New University of Ghana Collegiate System

College of Health Sciences

- School of Medicine and Dentistry
- School of Public Health
- School of Nursing
- School of Pharmacy
- School of Biomedical and Allied Health Sciences
- Noguchi Memorial Institute for Medical Research
- Centre for Tropical, Clinical Pharmacology & Therapeutics

College of Basic and Applied Sciences

- School of Physical and Mathematical Sciences
- School of Biological Sciences
- School of Agriculture
    - Livestock and Poultry Research Centre (LIPREC), Legon
    - Soil and Irrigation Research Centre (SIREC),Kpong
    - Forest and Horticultural Crops Research Centre (FOHCREC), Kade
- School of Engineering Sciences
- School of Veterinary Medicine
- Institute for Environment and Sanitation Studies
- Institute of Applied Science and Technology
- Biotechnology Research Centre
- West Africa Centre for Crop Improvement
- West African Center for Cell Biology of Infectious Pathogens

College of Humanities

- Business School
- School of Law
- School of Arts
- School of Languages
- School of Social Sciences
- School of Performing Arts
- Institute of Statistical, Social and Economic Research
- Institute of African Studies
- Regional Institute for Population Studies
- Centre for Social Policy Studies
- Centre for Migration Studies
- Legon Centre for International Affairs and Diplomacy
- Centre for Gender Studies and Advocacy
- Language Centre
- University of Ghana Accra City Campus

College of Education

- School of Information and Communication Studies
- School of Education and Leadership
- School of Continuing and Distance Education

COLLEGE OF BASIC & APPLIED SCIENCES

SCHOOL OF BIOLOGICAL SCIENCES

❖ DEPARTMENT OF ANIMAL BIOLOGY AND CONSERVATION SCIENCE

LEVEL 100 SEM 1

ABCS 101: Introductory Animal Biology Credits: 3

Objective: General survey of animals with reference to form and function - phylogeny; life cycles. Morphological and physiological adaptations to ways of life.

LEVEL 200 SEM 1

ABCS 201: Zoological Techniques Credits: 2

Introduction to basic microscopy. Basic techniques involved in collection, preservation andpreparation of zoological material. Microtome work, slide preparation and fixation techniques.

ABCS 203: Principles of Evolution Credits: 1

History and Development of Evolutionary thought and concepts, synthesis of the modern theory of Evolution. Definitions and Terminologies. Introduction to the species concept. Mechanisms and processes of Evolution. Evidence for Evolution. Importance of evolution to society. Brief evolutionary time line.

ABCS 205: Vertebrate Anatomy Credits: 3

The vertebrate body plan; Functional anatomy of the major vertebrate classes – Fish, amphibians, reptiles, birds and mammals.

LEVEL 200 SEM 2

BIOL 202: Introductory Cell Biology and Genetics Credits: 3

Basic cell physiology-bioelements, water, water in cells, method of expressing concentrations of solutions, osmotic phenomena, imbibition, biomolecules, carbohydrates, amino acids, proteins, lipids, nucleotides, nucleic acids, and the role of these in either cell biology and/orstructure, enzyme action; photosynthesis, respiration and nitrogen metabolism. Basicprinciples of genetics; gene interactions, sex and inheritance; chemical basis of heredity; mutation, medical and biochemical genetics.

ABCS 206: Introductory Biometry Credits: 2

Introduction to statistics. Experimental design (laboratory, field). Sampling methods; data presentation, analysis and interpretation.

LEVEL 300 SEM 1

ABCS 301: Comparative Chordate Biology Credits: 2

Characteristics, classification and general biology of the chordates. Theories of vertebrate evolution: phylogenetic relationship among the chordates: Myxini, Cephalaspidomorphi, Chondrichthyes, Osteichthytes, Amphibians, Reptilia, Aves and Mammalia. Flight and migration in birds. Interactions of humans with other mammals.

ABCS 303: Comparative Animal Physiology Credits: 2
Comparative physiology of digestion, respiration, circulation, osmoregulation and excretion. Sensory organs, nervous and muscular activity. Hormones, reproduction and related endocrine activities in animals.

ABCS 305: Behavioural Ecology Credits: 1
Definitions of terms. Ecological aspects of animal behaviour adaptations: foraging, mating systems and reproductive strategies. Parental care. Social systems in animals. Predator-prey relationships. Life-history strategies.

ABCS 307: Venomous Animals Credits: 1
Biology and ecology of venomous animals: aquatic fauna, terrestrial arthropods, amphibians, reptiles and mammals. Nature of venom and structure of venom apparatus. Interaction of humans with venomous animals: nuisance, phobias and allergens. Prevention and management of venomous animal bites and stings. Importance of venomous animals to humans and the ecosystem.

ABCS 309: Animal Ecology Credits: 2
Community Ecology – Structure, patterns and rules. Ecological diversity and its measurements. Ecological energetics. Invasive alien species.

ABCS 311: Systematics Credits: 1
Definitions and principles. Importance of taxonomy, International Code for Zoological Nomenclature, systems of Classification, Taxonomic characters, techniques and methodologies. Introduction to bio-informatics. Importance and management of Natural History collections. Introduction to Phylogenetics.

ABCS 313: Microbiology & Immunology Credits: 2
History of microbiology and the development of microscopy; Classification & Structure of bacteria, parasites and viruses; Transmission and Life cycles of protozoan and metazoan parasites; Public health significance of microbial organism; Common microbial infections; Principles of Sterilization and Disinfection; The immune system - Cells and organs of the immune system; Host responses to infections & Types of immunity; Cell receptor proteins and histocompatibitlity antigens; T helper cells, TH1/TH2 dichotomy and disease outcome; Antigen processing, presentation and antigen recognition by B and T cells; Regulation of the immune response; by cellular mechanisms and regulatory role of antibody.

BIOL 315: Principles of Genetics Credits: 3
Introduction to the principles of genetics and chromosome cytology from the molecule to the population aspects, including application of the principles in animal breeding, plant breeding and applied human genetics.

ABCS 321: Comparative Chordate Biology Practical Credits: 1
This is the practical component of ABCS 301.

ABCS 323: Animal Physiology Practical Credits: 1
This is the practical component of ABCS 303.

LEVEL 300 SEM 2

ABCS 302: General Entomology Credits: 2
Insect Diversity. Functional morphology and life styles. Classification and Diagnostic features of major insect orders, Relationships among insect complexes. Insect Collection and curatorial techniques.

Physiological processes: Alimentary, respiratory, circulatory, excretory, nervous, muscular, endocrine, exocrine and reproductive systems. Other processes involved in adaptation and survival.

ABCS 304: Public Health Zoology Credits: 2
Basic principles in parasitism, survey of animal parasites and vectors with emphasis onmorphology, lifecycle, pathogenesis. Parasite and vector control. Diseases of public health importance – HIV and AIDS, Zoonoses.

ABCS 306: Zoogeography Credits: 1
Introduction to zoogeography. Biogeographic zones of the world. Terrestrial Biomes and Faunal Distribution. West African Fauna: Abundance, endemism, diversity and adaptations. West African wetlands: Characteristics, Annual cycle of events, Faunal diversity.

ABCS 308: Terrestrial Invertebrates Credits: 1
Overview of classification. Adaptations of the spiders, scorpions, ticks, mites, (arachnids), centipedes and millipedes (myriapods), nematodes, earthworms and wood lice to terrestrial habitation with special emphasis on water relations, respiration and reproductive biology. Economic importance in the ecosystem.

ABCS 312: Wetland Ecology Credits: 2
Definition, types, characteristics and functions of wetlands. Wetland hydrology and soils: physico-chemical properties of wetland soils. Wetland flora and fauna: adaptations, competition and survival strategies. Wetlands in Ghana.

ABCS 314: Principles of Conservation Science Credits: 2
Relation between biological and physical resources; principles of biodiversity conservation, social and economic. Evolutionary processes and biological adaptations. Declining and small populations paradigms. Species extinction. Threats to biological diversity. Principles of management.

ABCS 318: Aquatic Biology Credits: 2
Water properties of biological importance. The seas: the open ocean and coastal waters. Factors determining water circulation. Effects of water circulation upon productivity. Pollution. Utilization and conservation. Lakes: origin of lakes and their biological types. Factors determining water circulation. Rivers: origin and water movement. Biotic communities, adaptations and distribution. Phytoplankton: distribution including temporal and special changes in relation to physico-chemical and biological factor in the environment.
Estuaries: optical and physical properties; water movement. Dissolved substances. Mangrove swamps.

ABCS 322: General Entomology Practical Credits: 1
This is the practical component of ABCS 302

ABCS 324: Public Health Zoology Practical Credits: 2
This is the practical component of ABCS 304.

ABCS 330: Zoological Field Studies Credits: 2
Introduction to the ecological biotopes and their faunal associations in the field. Practical field measurements of environmental variables responsible for survival of the biota. Evaluation of survival strategies of biota in freshwater, brackishwater, seawater and terrestrial environments.

LEVEL 400 SEM 1

ABCS 401: Animal Behaviour Credits: 2

Introduction and definitions. History of ethology; methods of recording animal behaviour; factors affecting the behaviour of animals, with special emphasis on interactions: physiological condition, genome and stimuli. Intervening variables: motivation and learning; communication; analyses of complex behaviour patterns (feeding, reproduction, sociality andmigration); sociobiology.

ABCS 403: Environmental Physiology Credits: 2

Physiological adaptations of animals to key environmental factors: temperature, water, light,air and semiochemicals. Adaptation to extreme environments.

ABCS 405: Population Ecology Credits: 3

Sampling techniques. Dispersion. Population parameters. Methods of animal population estimation. Natural regulation of animal populations. Life table and Key-factor analyses.

ABCS 407: Limnology Credits: 2

Introduction to Limnology. The water cycle. Basic hydrology. Stream classification. Lakeformation and morphology. Optical and thermal properties of water. Water movements in lakes.Global geochemistry. Ionic composition of natural waters. Dissolved gases. Nutrients and Nutrient Cycling. Eutrophication. Metals in the Aquatic Environment. Environmental effects of dams.

ABCS 419: Applied Insect Taxonomy Credits: 1

Application of the Biological species concept. Biodiversity informatics. Molecular Systematics. Taxonomic Products. Identification of Bio-indicators and their use in ecosystem analysis. Value and Management of reference collections. International Conventions and networks for species conservation. Intellectual Property rights. Insects as commercial resources.

ABCS 421: Research and Project Management Credits: 2

Research proposal writing, thesis/report writing, and introduction to projects, types of projects, project life cycle, experimental design, data collection techniques and analyses, introductory strategic management, basic human resource management, introductory organizational behaviour, leadership.

LEVEL 400 SEM 2

ABCS 402: Molecular Genetics and Biotechnology Credits: 3

Variety of genetic systems as illustrated by micro-organisms; genetic engineering; DNAprobes, polymerase chain reaction (PCR), isozymes and articular hydrocarbons for parasite and vector identification, DNA sequencing, DNA barcoding, Gene mapping and its application, DNA fingerprinting and application, Human genome project.

ABCS 404: Epidemiology of Tropical Diseases Credits: 3

Basic definitions and principles of epidemiology: The science of epidemiology, objectives, methods and tools. Introduction to modelling in epidemiology. Major parasitic diseasesystems and their management.

ABCS 406: Vertebrate Biology Credits: 2

Evolutionary trends among vertebrates. The Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves and Mammalia. Biology, ecology and systematic of vertebrates. Interaction of humans with other vertebrates (e.g. snakes).

ABCS 408: Wetland Ecology & Management Credits: 3

Wetland values, human impacts and regulations. Wetland evaluation and delineation. History of wetland management in Ghana. Principles of wetland restoration. Wetlands management for waterfowl. Integrated catchments management: challenges and realities. Current issues in wetland conservation.

ABCS 410: Field Trips and Reports Credits: 2

Field trips to selected areas with potential for vast ecological biodiversity in the major ecological biotopes. Reporting on the form and function of the ecological associations using statistical designs/ model. Presentation of study reports.

ABCS 412: Petroleum Ecology Credits: 2

Oil pollution: behavior, characteristics and impact of oil pollution on biota and recreational facilities. Damage estimation methods and management of oil spills in terrestrial and aquatic ecosystems. Impact assessment and clean-up. Ballast water ecology: introduction of invasive species; ecological significance of invasive species transfer, survival strategies of invasive species and implications on biodiversity conservation.

ABCS 414: Fishery Biology and Marine Ranching Credits: 2

Biological parameters of fish populations: age and growth, food and feeding habits. Ecology of pelagic and demersal species in Ghanaian waters. Theory of fishing (including stock assessment). Fishery management methods: fish population estimation; factors limiting abundance, habitat improvement and legislation. Fishery aspect of water pollution. Aquaculture: Principles and applications. Marine Ranching: principles and techniques.

