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## Master of Science in Biomedical Toxicology (Full Time)

## About the Programme

The interest behind the M.Sc. Biomedical Toxicology programme is ensuring that all drugs and herbal medicines are safe before release into the market, to ensure delivery of good health and well-being in support of Sustainable Development Goal 3. The programme will develop human capacity in toxicity testing procedures and safety benchmarks to assure safety of chemical-based products such as new drugs, pesticides and industrial chemicals that go to the market. The programme will train personnel in the use of analytical and molecular techniques for the evaluation of the safety profile in drug development; identification of xenobiotics in finished and crude drug products; knowledge of herbal medicine standards and regulations and safety; all in a bid to ensure wellness of the user and the environment.

The aim of the programme is to train and build human capacity in the development and maintenance of standards for protecting and preserving human health while the specific objectives are:

* To identify, maintain and foster standards for professional competency in the field of Toxicology.
* To offer training on a broad range of career options and employment opportunities in academics, the industry and regulatory agencies.
* To promote the establishment of regulations and policies at national, regional and international levels for production of safe drugs and herbal medicines.

The programme will be adding value to the development of drugs in Africa. Drug research and herbal medicine development is a promising area of entrepreneurship with great potential to contribute to the GDP of Africa. There is however critical skill gap at the national and African regional levels for the evaluation of the safety of these drugs and druggable substances before application. The M.Sc. Biomedical Toxicology programme is therefore designed to fill this skill gap by building capacity in biomedical toxicological evaluation and protocol development. The programme will train middle level professionals that upon graduation will have learnt and be able to:

* identify, create and maintain standards protocol in the field of Toxicology for drug research and development.
* build a career and/or employment in industrial, academic, government, non-governmental and other organizations toward contribution to national and regional development and excellent healthcare delivery.
* provide a breach for the skill gaps by giving services in applications fundamental principles as well as current concepts related to mechanisms of toxicity for the investigation of biomedical toxicity of various classes of natural, environmental and synthetic chemical substances such as drugs.

### **Admission Requirements**

A candidate for the M.Sc. Biomedical Toxicology programme must possess must have credit passes in English, Mathematics, Physics, Chemistry and Biology in ‘O’ level or its equivalent at one sitting and a minimum of second-class lower Bachelor’s degree or its equivalent in Pharmacy, Physiotherapy, Medicine, Dentistry, Veterinary Medicine, Biochemistry, Medical Laboratory Science or Pharmacology from any approved University.

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### **Graduation Requirement**

To obtain an M.Sc. in Biomedical Toxicology, a candidate must satisfy a minimum of **24 units** of courses in minimum of two (2) semesters and with cumulative grade point average (CGPA) of 2.40 at 800 level made up as follows:

1. 14 units of compulsory theory courses
2. 2 units of Research seminar
3. 4 units of Research project
4. 4 units of elective theory courses

The duration of the programme shall be minimum of two (2) semesters and maximum of four (4) semesters.

###  **List of Courses for M.Sc in Biomedical Toxicology**

**FIRST SEMESTER**

|  |  |  |  |
| --- | --- | --- | --- |
| **COURSE CODE** | **COURSE** **TITLE** | **STATUS** | **UNITS** |
| TOX 811 | Biochemical and Molecular Toxicology | Compulsory | 2 |
| TOX 812 | Techniques and Methods in Toxicology | Compulsory | 2 |
| TOX 813 | Environmental Toxicology and chemical carcinogens | Compulsory | 2 |
| TOX 814 | Use of Laboratory Animals in Research  | Compulsory  | 2 |
| PUH 801 | Medical Statistics  | Compulsory  | 2 |
| TOX 816 | Biochemical Toxicology | Compulsory | 2 |
| CBG807 | Genetic Toxicology | Elective | 2 |
| TOX 815 | Toxicokinetics | Elective | 2 |
| CBG 808 | Experimental Genetics | Elective | 3 |
| PHG 809 | General Physiology  | Elective | 2 |
| CBG 821 | Biotechnology  | Elective | 2 |
|  | **Total units** | **Compulsory** | **12** |
|  |  | **Elective** | **11** |

