally without any discrimination or prejudice that could compromise their professional roles or duty of care.

3. Never delegates a task or duty to anyone who is not trained, qualified or experienced sufficiently to undertake it without supervision.

COMMUNICATION, PARTNERSHIP, AND TEAMWORK

1. Communicates effectively and meet all applicable reporting standard
2. Ensures that colleagues under their management are fully supervised and supported

MAINTAINING TRUST

1. Act in the best interests of the service, clients and other professionals.
2. Respect the confidentiality of individual, employer, and service users unless disclosure is permitted by law and justified in the individuals or community interest management
3. Demonstrate awareness and apply administrative, management and finance principles.
4. Take up entrepreneurship challenges to complement public health services in the country.
5. Not allow bias, conflict of interest, or the undue influence of others, override their professional judgment.

5.0 CORE COMPETENCIES: SCIENCE LABORATORY TECHNOLOGIST

DOMAIN : KNOWLEDGE		
COMPETENCY STATEMENT	**COMPETENCY**	**SUBCOMPETENCIES**
Graduates should demonstrate the knowledge in water pollution, various types of water borne diseases and their causative, understand microbiological considerations of water quality and be able to apply this knowledge in laboratory practice.	1. Biological Techniques and Water quality assessment and pollution	1.1 Knows the qualities of water. 1.2 Knows water pollution and control. 1.3 Knows the various types of water borne diseases and their causative agents. 1.4 Explains water sampling techniques. 1.5 Knows different types of Microscopes. 1.6 Explains the techniques involved in the preparation of common biological reagents. 1.7 Know the microscope examination of micro-organisms 1.8 Understand systematic microbiology 1.9 Understand growth of micro-organisms
	2. Understand the Analytical Process	2.1 Understanding of Titrimetric Analysis, including the use of non-aqueous solvents 2.2 Understands the principles and applications of Gravimetric Analysis involved in separation methods 2.3 Understands the physical/chemical principles involved in separation methods
	3 Understand the Principles of toxicology and	3.1 Understands the basic concepts of toxicology 3.2 Knows the history and scope of technology 3.3 Understands environment toxicology

Graduates should assess the impact of toxic and foreign materials and radiation on the environment and human and animal health.	metabolism of foreign compounds (Xenobiotics) in the body	3.4 Knows toxicity factors 3.5 Knows the toxicants in the environment 3.6 Understands toxic effects of toxicants. 3.7 Knows absorption, distribution and excretion of toxicants. 3.8 Understands metabolism and Biotransformation of toxicants. 3.9 Knows toxicity testing 3.10 Metabolism of foreign compounds in the body. 3.11 Understands the analysis of materials of material interest 3.12 Carries out qualitative and quantitative analysis of drugs and chemicals using TLC, GC, HPLC, U.V. & I.R. spectroscopy 3.13 . Carries out urine analyses after administration of different drugs 3.14 Extracts drugs from biological tissues and identify by TLC etc 3.15 Practical extractions of food test. 3.16 Monitors contaminants in foods and beverages. 3.17 Extracts poison from a formulated sample 3.18 Practical spot tests on metallic poisoning.

	4. Instrumental analytical chemistry and quality control	4.1 Explains the principles of spectrophotometer 4.2 Explains the principles of atomic spectroscopy 4.3 Explains the principles of ion selective electrodes 4.4 Explains the principles of mass spectrometry 4.5 Explains the principles of NMR 4.6 Further understands the techniques of HPLC and GC 4.7 Understand the principles of Quality Control
Graduates should be able to follow laboratory rules and the techniques involved in maintenance of instruments and know how to prepare different types of solution in laboratory and how manage samples.	5. Preparation of Laboratory Slide Shelf Reagents, Separation Techniques and Sample Management. Safety in the laboratory, Care and maintenance of various Laboratory Equipment and techniques of preparing biological and non-biological materials.	5.1.Explains the preparation of solutions and reagents in the laboratory 5.2 Explains the different types of solvents and their applications 5.3 Knows the: storage, extraction 5.4 Describes the physical and chemical principles involved in some separation methods used in the laboratory 5.5 Demonstrates the collection, handling and preservation of biological laboratory specimens 5.6 Describes the physical and chemical principles involved in some separation methods used in the laboratory 5.7 Understands the common laboratory hazards 5.8 Understands the basic safety rules in the laboratory Understand Radiation 5.9 Explains the calibration of glass ware 5.10 Knows the various uses of glass ware in the laboratory