ABCS 416: Wildlife Management Credits: 3

Ecology of African game animals; methods of study: aging, identification. Ecology of pastures cropped by game; habitat and harvest management. Management techniques. Population studies of wildlife: game census, wild animal population regulation; capture techniques; threatened species management. Protected area systems; park design, introduction to park management and planning. Law enforcement in protected areas. Public relations. Human-wildlife conflict management. Wildlife utilization, domestication, ranching. Ghana's wildlife conservation policy. International Wildlife Laws.

ABCS 418: Applied Entomology Credits: 3

Beneficial and harmful insects. Principles and ecological basis of insect pest control. Control methods; legislative, mechanical, physical, cultural, biological, chemical, antocidal control; use of resistance and semi chemicals in control. Integrated pest management. Biology, control and management of insects of field crops, vegetable crops, tree crops and stored produce.

ABCS 422: Radiation Biology and its Applications Credits: 3

Nature of electromagnetic radiation with emphasis on the interaction of ionizing radiation with matter. Direct and indirect action in biological systems. Effects at the cellular, tissue and organ levels and their interactions. Comparative radio sensitivity of living organisms. Genetic and lethal effects of radiation. Applications in breeding, public health and pest/vector management.

ABCS 424: Innovation and Business Plan for Biologists Credits: 2

Concept development. Business proposal writing. Business plan development. Introduction to entrepreneurship and fund management

❖ DEPARTMENT OF ANIMAL BIOCHEMISTRY,CELL AND MOLECULAR BIOLOGY

LEVEL 200 SEM 1

BCMB 201: STRUCTURE AND FUNCTION OF BIOMOLECULES Credits: 3

Chemistry & Function of Biological Compounds: Biomolecules: - monomers; polymers; macromolecules; supramolecules. Carbohydrates: - mono-, di-, oligo- and polysaccharides (structural and storage); stereoisomerism; mutarotation; reactions of carbohydrates. Other derivatives of monosaccharides. Lipids: - classification (fatty acids, triacylglycerols, phospholipids, sphingolipids, steroids, cholesterol, eicosanoids); simple lipoproteins; glycolipids (cell-cell recognition, receptors etc). Proteins: - amino acids:- basic structure, classification, acid/base properties, essential & non-essential; peptides; protein structure- primary, secondary, tertiary and quaternary structures, classification and properties. Enzymes as proteins. Nucleic Acids: - nitrogenous bases, nucleosides, nucleotides, cyclic nucleotides and nucleic acids DNA and RNAs (brief review of replication, transcription, translation). Other cellular molecules: Porphyrins, Vitamins and co-enzymes alkaloids & inorganic ions.

BCMB 203: PRINCIPLES OF BIOCHEMICAL TECHNIQUES Credits: 2

Chromatography: Partition coefficient and chromatographic systems.
Basis of separation: adsorption and partition (polarity); ion-exchange (ionic nature), exclusion/gel (molecular size and shape). Principles and applications (HPLC, FPLC, GLC, TLC, Paper, Chromatofocusing and two-dimensional electrophoresis). Analytical aspects: retention time and volume, capacity ratio, peak resolution theoretical plates/plate height, peak capacity, internal and external standardization and analyte quantitation.
Centrifugation: Basic principles of sedimentation, RCF value, relationship between v, s and G. Centrifuges and rotors (types and uses). Preparative centrifugation: differential and density gradient; preparation of gradients, recovery and monitoring of fractionates. Analytical centrifugation: determination of relative molar mass (sedimentation velocity and equilibrium methods), purity and shape of macromolecules.
Electrophoresis: General principles. Low voltage thin sheets (paper, cellulose acetate, thin layer) and high voltage gels (agarose, polyacrylamide - native, gradient and SDS-PAGE). Applications; purity and molecular weight determination

BCMB 205: GENERAL BIOCHEISTRY Credits: 3

Cell Structure and Function and Methods and Techniques of studying the Cell: General features of prokaryotes & eukaryotes; compartmentalization of cellular processes; Source tissue/cells selection; cell disruption and fractionation. Structure, Function and Metabolism of Carbohydrates: - mono-, di-, oligo- and polysaccharides; functions of carbohydrates; stereoisomerism; Glycolysis, substrate level phosphorylation, hexose monophosphate shunt, gluconeogenesis, synthesis of other carbohydrates from monomers, fate of pyruvate in different organisms; the electron transport chain in mitochondria and ATP synthesis. Structure, Function and Metabolism of Lipids: Different types and functions of lipids (fatty acids, triacylglycerols, phospholipids, etc); beta oxidation of fatty acids; fate of acetyl CoA units (TCA cycle, ketone bodies, cholesterol); synthesis of fatty acids. Structure, Function and Metabolism of Proteins: Amino acids: buffer solutions & buffer capacity; the Henderson-Hasselbach equation in the preparation of buffers in biological assays and systems. pKa and pI. Oxidative deamination; decarboxylation; transamination ; urea cycle; NH3 assimilation; fate of carbon skeleton (glucogenic and ketogenic amino acids); metabolism of some individual amino acids. Integration of metabolism. Protein structure, classification and functions. Enzymes: Properties & classification; factors affecting activity (co-factors & co-enzymes, pH, temp., [S], [E]); control of activity; kinetics; Michaelis-Menten equation. Nucleic acids and Protein Biosynthesis: Nitrogenous bases, nucleosides, nucleotides and nucleic acids. General overview of DNA replication, transcription and translation; Molecular basis of mutations.

BCMB 207: VETERINARY BIOCHEMISTRY I Credits: 2

Cell and Tissue: Their principal chemical constituents and main metabolic activities. The characteristics of, and differences between eukaryotes, prokaryotes and viruses. Compartmentalisation and control of cellular environment. Functional role of the main cellular components; nucleus, ribosomes, Golgi bodies, endoplasmic reticulum, mitochondria and lysosomes. Biochemical technique for investigatin cell structure and function. Chemistry & Function of Biological Compounds: Biomolecules: - monomers; polymers; macromolecules; supramolecules. Carbohydrates: - mono-, di-, oligo- and polysaccharides (structural and storage); stereoisomerism; mutarotation; reactions of carbohydrates. Other derivatives of monosaccharides. Glycol-congugates: carbohydrates, sorting of molecules into-subcellular compartments, diseases of sorting. Lipids: - classification (fatty acids, triacylglycerols, phospholipids, sphingolipids, steroids, cholesterol, eicosanoids); simple lipoproteins; glycolipids (cell-cell recognition, receptors etc). Proteins: - amino acids:- basic structure, classification, acid/base properties, essential & non-essential; peptides; protein structure- primary, secondary, tertiary and quaternary structures, classification and properties. Enzymes as proteins. Nucleic Acids: - nitrogenous bases, nucleosides, nucleotides, cyclic nucleotides and nucleic acids DNA and RNAs (brief review of replication, transcription, and translation). Other cellular molecules: Porphyrins, Vitamins and co-enzymes alkaloids & inorganic ions.

LEVEL 200 SEM 2

BCMB 200: PRACTICAL BIOCHEMISTRY I Credits: 2

Acid-Base Reactions: Titration; pH measurement; buffer preparation; determination of pK.
Acid-base reactions; buffers, chromatography, qualitative analysis of carbohydrates, proteins and lipids.
Quantitative analysis of proteins: methods for protein estimation (Folin-Lowry, Biuret, Ultraviolet absorption); determination of amino acids (ninhydrin method); preparation, purification and standardization of proteins (serum proteins, cytochrome C).
Separation Methods: Paper and gel electrophoresis; chromatography (Paper, TLC, column).
Quantitative analysis of carbohydrates: Estimation of glucose (Folin-Wu); isolation of glycogen, determination of rate of hydrolysis and chromatography of hydrolysis products.
Quantitative analysis of lipids: Solubility; emulsification; determination of iodine number and acid value; separation of serum lipids.

BCMB 202: CELL BIOLOGY I Credits: 2

Cellular Compartments of Prokaryotes and Eukaryotes: Organization, Dynamics, and Functions; Cellular membrane systems (structure and transport); Nucleus (envelope and matrix), Mitochondria and chloroplasts (including biogenesis and evolution).
Cell Division, Differentiation, and Development: Bacterial division, Meiosis and gametogenesis; Eukaryotic cell cycles; mitosis, and cytokinesis; Fertilization and early embryonic development (including positional information, homeotic genes, tissue-specific expression, nuclear and cytoplasmic interactions, growth factors and induction, environment, and polarity); Differentiation of special cells in tissues of plants and animals.

BCMB 204: ENZYMOLOGY Credits: 2

Introduction to Enzymes: Comparison of chemical and enzyme catalysis, Activation energy and transition state, Free energy change, Chemical equilibria, Active site, Substrate specificity, Enzyme classification, enzyme assays, linked or coupled.
Factors affecting Enzyme Activity: Reaction rate (v), Effect of [S], [E], T, pH on enzyme activity; coenzyme, prosthetic groups.
Enzyme Kinetics and Inhibition: Michaelis - Menten model, Graphical representation of data (e.g. Lineweaver - Burk and Hanes plots)
Enzyme inhibition: Reversible (Competitive, noncompetitive, uncompetitive) and irreversible

Control of Enzyme Activity: Feedback regulation, allosteric enzymes, isozymes, covalent modification, activation, regulation of synthesis and breakdown (eg. lac operon, tryptophan biosynthesis).
Enzyme Purification: Cell disruption techniques, general purification strategy, enzyme assays, units of enzyme activity.
Application of enzymes in health, agriculture and industry

BCMB 206: SPECTROSCOPIC AND RADIOISOTOPIC TECHNIQUES — Credits: 1

Molecular spectroscopy; molecular fluorescence; infra-red, atomic, electron spin resonance and nuclear magnetic resonance spectroscopy, mass spectrometry, X-ray diffraction and radioisotopic techniques in biochemistry, radio/fluorescent labeling (RIA, scintillation counting), autoradiography ELISA.

BCMB 208: VETERINARY BIOCHEMISTRY II — Credits: 3

Carbohydrates Metabolism: Digestion of carbohydrates, glycolysis and fate of pyruvate in different organisms; tricarboxylic acid (TCA) cycle; pentose phosphate pathway and fate of reduced coenzymes; catabolism of monosaccharides other than glucose; gluconeogenesis, Calvin Benson cycle, Cori cycle, glyoxylate cycle; glycogenesis and glycogenolysis; regulation of carbohydrate metabolism; Diseases of carbohydrate metabolism. Aerobic metabolism of pyruvate, starvation and obesity. The coenzyme role of B vitamins. Changes in nutritional requirement and metabolic rate in injury and disease. Lipids Metabolism: Digestion of triacylglycerols; the different lipases (lipoprotein lipase, hormone-sensitive lipase); fate of glycerol; beta-oxidation of fatty acids; fate of products (acetyl and propionyl CoA, ketone bodies, reduced coenzymes); synthesis of fatty acids triacylglycerol, cholesterol; regulation of metabolism. Protein Metabolism: Digestion of proteins, transamination, deamination and decarboxylation of amino acids and the fate of ammonia (urea cycle) and carbon skeleton; metabolism of specific amino acids (aromatic and sulphur-containing amino acids); synthesis of amino acids; in-born errors of amino acid metabolism; regulation of metabolism. Enzymes as biological catalyst: Enzyme kinetics and concept of rate-determining step. Enzyme specificity and allosteric regulation. Mechanisms of enzyme action and examples. Coenzymes and vitamins. Drugs and their effect on enzymes.

BCMB 212: VETERINARY BIOCHEMISTRY III — Credits: 3

Glycosylation of proteins. Fibrous structural proteins. Structure and biosynthesis of collagen and elastin, intra-cellular and extra-cellular modification of proteins after translation. The collagen gene; disturbances in collagen synthesis. Diversity of protein function related to their structure. The relationship between structure and function as exemplified by haemoglobin, myoglobin and collagen. Plasma proteins. Detail of immunoglobin structure. Classes of immnuglobin and their functions. Protein in normal disease situations. Defects in protein structure as basis of disease e. g. sickle cell anaemia. Lipid and protein components: Glycoprotein and the cell surface. Erythrocyte membrane as a model system. Blood cells: Haemopoiesi, sites of production, growth inducers, differenciation inducers. Red blood cells (erythrocytes) functions, morphology and and membrane function formation and destruction, haemoglobin. White blood cells (leucocytes) types and morphology, functions, platelet functions. Blood clotting: haemostasis blood coagulation, definitions and components, mechanism of blood coagulation, anti-clotting mechanisms, fibrinolysis and haemostasis. Energetics: Chemical energy and concepts of energy transfer within cells; “high energy” compounds as “high energy currency”. Principles of energy abstraction. Energy source and utilization. Free energy and biochemical reactions (spontaneity, anabolic and catabolic reactions); metabolic reactions and ATP; energy of hydrolysis of ATP, ADP and phosphorylation products; ATP production (substrate level and oxidative phosphorylation, photophosphorylation, C_3, C_4); coupling reactions; uncoupling agents. Specific enzymes associated with inner and outer mitochondrial membranes, matrix and intermembrane space.Revrese electron transport, the concept of “high energy pool”. Michell’s chemiosmotic theory. Mitochondrial transport and inhibitors of mitochondrial function. Interplay of tissues, pathways and hormones in energy metabolism: Key

regulatory enzymes: allosteric control of pyruvate carboxylase, phosphofructokinase, fructose 1,6-phosphate, pyruvate dehydrogenase. Effect of ATP, AMP, NADH, citrate, relevance of energy status to control. "Futile" cycles and function in thermogenesis and control sensitivity. Covalent modification: beta-adrenergic receptor and cascade processes.