**SECOND SEMESTER**

|  |  |  |  |
| --- | --- | --- | --- |
| **COURSE CODE** | **COURSE** **TITLE** | **STATUS**  | **UNITS** |
| TOX 821 | Forensic Toxicology  | Compulsory | 2 |
| TOX 828 | Research Seminar | Compulsory | 2 |
| TOX 829 | Research Project | Compulsory | 4 |
| TOX 822 | Experimental Toxicology | Elective | 2 |
| TOX 823 | Systemic Toxicology | Elective  | 2 |
| CHM 806 | Environmental Chemistry and Chemical Pollution | Elective | 2 |
| CBG 821 | Bioinformatics  | Elective  | 2 |
| RSC 821 | Regulation of Pharmaceutical, Biologic Products and Medical devices | Elective | 2 |
|  | **Total Units** | **Compulsory** | **8** |
|  |  | **Elective** | **10** |

### Summary of number of units compulsory and elective courses to be taken/available at each Level

|  |  |  |  |
| --- | --- | --- | --- |
|  | **First semester** | **Second semester** | **Total** |
| **Level** | Units of Compulsory Courses  | Units of Elective Courses Available | Units of Compulsory Courses  | Units of Elective Courses Available | Total of Compulsory Courses  | Total of Elective Courses Available |
| **800** | **12** | **11** | **8** | **10** | **20** | **19** |

### **Course Contents/Description**

**TOX 811: Biochemical And Molecular Toxicology**

An outline of the basics of molecular biology, drug/receptor interactions, receptors and ion channels, regulation of second messengers and drug metabolism. Biochemical and molecular actions of environmental chemicals and toxicants, and assessment of cellular damage by biochemical measurements and other state-of-the-art technologies. Biochemical and molecular mechanisms of drug/chemical toxicities.

**CBG 807: Genetic Toxicology**

Introduction to the cell, cell theory, ultrastructure of the cell, prokaryotic vs eukaryotic cells, organization of eukaryotic cells, cell cycle, Cell membrane- Theories on the structure of biomembrane, organization of lipids & proteins, specific membrane proteins, cyto skeleton of plasma membrane, functions of plasma membrane (transport, diffusion, active transport, pumps, uniports, symports and antiports). Cytoskeleton, structure and dynamics of microtubules, actin filaments (microfilaments), intermediate filaments, cilia & flagella, role of kinesin and dymein. Cell organelles – Origin, structure and function of mitochondria, endoplasmic reticulum, Golgi complex, ribosomes, endosome, lysosomes, peroxysomes, centrosome. The nucleus- Nuclear envelope, nucleolus, chromosomes, type, structure and chemical composition of chromosomes, organization of genes and noncoding DNA. Cell communication- Cell-cell signaling, cell surface receptors, second messenger system, MDP kinase pathways, signaling from plasma membrane tonucleus. Cell adhesion & cell junctions- cellular affinity, cell adhesion molecules (CAMS), Ca++ dependent cell-cell adhesion, Ca++ independent cell-cell adhesion, cadherins, selectins, integrins, cell junctions. Cell division- Mitotic & meiotic cell division, the central cell cycle control system, feedback signals, cyclin dependent kinases (Cdks), regulation of Cdks.

**TOX 812 : Techniques and Methods in Toxicology**

Acute, subacute, subchronic and chronic exposures to xenobiotics, cytotoxicity, cellular responses, toxicokinetics, modelling, metabolism, cancer-related endpoints, developmental toxicity, prediction of allergenicity, development and application of biomarkers and standard models for toxicological experimental procedures.

**PUH 801: Medical Statistics**

Design, conduct and interpretation of clinical and epidemiological studies, standard statistical concepts of data descriptions, hypothesis testing including test statistics, correlation, p-values, significance levels, confidence levels and linear regression.