		5.11 Explains the maintenance of laboratory balances 5.12 Understands the principle application and maintenance of microscope 5.13 Understand microtomy and the maintenance of microtomy tools
Graduate should Understand the practical aspects of immunoassays including: preparation of hapten-carrier conjugates, immunisation, antibody detection, antibody titres, calibration, matrix effects	6 Understand the principles, design, operation and applications of immunoassays	6.1 Explains the basic principles and applications of automation in the laboratory 6.2 understands the different separation techniques used to separate bound analyte from free: dextran-coated charcoal, second antibody, immobilisation 6.3 Understands the practical aspects of immunoassays including: preparation of hapten-carrier conjugates, immunisation, antibody detection, antibody titres, calibration, matrix effects 6.4 Knows the use of affinity chromatography as an immunoassay. 6.5 Discuss immobilisation and elution techniques used with affinity chromatography 6.6 Understands the general principles, operation and applications of electro analytical methods
Graduate should be acquainted with foodstuff in terms of origin of raw material and techniques involved in food safety.	7. Understand the major classification of food and food preservation techniques	7.1 Describes colourants, flavours, preservatives, gelling and emulsifying agents, sweeteners etc. 7.2 Describes the significance of food additives. 7.3 List causes of food spoilage - bacterial, fugicidal via insects and enzyme activity. 7.4 Describes ways of prevention of food spoilage freezing, sterilization, drying etc. 7.5 Explains the basic biotechnology of food

		7.6 Understands the chemical principles and processes involved in food and beer brewing
DOMAIN :SKILL		
COMPETENCY STATEMENT	**COMPETENCY**	**SUBCOMPETENCIES**
	1. Biological Techniques and Water quality assessment and pollution	1.1 Carries out analysis of water using PH meter, Turbidi meter, salino- meter, Total dissolved solid meter, centrifuge, oven, magnetic stirrer 1.2 Tests for TDS, TSS. 1.3 Tests for pH, dissolved oxygen, hardness, magnesium chlorine, and residual chlorine 1.4.Tests for coliforms and other bacteria indicators of water pollution. 1.5.Demonstrates the Preparation of preservatives. alkaline and buffer solution 1.6.Demonstrates the Preparation of stains and Preparation of culture media for cultivation of bacteria, fungi and paramecium. . 1.7.Demonstrates the Preparation of animal tissue up to embedding stage 1.8.Demonstrates Staining techniques 1.9.Demonstrates microscopic techniques in observing the microorganism.
	2. Understand the Analytical Process	2.2 Separates mixture into its various components using silica gel TLC and column chromatography 2.2.Determine the extent of extraction of a material from one phase into a second phase applying the principle of partition law. 2.3.Identify colourless material in paper and thin layer chromatography

		2.4.Analysis of additives in soft drinks by HPLC 2.5.Analysis of drugs by back titration
	3 Understand the Principles of toxicology and metabolism of foreign compounds (Xenobiotics) in the body	3.1 Analyse air, water and soil samples and identify toxicants in them 3.2 Determine toxicity using extraction 3.3 Determine the toxicity of food additives and contaminants in food samples 3.4 Isolating, identifying and measuring toxic substances or radiation and any harmful effect they have on humans, animals, plants or ecosystems 3.5 Determine the toxicity of some selected pesticides 3.6 Determine the toxicity of various plant and animal toxins 3.7 Carries out qualitative and quantitative analysis of drugs using TLC, U.V. & I.R. spectroscopy 3.8 Carries out urine analyses after administration of different drugs
	4.Instrumental analytical chemistry and quality control	4.1.Principles and application of instruments in analysing different of different matrix of specimens.