LEVEL 300 SEM 1

BCMB 301: INTERMEDIARY METABOLISM Credits: 3

Carbohydrates: Digestion of carbohydrates, glycolysis and fate of pyruvate in different organisms; tricarboxylic acid (TCA) cycle; pentose phosphate pathway and fate of reduced coenzymes; catabolism of monosaccharides other than glucose; gluconeogenesis, Calvin Benson cycle, Cori cycle, glyoxylate cycle; glycogenesis and glycogenolysis; regulation of carbohydrate metabolism; Diseases of carbohydrate metabolism.

Lipids: Digestion of triacylglycerols; the different lipases (lipoprotein lipase, hormone-sensitive lipase); fate of glycerol; beta-oxidation of fatty acids; fate of products (acetyl and propionyl CoA, ketone bodies, reduced coenzymes); synthesis of fatty acids triacylglycerol, cholesterol; regulation of metabolism.

Amino acids: Digestion of proteins, transamination, deamination and decarboxylation of amino acids and the fate of ammonia (urea cycle) and carbon skeleton; metabolism of specific amino acids (aromatic and sulphur-containing amino acids); synthesis of amino acids; in-born errors of amino acid metabolism; regulation of metabolism.

Energetics: Free energy and biochemical reactions (spontaneity, anabolic and catabolic reactions); metabolic reactions and ATP; energy of hydrolysis of ATP, ADP and phosphorylation products; ATP production (substrate level and oxidative phosphorylation, photophosphorylation, C_3, C_4); coupling reactions; uncoupling agents.

BCMB 303: MOLECULAR BIOLOGY I Credits: 2

Purine and pyrimidine biosynthesis: Regulation of biosynthesis. Structure and properties of nucleosides and nucleotides. Biosynthesis of deoxyribonucleotides; thymidylate biosynthesis. Salvage pathways.

DNA and chromosome structure: Evidence for DNA as carrier of genetic information. Primary and secondary (A, B and Z DNA) and tertiary structure of DNA. Elucidation of DNA structure. Watson and Crick double helix. Structural differences between RNA and DNA. Methods for sequencing DNA. Organisation of DNA in chromosomes, nucleosome structure.

DNA replication: Mechanism of replication (prokaryotic and eukaryotic). Evidence for semi-conservative replication. DNA replicating enzymes. Directionality of replication.

Transcription: Mechanism of transcription (prokaryotic and eukaryotic). Features of a typical transcription unit. Characteristics of different types of RNA. Modification and processing RNA. Reverse transcription.

BCMB 305: BIOCHEMISTRY OF HORMONES Credits: 2

General introduction: Coordination in multicellular organisms

Major classes of hormones: Mammalian, plants, insects.

Major endocrine glands: Hypothalamus, pituitary, adrenals, testes, ovaries, pancreas.

Biosynthesis and degradation of hormones: regulation of synthesis/secretion; major biochemical effects and actions.

Hormone receptors: structure, relationship to binding to response, binding characteristics, segregation, auto-phosphorylation/cross-phosphorylation; internalization.

Types of post receptor mechanism: second messenger generation, hormone response elements, gene expression.

BCMB 307: DATA HANDLING & INTERPRETATION — Credits: 1

Data types; Discrete and ordinate data.
Simple definitions and Descriptive Statistics; mean, standard deviation, standard error of mean etc.
Statistical principles: Importance of statistics; sampling from populations; Gaussian and non-Gaussian distributions; confidence intervals; p-value; statistical significance; statistical power; Baysian perspective on interpreting statistical significance;
Data presentation tools: Tables, graphical types such as histograms, scatter plots, bar graphs, box plots etc
Data analysis: Multiple comparisons; analysis of one group; analysis of two or more groups; Analysis of variant (ANOVA); Analysis of survival data; Categorical data (contingency tables); odds ratios and proportions tests; correlation and linear regression; choosing the right statistical test.
Experimental Design: Response variables (*measurements of interest*); factors or treatments (*influencing variables*); number of replicates; type of randomization; time and place of the measurements; sources of error.
Statistical packages and their applications: Excel, Minitab etc.

BCMB 309: PRINCIPLES OF LAB ORGANIZATION & MANAGEMENT — Credits: 2

Principles of Laboratory Management: Organisational structure: concepts and models; Principles of Leadership: Past, Present, and Future; Management Functions; Managerial Problem Solving and Decision Making.
Human Resource Management: Human Resource Guidelines and Regulations; Job Analysis, Work Descriptions, and Work Groups; Supervision; Performance Evaluation and Professional Development.
Financial Management: Fundamentals of Financial Management; Effective Budgeting in the Laboratory; Cost/Benefit Analysis (Costing of Services; Justification for Introduction/ Continuation/ Discontinuation of a Service; Lease or Purchase decision analysis).
Operations: Laboratory design for different types and sizes of institutions (selection of equipment and systems, concepts of workstation consolidation, work flow analysis, concepts in laboratory automation [sample transportation systems, modular systems, robotics]); Procurement and Inventory Control; Work load statistics; Staffing; Personnel training and development; Equipment and facilities maintenance planning; Marketing Concepts. Public Relations.
General Principles of Quality Assurance and Quality Control: Introduction to Quality Assurance; Quality Management System, Quality Assurance (QA) and Quality Control (QC); Compliance/Regulations Issues: Laboratory Standards and their Main Features (ISO 9001, ISO/IEC 17025 and ISO 15189), Good Laboratory Practice (GLP).
Ethical Issues in Laboratory Management

BCMB 311: PRACTICAL BIOCHEMISTRY II — Credits: 3

Enzyme catalysed reactions: Time course of reaction; effects of various factors on reaction rate: enzyme concentration, pH, temperature, substrate concentration, activators and inhibitors; enzyme specificity; protease activity in plant extracts; purification of enzymes from plant juice; use of enzyme as an analytical tool (e.g. Estimation of urea in urine).
Mini project: Isolation, purification and characterisation of a known enzyme.

BCMB 313: BIOCHEMISTRY OF VIRUSES — Credits: 2

Viruses: Classification; particle structure and stability; the virus genomes; virus replication, cell to cell movement; virus genetics; virus transmission; virus-host interactions. Tools of virus research: electron microscopy, serology and immunochemistry, molecular methods (hybridization, PCR and RT-PCR). Virus epidemiology and control. Plant viruses (cocoa swollen shoot virus), animal viruses (HIV, bird flu virus) and bacterial viruses (Bacteriophages).

LEVEL 300 SEM 2

BCMB 302: CELL BIOLOGY II — Credits: 2

Cell Surface and Communication: Extracellular matrix (including cell walls), Cell adhesion and junctions, Signal transduction, Receptor function, Excitable membrane systems.
Cytoskeleton, Motility, and Shape: Actin-based systems (including muscle contraction), Microtubule-based systems, Intermediate filaments, Prokaryotic systems;
Protein Synthesis and Processing: Regulation of translation, Post-translational modification, Intracellular trafficking, Secretion and endocytosis.
Cells as organisms: bacteria life cycles, protozoa and algae, parasitic protozoa and fungi as free-living and parasitic organisms.

BCMB 304: MOLECULAR BIOLOGY II — Credits: 2

The genetic code: Deciphering the code. Universality and degeneracy of the genetic code. Wobble hypothesis, colinearity of gene polypeptide.
Translation: Ribosome structure. Activation of Amino acids. Initiation, elongation and termination. Eukaryotic and prokaryotic. Post-translational modifications; Polysomes, inhibitors of protein synthesis.
Control of gene expression: Inducible and repressible operons, (lac and trp operons).
Mutation: molecular basis of mutation. Point mutation – transitions, transversions, frameshift mutations. Site-directed mutagenesis, Radiation induced mutation. Chemically induced mutation. DNA repair mechanisms.
Recombinant DNA and genetic engineering: Restriction endonucleases, Methods for recombinant DNA production, transformation, amplification, screening for cloned DNA.

BCMB 306: INTEGRATION AND CONTROL OF METABOLISM — Credits: 3

Metabolic control: Design of metabolic pathways. Regulatory enzymes fine control (allosteric, substrate/product feed- back and feed-forward controls, covalent modification) and coarse control (induction and repression of enzyme synthesis).
Regulation of fuel metabolism: glycolysis, gluconeogenesis, glyceroneogenesis, glycogenolysis and glycogenesis, Krebs cycle, lipogenesis and lipolysis, β-oxidation, ketogenesis, amino acid metabolism. Role of hormones (e. g. insulin, glucagon, epinephrine) and DNA binding proteins (e. g. Cyclic AMP response element binding protein (CREB), Carbohydrate response element binding protein (ChREBP), Sterol regulatory element binding protein (STREB)).
Integration of metabolism: Glucose homeostasis and glucose transpoters. Interrelationships between carbohydrate, lipid, and protein metabolism. Enzyme profiles of tissues and organs. Interorgan relationships (liver, brain, muscle, adipose tissue) in different physiological states: e. g. Fed, fasted, running athlete and pregnancy.

BCMB 308: BIOENERGETICS — Credits: 2

Overview of chemical thermodynamics: Internal, energy, enthalpy, entropy, Gibb's free energy, laws of thermodynamics; Spontaneous and non-spontaneous processes; Free energy changes in biochemistry. Principles of thermodynamics and their application to the energetics of the cell: Redox systems, electron donors and acceptors, redox couples, redox potentials, electromotive force, protonmotive forces.
The concept of high energy compounds: phosphoric acid anhydrides, phosphoric-carboxylic acid anhydrides, phosphoguanidines, enolphosphates and thiol esters; basis for the high standard free energy of hydrolysis; the central role of ATP; (phosphate) group transfer potentials; substrate-level phosphorylation; energetics of coupled reactions.

ATP synthesis: review of structure of mitochondrion and chloroplast; sources of energy; redox complexes for electron transport in mitochondria and in chloroplasts; establishment of proton gradients; coupling of ATP synthesis to dissipation of proton gradient; H^+ -ATPase; couplers (thermogenesis). ATP utilization for the performance of cellular work; active membrane transport and mechanical work such as muscle contraction.

BCMB 312: CELL & MOLECULAR BIOLOGY PRACTICAL I — Credits: 3

Preparation of microbial cells: Safety precautions; sterility; types of growth media (liquid, solid); identification and classification of microorganisms: morphology, Gram stain, biochemical tests; measurement of microbial concentrations; comparison of growth rate in differently constituted media; selective action of antibiotics.
Cell fractionation: Cytoplasm, Nuclear, Mitochondria, Mitoplast; Assay for enzyme markers e.g. succinate dehydrogenase.
Use of protein assay to monitor cell growth: Cell growth; cell density; centrifugation; protein determination.
Cell Behaviour: Cell interactions; kinetics of cell pairing; phagocytosis; kinetics of phagocytosis; exocytosis.
DNA technology: Isolation, purification and manipulation of DNA; RFLP, PCR, Hybridization.

BCMB 314: MEMBRANE BIOCHEMISTRY — Credits: 2

Introduction: Membrane types and functions; chemical composition (lipids, proteins and carbohydrates); amphipatic nature of lipids (formation of monolayers, bilayers/liposomes, and micelles); Reactions of phospholipases.
Structure and properties: Models (Dawson and Danielli, Singer and Nicholson); integral (glycophorin A, anion channel ban 3, bacteriorhodopsin), lipid-anchored and peripheral (cytoskeleton of erythroid and non-erythroid cells) proteins; plasma membrane glycocalyx, antigenic properties (RBC M and N, blood group O, A and B); evidence for asymmetric, dynamic and fluid-like character of biomembranes; cell-cell recognition and fusion (eg flu virus and HIV infections); membrane biogenesis (synthesis and transport of membrane lipids).
Preparation and study: Physical, chemical and biochemical methods of study (lipid bilayer and vesicles of eukaryotic and prokaryotic cells).
Transport: Thermodynamics; modes (uniport, symport and antiport systems) and types (simple diffusion, passive-mediated, active, Na/K pump, co-tranport – Na/glucose pump of kidney/intestine, galactose permease of E. coli, exocytosis and endocytosis); channels (ligand gated and voltage-gated) and pores; ionophores (valinomycin, gramicidin A and nigericin).

BCMB 316: INDUSTRIAL MICROBIOLOGY — Credits: 2

Introduction: Importance and effects of microorganisms in industry, Nature of industrial microbiology, microorganism of industrial importance; Mutation, strain selection and development, hybridisation; media formulation and economic; optimisation of fermentation media at laboratory scale, perimeter design operation; Antifoams; aspects of biochemical engineering; patents and patent law.
Microbial contamination in industry: Microbial contamination in industry, Regulatory and advisory bodies, Microbiology testing programs, Quality control;
Microbial biotechnology: Properties of an industrial microorganism, growth factors and conditions of industrial microorganisms, Product formation, Aspects of the biology of moulds, yeasts, bacteria, actinomycetes and viruses of importance in various fermentation. Culture techniques and maintenance of selected cultures, Application of modern techniques of genetics and physiology to the large-scale production of microbial products; industrial strain improvement; scale-up of microbial processes; survey of industrial processes using microorganisms.