**TOX 815 : Toxicokinetics**

Definition, history, scope & sub-divisions of toxicology, Dose-effect and dose-response relationship- acute toxicity, chronic toxicity reversible & irreversible effects. Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity – species and strain, age, sex, nutritional status, hormones, environmental factors, circadian rhythms. Absorption and distribution of toxicants-portals of entry-skin, gastrointestinal tract, gills and respiratory system. Bio-distribution, biomagnification biotransformation of xenobiotics- brief introduction to Phase-I and Phase-II reactions. Reactions of toxins with target molecules- Covalent binding, Non-covalent binding, Hydrogen abstraction, Electron transfer, Enzymatic reactions. Elimination of toxicants-renal, hepatic, DMES, pulmonary systems, milk, egg and foetus.

**TOX 816: Biochemical Toxicology**

Basic principles of toxicology, definition and scope; absorption and distribution of toxicants; toxicokinetics, metabolism of toxicants; comparative toxicology; elimination of toxicants and their metabolites, toxicant-receptor interactions, genetic poisons, chemical carcinogenesis; trace element toxicity, hepatotoxicity. Biological effects of toxic substances in living organisms. Metabolism, cellular and tissue targets, mechanisms of action, and pathological effects. Resistance and tolerance of toxicants, natural toxicants, chronic testing in animals; tests for mutagenicity in toxicological evaluation of chemicals; isolation and structural elucidation of toxicants; enzymatic detoxification.

**CBG 808: Experimental Genetics**

Principles and techniques of genetic experiments with different organisms (Rats/Mice, *Drosophila*, *Allium cepa*, Grasshopper, Man, etc.), Determination of heritability, Instrumentation in molecular genetics, DNA extraction, Protein extraction, Electrophoresis and Polymerase Chain reaction techniques

**PHG 809: General Physiology**

Structure and functions of cells and organelles, cell membrane, nucleus and nucleolus, endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomes, peroxisome, microtubules and microfilaments, intercellular connections, membrane physiology, transport across the cell membrane simple diffusion, osmosis (osmotic pressure), solvent drag, facilitated diffusion, active transport, pinocytosis, phagocytosis and emeiocytosis, homeostasis and control system.

**CBG 821: Biotechnology**

Kinetics and thermodynamics of cell growth pathways, microbial fermentations and manipulation of cells to improve novel product development, immobilized enzymes, product isolation and purification, selected examples of applications in medicine, agriculture etc. and effects on the environment.

**TOX 813: Environmental Toxicology and Chemical Carcinogenesis**

Historical background- Environmental pollution and carcinogens, overview on carcinogens-, Epigenetic carcinogens, Genotoxicity; Mechanism of chemical carcinogenesis- Role of somatic mutation, Initiation and Promotion, Proliferation, Polycyclic aromatic hydrocarbons, Alkylating carcinogens, Oncogenes- Viral and cellular oncogenes, Mechanisms of Oncogene activation by retroviruses, Target Oncogenes in Chemical carcinogenesis, Persistance of DNA, Assay of chemical carcinogens in mammalian systems, transgenic animal models in carcinogenesis, AMES test. Environmental pollution- Sources and types of pollution, Important pollution, events, Priority pollutants, Ecotoxicology- Examples of ecotoxicology, Scientific approach to ecotoxicology, Entry, movement, and fate of pollutants in ecosystems, Air pollution- Classification and properties of air pollutants, Behaviour and fate of air pollutants, Photochemical smog, Acid Rain, health effects of air pollution, Public health aspects Soil and land pollution- Heavy metal contamination, Industrial soil pollutants, agricultural soil pollution, petroleum products as soil pollutants. Use of mathematical models and computer simulation tools to estimate the human health impacts of exposure to environmental pollutants. Environmental Impact Assessment.

**TOX 821: Forensic Toxicology**

Forensic toxicology (e.g. Drugs of abuse) and the clinical aspects of toxicology. Chemical poisoning identification and management with use of occupationally and environmentally relevant chemicals (metals, pesticides and insecticides, etc.). Forensic toxicology- Specimen sample collection, types of testing, detection of poisons, applications of forensic toxicology. DNA fingerprint, paternity testing.