	5. Ssolutions used in the laboratories and the application of solvents e.g. solid/liquid extraction and safety rules care, maintains of instrument	5.1 Prepare and standardise various solutions 5.2 Applies solvents in extractions and on other cases. 5.3 Be able to mounts the soxhlet apparatus and use it to separate a given material e.g. soya-beans powder for oil content 5.4 Prepares and preserve specimens without disturbing the chemical composition 5.5 Be able to use First Aid Box, Fire extinguisher Fire blanket 5.6 Extinguishers sources of fire controlled. First Aid Box 5.7 Knows how to Seal Radioactive source Unseal radioactive sources. 5.8 Knows the functions of the microscope 5.9 Be able to use autoclave in sterilization of the media 5.10 Applies solvents in extractions and on other cases. 5.11 Be able to mounts the soxhlet apparatus and use it to separate a given material e.g. soya-beans powder for oil content 5.12 Prepares and preserve specimens without disturbing the chemical composition
	6. Graduates should be able to use ELISA	6.1 Performs a qualitative enzyme linked immunoassay (ELISA). 6.2 Analysis of fluoride in toothpaste and Calculate the concentration of fluoride in samples of toothpaste and fluoride supplement tablet

		6.3 Potentiometric titration (e.g. determination of Fe(III) by titration with EDTA or determination of halides by titration with Ag+)
	7.Graduates should be able to describe the chemical and biochemical techniques in the quality control of food	7.1 Applies techniques in detecting preservatives in food 7.2 Isolates and identify different amino acids using chromatography 7.3 Determines the physical and chemical properties of fats and oils Density, 7.4 Refractive index, melting point, colour 7.5 Peroxide value, saponification value, iodine value, TBA value 7.6 Determines the value of colour from different foods using CIE L* a* b* system 7.7 Apply the quality control methods to determine the following in food: 7.8 Carbohydrates, Moisture, Fat, Protein Trace elements, Water soluble vitamins, Fibre 7.9 Applies chemical and biochemical techniques in the quality control of food

	COMPETENCY STATEMENT	**COMPETENCY**	**SUBCOMPETENCIES**

Attitude	Graduates are expected to maintain and uphold professional standards..	1. Professional and ethical practice	1.1 Demonstrate awareness of local, regional and international code of ethics
			1.2 Display the highest standards of professionalism and a commitment to ethical conduct giving at all times due care and consideration to others and putting the interests of the community and patient first.
			1.3 Act in the best interests of the service, community and other professionals.
			1.4 Respect the confidentiality of patients, employer, and service users unless disclosure is permitted by law and justified in the patient's or community interest
		2. Self-management	2.1 Not allow bias, conflict of interest, or the undue influence of others, override their professional judgment.
			2.2 Co-operate with employer and professional colleagues in the interests of providing a safe and high-quality service
			2.3 graduates have a professional duty of care to achieve and maintain a standard of professional competence commensurate with their scope of practice.
			2.4 Demonstrate efficiency and punctuality
			2.4 Prioritize work and implement innovative ideas
			2.6 Health Laboratory must abide by the legal and statutory requirements regulating the profession
		3. Continuous Professional Development (CPD)	3.1 Participate in appraisals, performance reviews and assessments
			3.2 Identify own limitations and act upon them
			The process of lifelong learning, which enables science laboratory professionals to expand and fulfil their personal and professional potential, as well as meet the present and

			future needs of community or a patient and deliver health outcomes and priorities.

6.0 BLUEPRINT WEIGHTING

GUIDE TO PREPARATION OF THE LICENSURE EXAMINATION OF LABORATORY TECHNOLOGISTS

The process of developing the blueprint for competency evaluation involves formulating a set of objectives, reflecting the outcomes and critical areas to be assessed in the licentiate examination. Using George E. Miller's model of competence (Table 2), there are **four main levels of competence** that demonstrate professional authenticity *(Miller, 1990)*[1] across the three domains of learning (knowledge, skills and attitudes).