Industrial processes: Production of pharmaceutical compounds, commercially valuable non-pharmaceutical compounds, food and food supplements. Pollution control.

LEVEL 400 SEM 1

BCMB 400: PROJECT Credits: 6

Research project covering a range of subjects utilizing biochemical principles, analytical, cell and molecular biology techniques, demonstrating candidates' ability to identify original subjects for research, plan, execute and report in seminars and a thesis.

BCMB 401: PROTEIN CHEMISTRY I Credits: 2

Primary structure: amino acid composition of proteins, determination of amino acid sequence, importance of primary structure synthesis of peptides, covalent modification of polypeptides.
Secondary structure (regular arrangement of the polypeptide backbone): peptide bond and its structural implications; random polymers; Ramachandran Plot. Regular conformation of polypeptides; α-helix, β-pleated sheets, other helices (3_{10}- helix), super-secondary structures (coiled-coil α-helix). Examples: fibrous proteins; α-keratins, silk fibroin, collagen.
Tertiary structure (folded conformation of globular proteins): determination of protein structure by X-ray crystallography, evidence for folding, reverse turns (β-turns) super-secondary structures (motifs), domains, interiors and exteriors, unfolding and folding. Example: Myoglobin.
Quaternary structure (aggregation of globular proteins). Example: haemoglobin.
Physical forces responsible for maintaining structure.

BCMB 403: MOLECULAR BIOTECHNOLOGY & APPLICATIONS Credits: 2

Tools of molecular biology: Agarose and polyacrylamide gel electrophoresis; Northern and Southern blots and hybridization analysis; Western blots and protein detection; PCR and RAPD, RFLP.
Purification and characterization of nucleic acids: Principles for extraction and purification; concentration and molecular weight determination; species differentiation (RNA/DNA, single/double stranded nucleic acids).
Modifying enzymes: Restriction endonucleases; other nucleases (DNAse, RNAse); ligases; polymerases.
Recombinant DNA technology: Cloning and expression vectors, recombinant molecules and transformation systems (prokaryotic and eukaryotic hosts); colony screening, plasmid isolation and characterisation; transduction and conjugation.
Nucleotide sequencing and mutagenesis: Sequencing of end labelled DNA by base specific chemical cleavage (Maxam and Gilbert) and analysis of primed enzymatic synthesis (Sanger); deletion and insertion mutagenesis.
Gene expression detection: principles of RT-PCR, real time RT-PCR, microarrays.
Applications: medicine, agriculture and industry.

BCMB 405: CELL SIGNALLING Credits: 2

Types of cellular regulation: endocrine, paracrine, autocrine, direct cell-to-cell communication
Primary signalling molecules: growth factors, hormones, neurotransmitters
Structure and properties of receptors: Cell surface and intracellular receptors, G-protein coupled receptors, receptor tyrosine kinases. Conserved domains, ligand recognition, binding characteristics, receptor dimerization and phosphorylation, docking sites and substrate interactions.
Guanine nucleotide binding-protein switches: Heterotrimeric and monomeric, G-protein regulators - GTPase activating proteins and guanine nucleotide exchange factors e.g. Son of sevenless, neurofibromin.
Second messenger generation: cyclic AMP, cyclic GMP, inositol trisphosphate, diacylglycerol, Ca^{2+}
Examples of major cascades: Ras-mitogen activated protein kinase pathway, phosphatidylinositol-3-kinase and Akt pathway, Janus kinase and Signal transducer and Activator of Transcription pathway

(JAK-STAT), Nitric oxide-guanylyl cyclase signaling. Effectors, transcription factors, amplification, signal diversity, cross-talk and signal termination.

BCMB 407: CELL & MOLECULAR BIOLOGY PRACTICAL II Credits: 3

Cell Biology: Preparation of Cytoskeleton: Reactivation of Ciliary Beat; Cytoskeletal transformation e.g of sea urchins coelomocyles: Induction of Shape Change via Hypotonic Shock; Effect of Colchicine on Coelomocyte Cell Shape Changes; Effect of Ca^{2+} and Ca^{2+} ionophore on Shape Changes of Coelomocytes. Preparation of lymphocytes

DNA technology: Isolation, purification and manipulation of DNA; transformation and screening.

BCMB 409: BIOCHEMISTRY OF PARASITES Credits: 2

Pathophysiology of the following tropical parasitic diseases: Malaria, trypanosomiasis, filarasis, schistosomiasis and gastrointestinal worm infestations. Biochemistry of the causative parasites with emphasis on host-parasite interrelationships: Molecular basis of chemotherapeutic attack of parasites.

BCMB 411: CLINICAL BIOCHEMISTRY Credits: 2

Introductory practical clinical biochemistry: Laboratory investigations; specimen collection, analytical methods and standardization (calibration standards, precision, accuracy, sensitivity, specificity etc); review of analytical and separation methods used in clinical biochemistry for metabolites, ions and enzymes; report and result interpretation; reference values and factors affecting them.

Organ function disorders and tests: gastrointestinal, liver, kidney, heart, pituitary, pancreas, thyroid, adrenal and gonadal.

Body fluid composition and abnormalities: water and electrolyte balance, acid-base disorders and O_2 transport.

Disorders of metabolism (in-born errors of metabolism): lipids, carbohydrates, amino acids, proteins, purines and porphyrins.

Industrial visits to Clinical Laboratories.

BCMB 415: XENOBIOTIC METABOLISM Credits: 2

Pathways of xenobiotic metabolism; Phase I and II reactions. Enzymology and molecular mechanisms of xenobiotic metabolism; cytochrome P-450-dependent mixed-function oxidation reactions, microsomal flavin-containing monooxygenases, prostaglandin synthetase, reduction enzymes, epoxide hydrolase and conjugating enzymes. Factors affecting xenobiotic metabolism; internal and external. Pharmacological and toxicological aspects of xenobiotic metabolism - Pharmacological; activation and deactivation, changes in pharmacological response, drug uptake and distribution, enterohepatic circulation. Toxicological; metabolic activation (increased toxicity) - carcinogenesis, mutagenesis, teratogenesis, pulmonary, hepatic and renal toxicities. Deactivation (decreased toxicity). Balance between toxification and detoxifying pathways.

LEVEL 400 SEM 2

BCMB 402: PROTEIN CHEMISTRY II Credits: 2

Protein-ligand Interactions: Binding sites of haemoglobin and myoglobin, binding of oxygen and carbon monoxide, micro-environment of the haem iron, the Hill Plot. Protein engineering.

Allostery: interaction between binding sites. Theoretical models; the Mond-Wyman-Changeux (MWC) concerted mechanism, the Koshland-Nemethy-Filmer (KNF) sequential model. Allosteric properties of haemoglobin; molecular mechanism of cooperative binding of oxygen to haemoglobin, the Bohr effect, binding of 2, 3-bisphosphoglycerate (BPG).Mechanism of Enzyme Catalysis: General acid-base catalysis and covalent catalysis. Catalysis by coenzymes; pyridoxal phosphate, thiamine pyrophosphate, ATP,

coenzyme A, $NAD(P)^+$, FAD/FMN. Structure and mechanism of action of selected enzymes. Examples; dehydrogenases, proteases, ribonuclease, lysozyme, glycolytic enzymes such as phosphofructokinase (PFK).

BCMB 404: IMMUNOLOGY AND IMMUNOCHEMISTRY Credits: 2

Defense systems: self and non-self; innate and acquired; cells and organs involved; humoral and cell-mediated.
Antigens: Immunogenicity and antigenicity; chemical nature (bacterial, viral and synthetic)
Antibodies: Structure and function of immunoglobulins; theories of antibody production; polyclonal antibody production; monoclonal antibody production (hybridoma Technology).
Antigen-antibody interactions: Agglutination and precipitation; immunoassays.
The complement system: components, activation (classical and alternative pathways); regulation.
Vaccines: Current methods for development. Immune regulation and tolerance; immunopathology (hypersensitivity, immunodeficiency, autoimmunity); transplantation immunology (mechanisms involved in tissue rejection).
Cytokines: General properties; biological activities of selected cytokines.
Immunology of diseases of public health interest: HIV/AIDS, Malaria, Schistosomiasis.

BCMB 406: MOLECULAR GENETICS Credits: 2

Genetic Foundations: Overview of Mendelian and non-Mendelian inheritance, Transformation, transduction, and conjugation, Recombination and complementation, Mutational analysis, Genetic mapping and linkage, Analysis.
Chromatin and Chromosomes: Overview of Karyotypes, Translocations, inversions, deletions, and duplications, Aneuploidy and polyploidy Structure.
Genomics: Genome structure, Physical mapping, Repeated DNA and gene families, Gene identification, Transposable elements,
Genome Maintenance: DNA replication, DNA damage and repair, DNA modification, DNA recombination and gene conversion.
Gene Regulation in Eukaryotes: *Cis*-acting regulatory elements, *Trans*-acting regulatory factors, Gene rearrangements and amplifications, Genetic manipulation of bacteria: transposons and plasmids. Large scale genome analysis: the human genome project.

BCMB 408: Entrepreneurship For Innovations In Biosciences Credits: 2

General Principles of Entrepreneurship: Nature and Importance; The Individual Entrepreneur; Technology Entrepreneurism; Characteristics of Successful Technology Based Businesses; Technical Risk Assessment; Alternative Technology Assessment; Entrepreneurial Process; Entrepreneurial Decision Making; Creativity and the Business Idea; Product Planning and Development System; Resource Needs; Alternative Financing Models; Intellectual Property Protection; Patents, Trademarks, and Copyright in Technology Venturing; Preparing for Venture Launch; Managing Growth and Expansion.
Innovation in Biosciences: Medicine (Diagnosis, Therapeutics, etc); Food & Agriculture (Quality, Safety, Production Efficiency and Processing); Environment (Remediation, Conservation and Restoration); Value added Natural Products;

BCMB 410: Seminars And Scientific Writing Credits: 1

Review of language structure and usage.
Types of scientific reports: Seminars, research papers, proposals, posters.

Structure of scientific reports: Title, authors, abstract/summary, Table of content, Glossary; Introuction (context, focus, justification); Materials and Methods; Results; Discussion; Conclusion; References; Appendixes.
Writing style and Rules: Dos and Don'ts; Plagiarism.
In addition, students are required to attend all departmental seminars, (presented by either internal or external speakers), present journal articles (journal club), research proposal and project seminars.

BCMB 414: Plant Biochemistry — Credits: 2

Carbohydrates: germination of seeds with carbohyrate stores; storage carbohydrates (starch, sucrose and other reserve carbohydrates); structural carbohydrates (cellulose, hemicellulose, pectin); the biosynthesis of carbohydrates.
Lipids: germination of oil seeds, the glyoxalate pathway and gluconeogenesis; chemistry of plant lipids: cutins, suberins and waxes; fatty acid biosynthesis.
Nitrogen metabolism: nitrogen fixation (dinitrogenase); nitrogen uptake and reduction.
Secondary metabolites: Terpenes (the mevalonic acid pathway); phenolic compounds (the shikimic acid pathway); saponins, cardiac glycosides, cyanogenic glycosides and glucosinades and alkaloids; functions
Photosythesis: Chloroplast structure; photoreceptors and transduction of light into chemical energy (the photosynthesis electron transport chain); carbon fixation; the C3, C2 and C4 cycles; CAM metabolism.
Molecular and biochemical regulation of plant metabolic pathways activated in response to environmental cues: environmental stress, and interaction with pathogenic and symbiotic organisms.
Cell wall formation (primary wall, wood), secondary metabolism (lignin, flavonoids, phenolics), wounding, plant defenses (phytoalexins, oxidative burst, hypersensitivity), responses to drought, flooding, salinity, pollutants (heavy metals, ozones).

BCMB 416: Bioremediation — Credits: 2

Review of bacterial genetics and genomics. Microbial diversity, distribution and detection in the environment.
Microbial responses to environmental changes: Direct physical and chemical effects, fine control, coarse control, morphological & genotypic changes.
Biochemical cycling of C*; N;* S, Fe, Hg.
Molecular mechanisms: Selected biochemical pathways in microbes involving Oxygenases and Peroxidases, microbial dechlorination reactions.
Biodegradation of aromatic, aliphatic chlorinated and non-chlorinated hydrocarbons; Polymer metabolism (eg. cellulose, xylan or pectin).
Environmental Applications: Replacement of Petroleum Products; Bio-fuels, Industrial Bio products.
Prevention and Management of Environmental Contamination: *S*ewage Treatment, Bio-leaching, Biodegradable Materials.
Introduction to Phytoremediation.