**TOX 814 : Use of Laboratory Animals in Research**

Animals, home-cage environment and animal care (rat, mouse, guinea pig, hamster, rabbit); Laboratory animals, stress and well-being; Anatomy and Physiology (rat, mouse, guinea pig, hamster, rabbit); Hygiene and application of barrier systems; Animals and animal testing; Legal aspects and their applicability; Handling animals (Theory and Practice); Experimental design and Alternatives to Animal Testing; Ethics and the assessment of DEC protocols; Biotechnical act in an animal lab; Experiments in practice; Establish a lawful animal experiment (only implementation 3Rs) and write DEC protocol; Theory Anaesthesia / Pain Management; Assignment Anaesthesia / pain-fighting protocol including making calculations; Responsible use of laboratory animals; Knowledge of animal distress and applying Humane endpoints; Statistics for animal use; Route of administration and reduction methods: theory; Route of administration and reduction methods: practice; Ethical discussion; Dec 2 protocol writing, applying 3VS, statistics and ethical considerations.

**TOX 822 : Experimental Toxicology**

Analytical methods for detection, identification, and measurement of foreign compounds (xenobiotics) in biological and other specimens, results interpretation in toxicology, xenobiotic explores

**TOX 823 : Systemic Toxicology**

Basics of organ toxicity- Target organs, Organ selectivity and specificity Cutaneous toxicology- Structure of the skin, Functions of the skin, Dermatological effects of toxic agents, Allergic contact dermatitis, Cutaneous carcinogenesis. Pulmonary toxicity- Structure of the lung, Lung injury, Systematic lung toxins, Lung pathology. Hepatic toxicity- Anatomy and physiology of the liver, Actions of toxins on the liver, Chronic liver injury. Renal toxicity- Renal structure and functions, susceptibility of kidney to toxic insult, chemically induced renal injury. Neurotoxicity- Cell types in the nervous system, Effect of toxic agents on neurons, axonopathy, myelinopathies, Ion channel neurotoxins, Convulsants. Cardiotoxicity- Cardiac structure and function, Cardiac contraction, pathology of cardiac toxicity, mechanisms of cardiotoxicity. Reproductive and endocrine toxicity – Teratogenicity, Reproductive organs, Chemicals affecting reproduction, General idea of endocrine glands, Toxicity to adrenal glands, Thyroid glands and Pancreas.

**CHM 806: Environmental Chemistry and Chemical Pollution**

Structure, Terminologies and Methods of investigation in environmental studies.  The main sources, chemistry, sinks and methods of measurement of pollutants.

Land Pollution: Concepts of advanced wastes treatment, pesticides residues; nuclear waste occurrence and disposal.

Water Pollution: - types and quantities of effluents, Biological effects of water pollution.  Effects of refractory contaminants, radionuclides, etc.

Air Pollution:  Health hazards associated with aeronomic pollutants.  Air pollution problems in Nigeria and quality criteria.

**CBG 821: Bioinformatics**

Introduction to bioinformatics- Applications of bioinformatics, molecular biology and bioinformatics, Toxicology and bioinformatics Genome analysis, gene mapping and toxico-genomics, Introduction to proteomics, metabolomics and drug discovery

**RSC 821: Regulation of Pharmaceutical, Biologic Products and Medical devices**

The course will explore the relationships between scientific discovery, testing and regulatory oversight. It will look at the rules governing prescription and over-the-counter drugs, and look at the changes that are introduced by the burgeoning influence of genetic engineering and biological product development. It will consider the practical issues facing regulatory specialists as they work with the NAFDAC and other international regulatory bodies to secure and keep product approval. Legal framework for drug regulation ethical issues in drug/biologic/device development and drug/biologic/device use; global regulatory guidance approaches; types of communications with NAFDAC, including Investigational New Drug (IND) application, New Drug Application (NDA), and Abbreviated New Drug Application (ANDA) requirements, and clearance and Premarket Approvals / Biologics Licensing Applications (PMA/BLA) approval requirements; chemistry, manufacturing, and control (CMC) issues; and post-marketing topics.

**TOX 828: Research Seminars in Toxicology**

Presentations by students on systemic, environmental and forensic toxicology

**TOX 829: Research Project**

Research on toxicological issues