Table 2: Miller's model of competence

Competence level	Outcome and attributes demonstrated by the graduate:
1. 'Knows'	Cognitive facts gathered in scientific knowledge, skill and attitudes
2. 'Knows How'	Interpretation and application of cognitive knowledge, skills and attitudes
3. 'Shows How'	Demonstration of performance, skills and attitudes
4. 'Does'	Performance integrated into professional practice and behaviour

Therefore, the key areas that guide the formulation of the licensure examination are informed by the levels of competence attainment of the learning objectives for Laboratory technologists. The objectives set for the licensure examination to competence are as follows:

1. To assess **knowledge** of Laboratory Science
2. To assess ability to carry out **laboratory practices** and procedures.
3. Maintain **high standards of safety, health** and environment in a laboratory.
4. Carry out **preventative maintenance** of laboratory equipment and tools

[1] Miller GE (1990). The assessment of clinical skills/performance. Academic Medicine (Supplement), 65: S63 – S67

5. To ascertain adherence to **professional ethics and conduct.**

The blueprint developed for theoretical Licensure Examination questions for Diploma in Laboratory Science Technology graduates seeking to practice as Laboratory Technologists in Zambia is spread among the three domains of learning (i.e. scientific knowledge, skills and attitudes) to cover Level 1 and 2 of the competency framework (Table 2).

Considering the great need for graduates to apply skills and performance attributes, including practice evidence based-laboratory sciences, demonstration of skills and performance is extremely important hence the skills performance domain (Level 3) is given the highest weighting followed by application of scientific knowledge and lastly the professionalism and attitudes. The practical Licensure Examination questions for Diploma in Laboratory Science Technology graduates seeking to practice as Laboratory Technologists in Zambia is spread to cover the relevant skills, performance, applied scientific knowledge and attitude domains accordingly.

Table 3: Weighting of Competence Areas for Theory Licensure Examination for Laboratory Technologists

Objectives	**Content & Weighting of Laboratory Technologists Competences**			
	Scientific Knowledge	**Skills & Performance**	**Professionalism & Attitudes**	**Total**
1. To assess the **knowledge** of Laboratory Science	**50%**	**0%**	**0%**	**50%**
2. To assess ability to carry out **laboratory practices** and procedures.	**10%**	**%**		**10**
3. To ascertain maintenance of **high standards of safety, health** and environment in a laboratory.	**15%**	**%**	**0%**	**15%**

4. Carry out **preventative maintenance** of laboratory equipment and tools	**5%**	**5%**	**0%**	**10%**
5. To ascertain adherence to professional ethics and conduct.	**5%**	**%**	**10%**	**15%**
Total	**85%**	**5%**	**10**	**100%**

Table 4: Weighting of Competence Areas for Practical Licensure Examination for Laboratory Scientists

Objectives	**Content & Weighting of Laboratory Scientist Competences**			
	Scientific Knowledge	**Skills & Performance**	**Professionalism & Attitudes**	**Total**
1. To assess the **knowledge** of Laboratory Science	**10%**	**0%**	**0%**	**10%**
2. To assess ability to carry out **laboratory practices** and procedures.	**5%**	**60%**	**0%**	**65%**

3. To ascertain maintenance of **high standards of safety, health** and environment in a laboratory.	**0%**	**10%**	**0%**	**10%**
4. Carry out **preventative maintenance** of laboratory equipment and tools.	**0%**	**10%**	**0%**	**10%**
5. To ascertain adherence to **professional ethics and conduct.**	**0%**	**%**	**5%**	**5%**
Total	**15 %**	**70%**	**5%**	**100%**

7.0 CORE PROCEDURES

The following procedures are the minimum standards and a full list could be found in the curriculum

Common Procedures(these procedures cut across all the four subject areas mentioned in 4.0)	1	Preparation of preservatives. Sterilize various laboratory objects using the autoclave.
	2	Preparation of alkaline and buffer solution.
Microbiology techniques	3	Preparation of stains
	4	Preparation of culture media. Prepare, sterilise and preserve microbial growth cultures
	5	Preparation of animal and plants tissue and pure culture from a mixed culture
	6	Microtome techniques
	7	staining, Cultivation and observation and measurement of growth of micro-organisms
	8	serological tests, oxidase test, catalase test
	9	Grow micro-organisms under aseptic conditions
	10	Isolated microorganisms
	11	MBA membrane filtration technique
Analytical chemistry techniques	1	Physical parameter for water test for TDS, TSS.