BCMB 418: Insect Biochemistry & Chemical Ecology — Credits: 2

Distinctive nature of insect metabolism: Energy metabolism; synthesis; storage mobilization; transport and utilization of fuels in flight; regulatory factors.
Insect hormones affecting growth and development: Biochemical activities; insect growth regulators. Insect control: Insecticides and their modes of action; detoxification mechanisms; insecticide resistance, synergists; new approaches to insect control.
Chemical ecology: Plant adaptation to environment; chemistry of pollution; plant-insect interactions (insect feeding stimulants, repellents, chemistry of plant defence); animal-animal relationships; pheromones; plant-plant relationships; plant-microorganism relationship-phytoalexins.

❖ DEPARTMENT OF BOTANY

LEVEL 100 SEM 1

SAMP 101: Sample Course 1

Objective: The course is intended to introduce students to the importance of this sample course.

ABCS 101: Introductory Animal Biology Credits: 3

CHEM 111: General Chemistry I Credits: 3

Uncertainty in measurements, significant figures; Normal distributions, standard deviations; Precision, Accuracy; Propagation of errors in calculations;Bronsted-Lowry concept of acids and bases ($\geq 10^{-}6$ M); strong and weak acids/bases; levelling effect of water. pX scale. Hydrolysis of salts (cations and anions). Simple pH calculations for solutions of acids, bases and their salts. Indicators as weak acids/bases and their choice in acid/base titrations, including polyprotic acids/bases; Calculations of pH throughout such titrations;Redox systems: Oxidation states, formal charges. Balancing of Redox reactions; applications. ;Solubility, ionic product constants and Ksp; common-ion effect. Selective precipitation; principles of Mohr and Volhard titrations.

MATH 101: General Mathematics Credits: 3

Indices and Logarithms. Equations and inequalities. Functions and graphs. Arrangements and selections. Binomial theorem. Limits, differentiation and integration

PHYS 101: Practical Physics I Credits: 1

PHYS 143: Mechanics and Thermal Physics Credits: 3

Mechanics:

Properties of Vectors: Geometrical representation, multiplication (dot product and cross product), the three-dimensional Cartesian co-ordinate system, Components of a vector, Direction Cosines, Linear Independence, Magnitude of a vector, Geometrical methods of vector addition, The sine rule and the cosine rule, Vectors in two dimensions

Linear Momentum: Conservation Law, Direct and indirect collisions, The co-efficient of restitution

Motion: Newton's laws, equations of motion, Motion in one dimension, Parametric equations of motion, Motion in two dimensions, Projectile motion, Relative velocity

Force:

Addition of Forces, Equilibrium, Impulse, Tension and the motion of connected masses, Friction

Circular motion: Uniform circular motion, Motion in a vertical circle, the conical pendulum

Work and Energy: Work done by a constant force, Work done by a varying force, Work and kinetic energy, Work and potential energy, Conservation of energy, Conservative and non-conservative forces – definition and examples

Rotational motion: Centre of mass, Moment of inertia, Angular momentum, Rotational kinetic energy, Torque

Gravitation: Kepler's laws, The law of Universal gravitation, Gravitational potential energy, Escape velocity

Thermal Physics

Microscopic and Macroscopic Definitions: Thermodynamic systems, Simple systems, Closed systems, Open systems, Isolated systems, Thermodynamic properties, States

Processes, Paths, Intensive and extensive quantities

Thermal Equilibrium: Temperature, Adiabatic walls, Diathermal walls, Thermometers and thermometric properties, Comparisons of thermometers, Thermometric scales and conversions, Zeroth law of thermodynamics

Work and Heat: Thermodynamic equilibrium – conditions, Chemical equilibrium, mechanical equilibrium, thermal equilibrium, Effects of conditions not satisfied, Change of state, Quasi-static processes, Work done, Work depends on path, Isothermal processes, Isobaric processes, Isochoric (isovolumetric) processes, Adiabatic processes, Concept of heat, Internal energy, Heat capacity, Specific heat, Heat flow (Conduction, Radiation, and Convection)
First law of thermodynamics: Cyclic processes, Non-cyclic processes, Nature of stored energy, First law and its implications under (i) Isothermal processes (ii) Isobaric processes (iii) Isochoric processes
Application: Introduction to entropy
Gas Laws: Properties of an ideal gas, Charles Law, Boyle's Law, Gay Lussac Law, Kelvin temperature scale (absolute temperature)
Kinetic theory of Gases: Assumptions, Force exerted on the walls of the container, Pressure, Equation of state, Molecular velocities: (i) Mean velocity (ii) mean square velocity (iii) root mean square velocity, Equipartition of Energy

LEVEL 100 SEM 2

CHEM 112: General Chemistry II Credits: 3

Short introduction to organic chemistry; what is meant by the structure of an organic molecule; Functional groups;Test for purity of organic molecules; Brief description of purification processes; Qualitative analysis; Quantitative analysis; Empirical formula; Molecular formula;Mention of the use of spectroscopic methods in determining structure; Alkanes and Cycloalkanes: Sources of hydrocarbons; fractional distillation of petroleum and uses of the different products; cracking, reforming; octane number; additives; Reactions of alkanes.Alkenes: Isomerism in alkenes; Preparation of alkenes; Reactions of alkenes; commercial uses of some polymers; alkynes: Lab preparation; Chemical reactions; Optical Isomerism; importance of stereoisomers in natural products, drugs etc.

PHYS 102: Practical Physics II Credits: 1

Basic Laboratory experiments to expose students to handling various measuring instruments and to data and error analysis.

PHYS 144: Electricity and Magnetism Credits: 3

Electricity:
Electric Charge and Electric Field: Electric charge, Conductors, insulators and induced charges, Coulomb's law, Electric field and Electric forces, Charge distributions, Electric dipoles
Gauss' Law: Charge and electric flux, Gauss' Law, Application of Gauss' Law
Electrical Potential: Electric potential energy and work, electric potential
Capacitance and Dielectrics: Capacitors (parallel plate capacitors, spherical, and cylindrical shaped capacitors) and dielectrics, Capacitors in series and parallel, Charging and discharging a capacitor, time constant, Energy storage in capacitors
Electric Current, Resistance and Direct-current circuits: Electric current, Resistivity and Resistance, Electromotive force and electric circuits, Energy and power in Electric circuits, Resistors in series and Parallel, Kirchoff's Rules, Electrical measuring instruments
Magnetism:
Magnetic Field and Magnetic Forces: Magnetic field, Magnetic field lines and Magnetic flux, Motion of charged particles in a magnetic field, Electric and magnetic fields acting together – application to velocity selectors, Magnetic force on a current-carrying conductor, Force and Torque on a current loop (a magnetic dipole moment)
Sources of Magnetic fields: Magnetic field of a moving charge, Magnetic field of a current element, Magnetic field of a straight current-carrying conductor, Force between parallel conductors, Magnetic field of a circular current loop, Ampere's law and its applications, Magnetic materials

Electromagnetic Induction: Faraday and Lenz's laws, Motional electromotive force, Induced electric fields, Eddy currents, Displacement current and Maxwell's equations
Inductance: Mutual inductance, Self-induced inductance, Inductors and magnetic-field energy, R-L and L-C circuits, L-R-C series circuits
Alternating current: Phasors and alternating current, Resistance and reactance, L-R-C series circuit, Band-Pass filters, Power in alternating-current circuits, Power factor, Resonance in alternating-current circuits, Transformer

LEVEL 200 SEM 1

BIOL 201: Introductory Plant Morphology Credits: 3
Survey of the form of the vegetative and reproductive body of seed plants. Primary meristems and development of the primary vegetative body of angiosperms; internal organization of the primary vegetative body and the relationship between structure and function of tissues; mechanism and importance of secondary growth in dicotyledons; brief survey of the relationship between structure and industrial uses of secondary tissues.

BOTN 203: Flowering Plants and Civilization Credits: 3
A theoretical and field work approaches to the knowledge of society's historical connection to plants. Plants and history: Greek and Roman pioneers in the history of plants in medicine, age of herbals and Doctrine of Signatures; Origin of cultivated plants. Plants as stimuli of exploration and exploitation: spices, New World spices, timber, the potato famine and Irish migration; early history of marijuana in China and India and its spread to the West; South American Origins of the coca plant, history of opium and heroin. Early history of plant classification and introduction to how plants are named: common names, scientific names, the language of flowers, genus names and their meanings. The past uses of the following well-known plant families: buttercup family, Laurel family, Poppy family, mustard family, rose family, legume family, spurge family cactus family, mint family, nightshade family, carrot family, pumpkin family, sunflower family, grass family, lily family, orchid family.

LEVEL 200 SEM 2

BIOL 202: Introductory Cell Biology and Genetics Credits: 3
Basic cell physiology-bioelements, water, water in cells, method of expressing concentrations of solutions, osmotic phenomena, imbibitions, biomolecules, carbohydrates, amino acids, proteins, lipids, nucleotides, nucleic acids, and the role of these in either cell biology and/or structure, enzyme action; photosynthesis, respiration and nitrogen metabolism. Basic principles of genetics; gene interactions, sex and inheritance; chemical basis of heredity; mutations, medical and biochemical genetics.

BOTN 204: Plants and Health Credits: 3
A theoretical and practical study of medicinal, psychoactive, poisonous and allergic plants. Why the study of medicinal plants. Description and uses of some selected plant species. Preparations of medicinal plants for the treatment of specific diseases. General treatment of the importance of secondary plant metabolites: alkaloids and polyphenolic compounds, with examples from common medicinal plants. Elementary treatment of the effects of caffeine, ephedrine and cocaine on the central nervous system. Mention of free radicals and antioxidant properties of medicinal plants. Brief treatment of each of the following: poisonous plants in the home, plant causing mechanical injury, insecticides from plants, allergy and the immune system.

LEVEL 300 SEM 1

BOTN 311: Vegetative Anatomy of Seed Plants Credits: 3

A theoretical and practical light-microscope study of the anatomy of vegetative parts of the seed plants, with some reference to economic importance of some of the tissues, and use of some of the anatomical features in taxonomy and phylogeny

BOTN 313: Phychology Credits: 3

Classification, structure and reproduction of the major algae divisions. Littoral zonation of the larger benthic algae and the factors affecting their distribution. Economic importance of algae, their use inagriculture and as food and feed source.

BIOL 315: Principles of Genetics Credits: 3

An introduction to the principles of genetics and chromosome cytology from the molecular aspects to population aspects, including applications of the principles in animal breeding, plant breeding and applied human genetics. Some of the practical techniques in formal genetics and cytogenetics are introduced.

BOTN 317: Biometry I Credits: 2

The course is designed to equip students with the skills to use biometry as a tool for quantitative scientific research. The binomial theories and its application to probability (Pascal's triangle). Introduction to linear, logarithmic and exponential functions. Description of methods used in biology in biometry. Sets application in biology . Data collection and data management. Sampling, Basic statistical methods Basic experimental design. Report writing. Computers and data analysis. Systems approach

BOTN 321: Evolution Credits: 3

The synthetic theory of evolution and is historical developments. Sources of variation. Selection and its types of selection. Polymorphisms. Speciation, isolating mechanisms. Hybridization and introgression. Evolution at the molecular level.

BOTN 323: Principles of Plant Propagation, Conservation and Utilization Credits: 3

The course is designed to introduce the student to the principles and practices of plant conservation and utilization. The course will cover the following: Propagation structures and media. Sexual propagation: methods and importance. Asexual propagation methods: cuttings, layering, budding and grafting, specialized organs. Anatomical basis of asexual propagation and propagation of selected plant species. Nurseries. Germplasm collection and utilization. Introductory tissue culture techniques

BOTN 325: Bacteria and Viruses Credits: 3

Morphology of bacteria, distinguishing between Gram-positive and Gram-negative bacteria. Growth and recombination in bacteria. Formation, structure and function of endospores. Characteristics of Aerobic and Anaerobic bacteria. Physical and chemical anti-bacterial agents. Structure and composition of viruses, bacteriophages and viroids: classification of plant viruses, and culturing of plant and animal viruses.. The symptoms and economic effects of the Cocoa Swollen Shoot Virus disease. African Cassava Mosaic virus disease. Cassava Mosaic Virus disease and Groundnut Rosette Virus disease, and the control of the viruses.

LEVEL 300 SEM 2

BOTN 310: Language for Scientists I Credits: 1

Most scientific materials are written in French. These materials are sometimes vital to the research and academic needs of the science student. For the student with an Anglophone background and little or no

knowledge in French, such information needs to be translated into English. Language for scientists I is a course designed to guide students to the knowledge of basic French grammar

BOTN 312: Whole Plant Physiology Credits: 3
Treatment of biophysical concepts: plant water relations; absorption of water; transpiration; stomatal physiology; ion uptake; transport systems in plants; survey of phytohormones; brief coverage of dormancy, germination and growth, flowering and fruiting.

BOTN 314: Taxonomy and Evolution of Seed Plants Credits: 3
Comparative morphology and/or evolutionary trends in seed plants, with special reference to common seed plant families in Ghana. Basic principles of taxonomy to include classification, nomenclature and identification.

BOTN 3I6: Plant Ecology of West Africa Credits: 3
Introduction to description and classification of plant communities; climax vegetation; the West African environment. Basic concepts in plant ecology; biological associations: mutualism commensalism, parasitism, predation. Pollination mechanisms; social insects. General distribution of vegetation types in relation to climate and soils. Forest and savanna types and their interrelationships. Strand, mangrove, lagoon and montane vegetation types. Accra plains. Human ecology in hese vegetation types. Introduction to quantitative ecology. Species diversity indices

BIOL 318: Aquatic Biology Credits: 3
Water properties of biological importance. The seas: the open ocean and coastal waters. Factors determining water circulation. Effects of water circulation upon productivity. Pollution. Utilization and conservation. Lakes: Origins of lakes and their biological types. Factors determining water circulation. Rivers: Origins and water movement. Biotic communities, adaptations and distribution. Phytoplankton: Distribution including temporal and special changes in relation to physico-chemical and biological factors in the environment. Estuaries: Optical and physical properties; water movement. Dissolved substances. Mangrove swamps.

BOTN 322: Biology of Lower Plants Credits: 3
The life cycle of archegoniates. Classification of the bryophytes and pteridophytes. Morphology, anatomy and life cycle of representatives of the principal orders of bryophytes and pteridophytes. Water relations and ecology of bryophytes and pteridophytes. Evolution of thallus structure in the Hepaticae.

LEVEL 400 SEM 1

BOTN 400: Project Work Credits: 3
A year-long project to be carried out by the student under the supervision of senior member(s) of the Department

BOTN 411: Fungi and Lichens Credits: 3
The course is designed to give students an understanding of the structure, including ultrastructure, reproductive processes and ecology of fungi. It will also bring to students an appreciation of fungal roles in agriculture, forestry and industry. In the treatment of lichens, emphasis will be laid on the structure, reproduction and the physiological relationship between the mycobiont and phycobiont components of Ascolichenes.

BOTN 413: Cell Ultra Structure and Function Credits: 3

Detailed coverage of the ultra structure and functions of the cell and cell organelles in relation to their chemical constituents; bio-energetics; enzyme classification and kinetics; photosynthesis; respiration; nitrogen metabolism.

BOTN 417: Microbiology Credits: 3

The course gives a general knowledge of microbiology, microorganisms and viruses. The emphasis is on their structure, physiology and ecological relationships and on the activities of interest to man that they carry out. Prokaryotic microorganisms and viruses will be more emphasized as the eukaryotes are extensively treated in other courses

BOTN 419: Advanced Plant Taxonomy Credits: 3

The taxonomic character, sources and uses. Chemotaxonomy. Modern methods in assessing relationships. Numerical taxonomy and cladistics

BOTN 425: Quantitative Plant Ecology Credits: 3

Description and measurement of vegetation and environment. Sampling methods; accuracy and significance tests. Species diversity; diversity indices. Spatial arrangement of organisms. Pattern. Association between species. Association analysis and other classificatory analyses. Ordination. Interpretation of taxonomic and ecological data by multivariate methods. Field collection of samples for the herbarium; field notes; Photography.

BOTN 427: Conservation and Environmental Studies Credits: 3

Principles of conservation and plant and animal protection and their application to the West African environment. Management of renewable natural resources. Conservation of Plant Genetic Resources. Pollution of the Environment. Ghana's Environmental Action Plan. Environmental management for vector control; the Volta sand Weija experience. Climate change and other global environmental problems.

BOTN 429: Population and Biometrical Genetics Credits: 3

History of population genetics. Hardy-weinberg law and its use, including cases of sex linkage and multiple alleles. Coefficient of inbreeding. Inbreeding: Mutation, Selection, Equilibria, Evolution of dominance. Polymorphism and balanced polymorphism. Chromosome frequencies and recombination, Polymorphism and multiple alleles. Alternative theories to natural selection. History of biometrical genetics. Genotype-environment interaction. Scaling. Components of means: additive and dominant effects; interaction and heterosis. Components of variation. Interaction, Linkage. Randomly breeding populations. Dialleles, special races: sex linkage, maternal effects, haploide, polyploids. Number of effective factors. Concepts of biometrical genetics. Artificial selection experiments, and responses to selection.

BOTN 431: Plant Hormones Credits: 3

Introduction to methods of studying phytohormones: extraction, isolation, identification and quantification; determination of sequence of amino acids in proteins; biosynthesis of amino acids, lignin and phytohormones including a brief treatment of their mode of action.

BOTN 433: Fresh Water Biology Credits: 3

Chemical aspects of rain water, ionic composition of lakes and rivers; oxygen, carbon dioxide and pH and chemical stratification. Biological aspects: primary production, population dynamics and correlation with physico-chemical aspects. Pollution: effects of pollution on inland waters; eutrophication. Fresh water macrophytes: types/classification, zonation, biological adaptations of hydrophytes; succession; production. Algal physiology. Bacteria morphology and physiology. Aquatic fungi. Economic aspects of

fresh water plants (micro-and macrophytes): aquatic weed problems including toxic algae; aquatic weed control; value of aquatic plants (algae and macrophytes); beneficial and harmful bacteria and fungi in fresh water.

BOTN 435: Developmental Plant Anatomy Credits: 3
Quantitative description of growth. Phyllotaxy and leaf development. Experimental observation of leaf growth and development in some elected plants. Developmental and differentiation of (i) the cell wall (ii) vascular system and reproductive structures of seed plants. Embryology. Systematic anatomy of useful plant products: fibres, seeds, latex, osmophores. Cell wall structure.

BOTN 437: Biometry II Credits: 2
Calculus: Differentiation. Matrix algebra (latent roots and latent vectors). Maximum likelihood of statistical estimation. Analysis of variance (Duncan's multiple range test). Factorial experiments. Correlation and regression. Multivariant methods. Use of the computer.

BOTN 439: Physiology of Fungi Credits: 3
This course is designed as a sequel to course BOTN 411 to relate the functioning of the fungus to its structure. The course, therefore, covers the function of the fungus spore, growth and metabolism of the vegetative thallus and the physiology of reproduction. Discussions at relevant places of the course will include associations of fungi with other organisms other than parasitism. Attention will also be drawn to the involvement of fungi in agriculture, industry and human welfare.

LEVEL 400 SEM 2

BOTN 400: Project Work Credits: 3
A year-long project to be carried out by the student under the supervision of senior member(s) of the Department

BOTN 410: Language for Scientists II Credits: 1
Language for Scientists II is designed to help students to acquire translation skills to be able to translate scientific French materials into English. Students will therefore be: (i) taken through scientific terms in French and (ii) given a number of French scientific materials for translation into English with the use of dictionaries

BOTN 414: Economic Botany Credits: 3
The origins, distribution and ecology (botany and cultivation) of crop plants in Ghana. Ethnobotany. The elements of silviculture and forest utilization in Ghana (timber, fuel etc.)

BOTN 418: Plant Pathology Credits: 3
This course is designed to give a wide approach to plant diseases caused by parasites (fungi, bacteria, nematodes and flowering plants) and viruses and by nutritional disbalance. Consideration of diseases caused by parasites and viruses will fall into four interrelated phases: aetiology, interaction of plant and pathogen, interactions of populations of plants and pathogens and environment, and control of plant diseases.

BOTN 422: Floral and Reproductive Biology Credits: 3
Types of pollination; pollen and animals; nectar, nectaries and animals. Fertilization and changes in ovary and ovule Isolating mechanisms in flowers; limitations naturally placed on variations in populations. Place of floral biology in plant breeding.

BOTN 426: Production Ecology Credits: 3

The ecosystem concept. Variations of ecosystem structure. Turnover of energy, organic matter, water, mineral nutrients in the ecosystem. Productivity of terrestrial ecosystem; control and measurement of primary and secondary productivity. Ecological mechanisms controlling distribution of plants and animals. Interaction between organisms; interaction between organisms and environment, Floral ecology.

BOTN 428: Molecular Genetics, Plant Breeding and Cytogenetics Credits: 3

Molecular Genetics: Haemoglobin variants in man. Genetic engineering and biotechnology, Recombinant DNA technology and its application in Biology, Medicine and Agriculture. Plant Breeding: Sex determination in plants. Incompatibility in flowering plants. Principles of plant breeding. Cytogenetics: Chromosome structure. Chromosomal aberrations. Karyotype evolution. Advanced topics in Meiosis. Cytogenetics of the Nucleolus.

BOTN 432: Whole Plant Physiology Credits: 3

Growth, developmental and environmental physiology: dynamics of growth, detailed coverage of flowering and fruiting, regulation of organ longevity, senescence and death; introduction to the effects of light, temperature, water, pollution and climate change on plant growth and development; the physiology of plants under stress; biological clocks; allelopathy.

BOTN 436: Applied Plant Anatomy Credits: 3

Anatomy in plant identification, classification and phylogeny. Anatomy in plant pathology. Forensic plant anatomy. Food adulterants and contaminants. Dendrochronology. Ecological plant anatomy. Wood in archaeology. Forensic applications.

❖ DEPARTMENT OF MARINE AND FISHERIES SCIENCES

LEVEL 100 SEM 1

SAMP 101: Sample Course 1

Objective: The course is intended to introduce students to the importance of this sample course.

STAT 101: Introduction to Statistics Credits: 3

ABCS 101: Introductory Animal Biology Credits: 3

CHEM 111: General Chemistry I Credits: 3

Uncertainty in measurements, significant figures; Normal distributions, standard deviations; Precision, Accuracy; Propagation of errors in calculations;Bronsted-Lowry concept of acids and bases ($\geq 10^{-}6$ M); strong and weak acids/bases; levelling effect of water. pX scale. Hydrolysis of salts (cations and anions). Simple pH calculations for solutions of acids, bases and their salts. Indicators as weak acids/bases and their choice in acid/base titrations, including polyprotic acids/bases; Calculations of pH throughout such titrations;Redox systems: Oxidation states, formal charges. Balancing of Redox reactions; applications. ;Solubility, ionic product constants and Ksp; common-ion effect. Selective precipitation; principles of Mohr and Volhard titrations.

EASC 101: Physical Geology Credits: 3

Physical Geology is the science of the earth and the processes that are acting upon it. The course cover the following topics: minerals; volcanism and extrusive rocks; intrusive activities and origin of igneous rocks; weathering and soil; sediments, sedimentary rocks and structures; metamorphism, metamorphic rocks and hydrothermal rocks; the rock cycle; mass wasting; streams and landscape; groundwater; glaciers and glaciation; deserts and wind action; shorelines and coastal processes; crustal deformation and folds;

faults; earthquakes; the Earth's interior; the ocean floor; plate tectonics; mountain building. The course may include trips to the field to reinforce geological concepts learned in class and laboratory.

MATH 101: General Mathematics Credits: 3

Indices and Logarithms. Equations and inequalities. Functions and graphs. Arrangements and selections. Binomial theorem. Limits, differentiation and integration

MATH 121: Algebra and Trigonometry Credits: 3

This course is a precalculus course aiming to develop the students ability to think logically, use sound mathematical reasoning and understand the geometry in algebra. It examines:logic and concept of mathematical proof; sequences and series; elementary set theory; the algebra of surds, indices and logarithms; the concept of a function, identifying domain and range and injective and surjective functions; trigonometric functions, their inverses, their graphs, circular measure and trigonometric identities.