	2	Chemical parameters water test (metals) pH, dissolved oxygen, hardness, magnesium chlorine, and residual chlorine.
	3	preparation of specimens for toxicology
	4	Extraction of toxic from biological and non-biological specimens
	5	Concentration of the extracts
	6	Reconstitution of the extracts
	7	Separation techniques of the substance
	8	Substance isolating, identifying and measuring toxins
	9	Solution preparation
Instrumentations	1	Calibration of instruments
	2	Measurement using colorimeters
	3	Beer - Lambert's Law and using spectrophotometer
	4	Measure the absorbance of a sample of known concentration using the AAS
	5	Measure counter per sec of a beta emitter using scintillating counter
	6	Chromatography analysis
	7	Measure accurately oxygen concentration using the gas measuring electrodes.
	8	Carry out routine maintenance of instruments
	9	Perform instrumental analysis
	10	Flame photometer

Laboratory Management's	1	Assessing, designing, evaluating and implementing new laboratory test methods
	2	Designing and implementing cost-effective delivery models for laboratories, including their services and personnel
	3	Developing and implementing a comprehensive Quality Management System
	4	Procuring laboratory reagents and test samples in an efficient and timely manner
	5	Producing accurate laboratory test results
	6	Correlating and interpreting laboratory test data
	7	Evaluating the outcome of laboratory tests for each individual specimen and the entire quality control system

8.0 REFERENCES MATERIALS

Kindly refer to the curriculum for full list of books.

1. Microbiology techniques	1	Kent Michael, (2000), Advanced Biology, Oxford, UK.

	2	Taylor, D.J, (1997), Biological Science, Cambridge University Press, UK.
	3	Study guide to accompany microbiology by C.F.Norton
	4	Nelson Michael Roberts,(nd) Biology: A Functional Approach, Thornes (Publishers) Ltd
2. Analytical chemistry techniques	1	Miller J.N. and Miller J.C.(2000). Statistics and Chemometrics for Analytical Chemistry. Fourth Edition. Prentice Hall..
	2	Harris D.C.(2002) "Quantitative Chemical Analysis", 6th Edition, Freeman, New York.
	3	Skoog D.A. West D.M. & Holler F.J.(1996). "Fundamentals of Analytical Chemistry", 7th edition. Saunders and Holt, New York.
	4	Kellner R., Mermet J.-M., Otto M. & Widmer H.M. (eds.). (1998)"Analytical Chemistry" Wiley-VCH, Chichester.
	5	Derek A.(nd) Introduction to Clinical Chemistry . Woodrow
	6	Coultate T.P. (1996) Food: The Chemistry of Its Components (3rd Edition), , Royal Society of Chemistry,
	7	Ihekoronye, A.I and Ngoddy, P.O.(nd)“Integrated Food Science and Technology for the Tropics” Macmillan Publishers, London and Basingstok.
4. Instrumentations	1	Skoog D.A., Holler F.J. and Nieman T.A. (1998) Principles of Instrumental Analysis, Fifth Edition. Thomson Learning.
	2	Skoog D.A. West D.M. & Holler F.J.(1996). "Fundamentals of Analytical Chemistry", 7th edition. Saunders and Holt, New York.

5. Laboratory Management's and communication skills	1	Mary Ann, Lowry Etal: People to People: The Business of Communication
	2	Shirley Taylor (1993) 3rd edition Communication for Business
	3	The Royal Society of Chemistry Communicating Chemistry published (UK)