PHYS 105: Practical Physics Credits: 1

PHYS 143: Mechanics and Thermal Physics Credits: 2

Mechanics:

Properties of Vectors: Geometrical representation, multiplication (dot product and cross product), the three-dimensional Cartesian co-ordinate system, Components of a vector, Direction Cosines, Linear Independence, Magnitude of a vector, Geometrical methods of vector addition, The sine rule and the cosine rule, Vectors in two dimensions

Linear Momentum: Conservation Law, Direct and indirect collisions, The co-efficient of restitution

Motion: Newton's laws, equations of motion, Motion in one dimension, Parametric equations of motion, Motion in two dimensions, Projectile motion, Relative velocity

Force:

Addition of Forces, Equilibrium, Impulse, Tension and the motion of connected masses, Friction

Circular motion: Uniform circular motion, Motion in a vertical circle, the conical pendulum

Work and Energy: Work done by a constant force, Work done by a varying force, Work and kinetic energy, Work and potential energy, Conservation of energy, Conservative and non-conservative forces – definition and examples

Rotational motion: Centre of mass, Moment of inertia, Angular momentum, Rotational kinetic energy, Torque

Gravitation: Kepler's laws, The law of Universal gravitation, Gravitational potential energy, Escape velocity

Thermal Physics

Microscopic and Macroscopic Definitions: Thermodynamic systems, Simple systems, Closed systems, Open systems, Isolated systems, Thermodynamic properties, States

Processes, Paths, Intensive and extensive quantities

Thermal Equilibrium: Temperature, Adiabatic walls, Diathermal walls, Thermometers and thermometric properties, Comparisons of thermometers, Thermometric scales and conversions, Zeroth law of thermodynamics

Work and Heat: Thermodynamic equilibrium – conditions, Chemical equilibrium, mechanical equilibrium, thermal equilibrium, Effects of conditions not satisfied, Change of state, Quasi-static processes, Work done, Work depends on path, Isothermal processes, Isobaric processes, Isochoric (isovolumetric) processes, Adiabatic processes, Concept of heat, Internal energy, Heat capacity, Specific heat, Heat flow (Conduction, Radiation, and Convection)

First law of thermodynamics: Cyclic processes, Non-cyclic processes, Nature of stored energy, First law and its implications under (i) Isothermal processes (ii) Isobaric processes (iii) Isochoric processes

Application: Introduction to entropy
Gas Laws: Properties of an ideal gas, Charles Law, Boyle's Law, Gay Lussac Law, Kelvin temperature scale (absolute temperature)
Kinetic theory of Gases: Assumptions, Force exerted on the walls of the container, Pressure, Equation of state, Molecular velocities: (i) Mean velocity (ii) mean square velocity (iii) root mean square velocity, Equipartition of Energy

LEVEL 100 SEM 2

BOTN 104: Growth of Flowering Plants Credits: 3

CSCD 110: Computer Applications Credits: 3

CHEM 110: Practical Chemistry Credits: 1

CHEM 112 General Chemistry II Credits: 3
Short introduction to organic chemistry; what is meant by the structure of an organic molecule; Functional groups;Test for purity of organic molecules; Brief description of purification processes; Qualitative analysis; Quantitative analysis; Empirical formula; Molecular formula;Mention of the use of spectroscopic methods in determining structure; Alkanes and Cycloalkanes: Sources of hydrocarbons; fractional distillation of petroleum and uses of the different products; cracking, reforming; octane number; additives; Reactions of alkanes.Alkenes: Isomerism in alkenes; Preparation of alkenes; Reactions of alkenes; commercial uses of some polymers; alkynes: Lab preparation; Chemical reactions; Optical Isomerism; importance of stereoisomers in natural products, drugs etc.

EASC 102: Geological Map Work Credits: 1
This course is mainly concerned with the interpretation of geological maps and the relationship between the landscape and underlying rocks. It covers the recognition and interpretation of geological structures from maps.

EASC 104: Historical Geology Credits: 2
Historical Geology deals with the events that took place all over the world, throughout time. The syllabus covers the following topics: the structure of the Earth, the origin of the Universe, the origin of the Earth, and origin of the elements; the tempo of Earth history: catastrophic and/or uniformitarian; age of the Earth; time, including the vastness of geologic time, relative dating, radioactivity and isotopic dating; Geological Time Scale; fossils and fossilization; recognition, correlation, and interpretation of strata; origin and evolution of life; changes in sea level and climate; the evolution of continents; the geological record: events in Precambrian, Palaeozoic, Mesozoic and Cenozoic eras.

MATH 122: Calculus I Credits: 3
Calculus is the mathematics of change and motion. This course develops the mathematics of change and the course MATH 124 will explicitly develop the mathematics of motion. In this course we address: limits and continuity of real valued functions of a single real variable; the derivative as a limit, algebraic rules of differentiation, implicit differentiation and the derivative of a function in parametric form; integration and the solution to first order differential equations.

PHYS 106: Practical Physics II Credits: 1

PHYS 144: Electricity and Magnetism Credits: 2

Electricity:

Electric Charge and Electric Field: Electric charge, Conductors, insulators and induced charges, Coulomb's law, Electric field and Electric forces, Charge distributions, Electric dipoles

Gauss' Law: Charge and electric flux, Gauss' Law, Application of Gauss' Law

Electrical Potential: Electric potential energy and work, electric potential

Capacitance and Dielectrics: Capacitors (parallel plate capacitors, spherical, and cylindrical shaped capacitors) and dielectrics, Capacitors in series and parallel, Charging and discharging a capacitor, time constant, Energy storage in capacitors

Electric Current, Resistance and Direct-current circuits: Electric current, Resistivity and Resistance, Electromotive force and electric circuits, Energy and power in Electric circuits, Resistors in series and Parallel, Kirchoff's Rules, Electrical measuring instruments

Magnetism:

Magnetic Field and Magnetic Forces: Magnetic field, Magnetic field lines and Magnetic flux, Motion of charged particles in a magnetic field, Electric and magnetic fields acting together – application to velocity selectors, Magnetic force on a current-carrying conductor, Force and Torque on a current loop (a magnetic dipole moment)

Sources of Magnetic fields: Magnetic field of a moving charge, Magnetic field of a current element, Magnetic field of a straight current-carrying conductor, Force between parallel conductors, Magnetic field of a circular current loop, Ampere's law and its applications, Magnetic materials

Electromagnetic Induction: Faraday and Lenz's laws, Motional electromotive force, Induced electric fields, Eddy currents, Displacement current and Maxwell's equations

Inductance: Mutual inductance, Self-induced inductance, Inductors and magnetic-field energy, R-L and L-C circuits, L-R-C series circuits

Alternating current: Phasors and alternating current, Resistance and reactance, L-R-C series circuit, Band-Pass filters, Power in alternating-current circuits, Power factor, Resonance in alternating-current circuits, Transformer

LEVEL 200 SEM 1

FISH 201: Introduction to Fisheries Science Credits: 3

Scope of Fisheries Science. History of fishing. Diversity of fisheries. Taxonomic classification of fishes. Common fish resources, their exploitation and management. The fishing industry in western Africa: artisanal (both marine and inland) semi-industrial, industrial, aquaculture. The socio-economic setting of fishing communities. Economic importance of fisheries.

FISH 203: Introduction to Limnology Credits: 3

Characteristics of streams and rivers and lakes. Formation and classification of lakes. Major man-made and natural lakes of Africa. Abiotic factors influencing productivity in the fresh water environment. Primary and secondary production in freshwater ecosystems. Tropical freshwater-water-borne diseases. Invasive aquatic weeds. Ecological adaptations of freshwater organisms. Crisis in the world's freshwater resources.

MASC 201: Introductory Oceanography Credits: 3

History of oceanography. Oceanography as a science. Geologic and evolutionary history of the Earth. Internal structure of the Earth, isostasy and plate tectonics. Origin and structure of the ocean basins. The climatic seasons. Shape of the Earth and location systems. Bathymetric and physiographic charts. Hydrologic cycle. Seas and oceans. Seawater – composition, physical and chemical properties. Distribution of heat in the oceans. Motion in the ocean – wind patterns, surface currents, waves and tides. Life in the oceans. Environmental issues in oceanography.

MASC 203: Aquatic Ecology Credits: 3

Aquatic Habitats - Freshwater (lentic and lotic habitats); Marine (brackish, estuaries, lagoons, coastal, shelf, deepsea habitats). Importance of oceans, lakes and reservoirs. Measurement of productivity. The physical and chemical factors in aquatic environments. Biological communities – biodiversity of aquatic ecosystems. Plankton, Neuston, Nekton, Benthos, Periphyton, Awfwuchs, Mangroves/Macroflora. Common weeds in impoundments and their management. Adaptation to aquatic ecosystems - Preventing Desiccation, Maintaining position, Avoiding Crushing by Waves, Respiration, Reproduction, Feeding, Avoiding Predation, Excretion, Preventing, OverheatingAnthropogenic impacts on aquatic ecosystems. Resource exploitation (Fishing and Mining); Alterations of aquatic ecosystems; Pollution (agricultural, domestic and industrial Effluents). Conservation and management of aquatic ecosystems. Water and sustainable development- the crisis in water resources and need for management. Traditional methods; National and International Regulations and Global Agreements. Hydrobiological problems in the tropics-man-made lakes and water-borne diseases associated with impoundments.

MASC 202: Marine Resources and Man Credits: 2

The living resources of the sea: major fishing areas, major food species, other commercial resources – e.g. pharmaceutical products. The non-living resources of the sea: oil and gas, minerals, fresh water, energy. Threatened and endangered species: mammals, sea turtles, seabirds, invertebrates. Special habitats: lagoons, estuaries, mangrove forests, coral reefs.

FISH 202: Principles of Aquaculture Credits: 3

Basic definitions and terminologies in aquaculture and mariculture: standing crop, carrying capacity, etc. Fish husbandry: aquatic farming systems (pond, cage, pen, raceways, etc), intensive and extensive systems. Characteristics of desirable species for culture. Cultured species of tropical Africa. Water quality and fish health. Economic importance of aquaculture.

MASC 204: Oceanography & Fisheries Practical I Credits: 2

The practical will be based on topics covered during the entire year

LEVEL 300 SEM 1

FISH 313: Introduction to Aquaculture Credits: 3

Water as environment for aquaculture; characteristics for selection of fish for aquaculture; energy budget of fish of typical fish for aquaculture. Aquaculture systems and techniques. Concepts of integrated aquaculture. Mariculture. Principal food chain in fish ponds. Control of aquatic plants, predators and diseases. Status of aquaculture in West Africa Biotechnology and aquaculture. General economics of aquaculture.

FISH 315: Fish Microbiology Credits: 2

Introduction to general microbiology. Fish micro-organisms & pathogens – types, morphological characteristics, processes, mechanisms, disease and prevention. Microbial causes of fish spoilage-enzymatic breakdown of fish molecules, roles of glycolytic and autolytic enzymes. Food and water-borne diseases, fish infections and intoxication. Microbiological methods for assessment of fish quality. Spoilage of fish and influence of temperature. Food contamination and public health microbiology. Importance of potable water in fish processing. Microbial risk assessment, quality control, and microbiological standards in fish consumption and international trade. Sampling, culture techniques, and analysis. Microbial preservation techniques to preserve fish quality and increase shelf life. Survey of tropical fish processing methods including traditional and industrial. Genetic modification of fish and their importance in aquaculture. Nutrient interactions and fish health. Fish immunology. Introduction to

fish endocrinology with particular reference to the pituitary hormones, testicular and ovarian steroids and their importance in fish reproduction.

FISH 317: Introductory Research Methods Credits: 3
Types of data and their manipulation (samples and population, variables in environment, accuracy and data precision, frequency distributions, computations using spreadsheet). Descriptive statistics. Estimation and hypothesis testing. Univariate and multivariate statistics. Parametric and non-parametric tests. General experimental design. Introduction to modeling.

FISH 321: Ichthyology Credits: 2
Fish evolution and diversity. Classification and identification of fishes. Fish anatomy (internal and external structure) and function. Modes of reproduction. Fertilization and early development of fishes. Sex differentiation. General characteristics of organismic growth. Feeding categories and adaptations. Fish migration. Methods of studying fish migrations.

FISH 323: Fish Diseases and Pathology Credits: 2
Host-pathogen-environment relationship, Identification and diagnosis of fish diseases. Causative agents - bacteria, virus, parasites etc. Infections and diseases of fish in Africa - viral disease, bacterial infections, fungal and parasitic infections. Environmental and nutritional diseases. Transboundary fish diseases. Fish immunology. Control and management of fish diseases. Public health and fish consumption.

FISH 325: Marine Fisheries Credits: 3
Status and importance of marine fisheries (global and national). Types of fisheries. Marine fisheries of the world. Common marine fishes in Ghana. Factors affecting fish abundance. Fish sampling strategies. Methods for determining and/or measuring growth, spawning season, food habits, migration, catch and effort. Marking and tagging fish. Impacts of fishing on marine ecosystems. Aquaria and ornamental fishes. Contemporary issues in fishing – e.g. overfishing, bycatch, discards and trash fish, Illegal, Unregulated and Unreported (IUU) fishing; Monitoring, Control and Surveillance (MCS), and fisheries extension. Socio-economic aspects of fisheries including gender, poverty reduction and alternative livelihood.

FISH 327: Fisheries Practical I Credits: 2
Practical covering all core courses in First Semester.

FISH 329: Fish and Fisheries of West Africa Credits: 2
Fisheries resources of West Africa other than fishes and (molluscs, bivalves, gastropods, cephalopods, echinoderms, sea urchins, and crustaceans) – their diversity, occurrence and distribution. Types of fisheries (artisanal, industrial and recreational) in both marine and inland waters. Capture methods in the sub-region. Fisheries and partnership agreements in the sub-region. Traditional and cultural practices in fishing communities. Role of women in the fishing industry. Exclusive Economic Zones (EEZ). Role of regional and sub-regional bodies e.g. NEPAD in fisheries capacity building and development.

MASC 311: Nautical Science Credits: 3
General Ship knowledge: ship cargoes, merchant fleet, classification societies, International load line, ship tonnage, shift of ships center of gravity. Field exercises: Practical seamanship, anchors and markings, ropes, tackles, knots, splices. First Aid, fire fighting, swimming, snorkelling and diving. Navigation: Earth, mercator and gnomonic charts, other charts, datum, information from charts and publications, distances, the nautical mile, the knot, position lines and position fixes, dead reckoning, estimated position, observed position. Chartwork exercises: Compass rose, gyro, and magnetic compass courses. Running

fixes: Taking of bearings and laying down courses, courses and distances made good. Marine research vessels: equipments and operation.

MASC 313: Coastal Wetlands Credits: 2

Definition and Classification of Wetlands; Wetland Hydrology; Wetland Soils; Patterns in Wetland Vegetation; Gas Transport in Wetland Plants; Introduction to Wetland Delineation; Wetland Assessment (Functions and Values); Economic Valuation of Wetlands; Wetland Mitigation

MASC 315: Coastal Geomorphology Credits: 2

Coastal classifications. Types of Coastlines. Morphology of the coast. Waves and wave-induced currents. Wave types (progressive, Tsunamis, internal and standing waves). Wave effects. Effect of tides on coasts. Coastal sediments. Sediments movements by currents. Sediment movement by wind. Coastal sand dunes. Tidal landforms (wetlands, mudflats, salt marshes and coastal mangrove forests). Other coastal landforms (sandy and rocky shores, cliffs and shore platforms, arches and stacks, pocket beaches, spits, hooks and tombolos, etc). Coastal morphology and sea level. Coastal and shore line protection.

MASC 319: Marine Non-living Resources and Industry Credits: 2

Types & characterisation of marine non-living resources; their exploration, development and constraints.

MASC 321: Principles of Remote Sensing and Geographic Information Systems Credits: 3

Principles of remote sensing. Electromagnetic Radiation. Interaction of Light with atmosphere and surfaces. Satellite observation systems. Principles of image processing. Digital Image Processing – acquisition, correction, calibration and interpretation. Introduction to Geographic Information Systems. Satellite-based positioning systems. Datums and map projections. Digitization. Database management systems. Basic spatial analysis. Data visualization (maps). Data quality and documentations.

MASC 323: Coastal Tenure and Ethnobiology Credits: 2

Importance of relationships between people, biota, and the coastal environment – past and present. Marine and coastal tenure. Property rights. Traditional environmental knowledge. Community based environmental awareness raising programmes. Environmental education and management frameworks in relation to marine and coastal resources. Introduction to approaches for educating children and adults. The importance of incorporating environmental knowledge in customary marine tenure, and its value in modern management practices. The decline in environmental knowledge and its consequences on biological education and environmental management. Cultural heritage in adopting a marine and coastal conservation ethos. The importance of the coasts and seas as sources of music, poetry, art and creative crafts. The development of sustainable tourism. The roles, responsibilities and engagement of Ghanaian and international NGOs and other civil organizations in the governance of marine and coastal resource management. Sustainability of educational programmes.

MASC 325: Aquatic Plants Credits: 2

Identification and systematics. Structure and reproduction of the major groups (green, brown and red macroalgae). Zonation and factors affecting distribution of aquatic plants. Marine plants and their production (sea grasses and mangroves). Economic importance of aquatic plants. Alien and invasive aquatic plants. Algal blooms including harmful microalgae.

MASC 327: Oceanography Practical I Credits: 2

Practical covering all core courses in First Semester.

MASC 329: Behaviour of Aquatic Animals Credits: 2

Concepts of animal behaviour. Behavioural ecology (learning, stimuli, feeding, communication, courtship and mating, migration, protection, territoriality, social organization, orientation, rhythms, hormones and pheromones). Case studies on behaviour of named aquatic organisms.

LEVEL 300 SEM 2

FISH 312: Fish Physiology Credits: 2

Introduction & scope of fish physiology. Internal environment and composition of body fluids. Osmotic and ionic regulation water and salt balance, kidney structure and function. Functional adaptations to environmental change. Vascular transport and gaseous exchange - the heart and the cardiac cycle, respiratory organs, air-breathing fishes, transport of respiratory gases. Introduction to fish nutrition. Bioenergetics and metabolism (digestion and absorption). Fish locomotion Effect of changes in pressure and depth on fishes. Colouration in fishes. Sensory systems. Fish reproduction. Endocrine systems - pituitary hormones, non-pituitary endocrine functions.

FISH 314: Principles of Fisheries Management Credits: 2

Definition and scope of fisheries management. Management measures and approaches (e.g. fishery and area closure, fish quotas, licensing,). General management objectives guided by the FAO Code of conduct for responsible fisheries. Fishery regulation and policies. Fisheries law of Ghana. IUCN categories and criteria for threatened animals. Threatened species. Extinction in the aquatic wild. Exclusive Economic Zone (EEZ). Special conservation areas e.g. Marine protected areas and Ramsar sites. Framework survey of fisherfolks and communities. Traditional management and community-based management. Problems in the management of tropical multispecies stocks.

FISH 316: Fishing Technology Credits: 2

Basic terms and definitions of fishing gears. Fishing gears and methods (traps, hook and lines, stationery nets, towed nets and dredges, surrounding nets, fish aggregation devices (FADs)).
Indigenous fishing gears. Gear selectivity. Fishing gear construction. Netting. Availability of fish to gear. Characteristics of common fishing gears employed in Ghanaian waters. Types of fishing crafts and their operation. Maintenance of crafts and gears. Electronic and acoustic fishing methods. Landing facilities. Harmful fishing practices. Destructive effects of fishing.

MASC 318: Marine Invertebrates and Tetrapods Credits: 3

Taxonomic diversity of major invertebrate groups. Invertebrate life cycle and larval forms. Important migratory species: marine reptiles (turtles); marine birds (population trend and status; bird diversity, bill shape and pursuit patterns, range and country distribution, important bird areas (IBAs), threats and impact, the roles of Birdlife International and other relevant NGOs in their conservation)); representative members of the cartilaginous fish (sharks and rays- main types of shark fisheries and fishing methods; global shark catch and trade trends); marine mammals (representative sirenians, cetaceans and pinnipeds, diving physiology, aerobic dive limit, apneustic breathing patterns, echolocation, whaling, ecological status of marine mammals and their protection).

MASC 324: Aquatic Biodiversity and Conservation Credits: 3

Principles of biodiversity and conservation. measurement and analysis of biodiversity; Patterns of species diversity. Indicators of Biodiversity. Conservation of aquatic resources – Protected areas, Heritage sites, Ramsar sites etc. Convention on Biological Diversity. Resource valuation. National case studies of institutional and legislative framework for biodiversity conservation. Biodiversity and climate change;

climate change impacts on aquatic biodiversity. Key biodiversity areas (KBAs) in Ghana and key stone species.

MASC 326: Oceanography Field Course Credits: 4
Field visits for practical exposure. Designing, planning and execution of scientific investigations in Oceanography. This may involve laboratory activities. Assessment is based on an oral presentation and submission of field reports.

MASC 328: Oceanography Practical II Credits: 2
Practical covering all core courses in Second Semester.

FISH 326: Fisheries Field Course Credits: 4
Field visits for practical exposure. Designing, planning and execution of scientific investigations in Fisheries. This may involve laboratory activities. Assessment is based on an oral presentation and submission of field reports.

FISH 328: Fisheries Practical II Credits: 2
Practical covering all core courses in Second Semester.

FISH 332: Industrial Internship Credits: 2
Students will be attached to relevant stakeholder institutions for a period of six (6) weeks during the long vacation. Students will be assessed from reports received from supervisors at the industry as well as report written by students of learning outcomes during the internship.

MASC 312: Marine Ecology I Credits: 3
The nature and global distribution of marine organisms and habitats. Ecological concepts. Primary and secondary production in the ocean. Measurement of productivity. Trophic interactions and flows of material and energy in marine food webs. Plankton communities: larval ecology, Life history strategies (r- and K-selection) and population dynamics. Intertidal environment: physical factors, biological patterns, adaptations of intertidal organisms; Biological interactions (Competition, predation and patch dynamics). Ecological methods: quantifying physical patterns; behavior; biological patterns. Anthropogenic impacts on the ocean.

MASC 314: Coastal Hydrology Credits: 2
Hydrologic cycle. Tides, waves, currents and their effects on coastal landforms. Tidal land forms – tidal inlets, intertidal flats and coastal wetlands, mangrove ecosystems. Coastal lagoons Estuaries and River deltas. Types of estuaries. Estuarine circulation patterns. Flushing time. Tidal exchanges – rivers and seas; rivers and aquifers, sub-surface flow into the sea.

MASC 316: Marine Biogeochemistry Credits: 2
Global hydrological cycle. Chemistry of seawater. Redox chemistry of seawater – importance of oxygen, organic matter production and destruction. Trace metal biogeochemistry. Biogeochemical cycles. Origin of petroleum in the marine environment. Chemistry of marine sediments. Pharmaceutical and other organic products from the sea.

LEVEL 400 SEM 1

FISH 400: Project Credits: 3
A supervised individual investigation in fisheries

MASC 400: Project Credits: 3
A supervised individual investigation in oceanography

FISH 411: Introductory Fisheries Taxonomy Credits: 2
Principles and scope of fisheries taxonomy. The binomial system of naming species; fish origins and diversity in shapes and feeding; Trophic categories in fishes; scope of classification; method of classification; Classification of major groups of fishes; Primitive bony fishes (Coelacanth, Latimeria chalumnae, the three living lung fishes, Protopterus, Lepidosiren, and Neoceratodus). Introduction to the use of FAO Fish Species Identification keys with particular reference to species of major importance to fisheries- Elasmobranchs (Sharks and rays), Mollusca (squids, octopus, oysters and clams; Crustacea (crabs, lobsters, shrimps); aquatic plants (e.g. Laminaria as source of food and additive); high seas fisheries resources- baleen whales and cetaceans (toothed whales and dolphins); Tuna stocks in principal world fish markets (albacore (Thunnus alalunga), big eye (Thunnus obesus), yellowfish (Thunnus albacares), skipjack (Katsuwonnus pelamis), bluefin (Thunnus thynnus); Bill fishes in principal world fish markets (Atlantic bluefin marlin, Atlantic whitefish marlin, black marlin, striped marlin, indo-pacific marlin, and the sword fish); Classification of top species produced in world aquaculture. The role of genetics or genetically modified organisms in fisheries. Taxonomy. Identification of unusual fish species and their adaptations e.g. deep sea fishes.

.FISH 415: Fisheries and Aquatic Wildlife Management Credits: 3
Effects of fisheries on the aquatic ecosystem. Definition and scope of fisheries management. General management objectives guided by the FAO Code of conduct for responsible fisheries. Fishery management scopes: single-species management compared with multi-species and multi-gear management; ecosystem management. Traditional management and community-based management. Fisheries management approaches. Management strategies and measures. Fishery regulation and policies. Fisheries law of Ghana. IUCN categories and criteria for threatened animals. Threatened species. Extinction in the aquatic wild. Exclusive Economic Zone (EEZ). Special conservation areas and their roles. Framework survey of fisherfolks and communities. Problems in the management of tropical multispecies stocks. Marine mammals of the world and their protection needs.

FISH 417: Fisheries Data Management Credits: 2
Data gathering, verification and processing. Standardization of data collection systems. Tools for fisheries data collection e.g. Frame surveys. Fisheries Dependent and fisheries independent data (experimental). Time series data. Fisheries monitoring and feedback mechanisms. Gathering and use of Social and Economic information. Statistical and modeling tools. Information and Computer Technology and fisheries data management. Communicating scientific fisheries information. Timely distribution and utilization of data for management purposes.

FISH 421: Fisheries and Higher Vertebrate Interactions Credits: 2
Impacts of fisheries on marine mammals, turtles and birds. Impacts of birds, mammals, etc. on fisheries. Fishing and stock fluctuations: effect of fishing on the ‘optimum’ take; cannibalism and fishing interactions; impact of trawling on seabed; effects of discards and industrial fisheries on stocks. Food and habitat interactions. Spatial and temporal competition between fish and higher vertebrates. Modelling interactions between man, vertebarates and fish resources. Management of shared resources of fishes and higher vertebrates.

FISH 425: Fish Stock Assessment Credits: 2
Fish stock assessment as a management tool. Status of world fisheries. Trends of national fish production and consumption. Types of overfishing. Key fish species targeted for stock assessment in Ghanaian coastal waters; constraints that hinder fish stock assessment in tropical waters. Collection of fishery data

for stock assessment: catch, effort and abundance data, size composition data and other biological data. Simple methods for the estimation of growth and mortality parameters using size composition data. Measurement of status of fishery: CPUE, stock size, fishery mortality rate and other indicators. Estimation of Maximum Sustainable Yield (MSY) and optimal fishing effort using Schaefer's Surplus Production Model as technical reference point for providing management advice. Introduction to stock assessment tools.

FISH 427: Fisheries Practical III Credits: 2
Practical covering all core courses in First Semester.

FISH 429: Fisheries Economics Credits: 2
Studies of resource economics and economic theories with application to fisheries. Bioeconmic theories and models of fisheries. Dynamic optimization and the economics of shared stocks. The socio-economics of fishing communities in the African setting. Status and importance of world fish trade. Producer-consumer linkages. Product type and processing. Equipment and installation. Prices, costs and internal rate of returns

MASC 411: Marine Plankton Ecology Credits: 2
Taxonomy and systematic of phytoplankton and zooplankton. Adaptation to pelagic life. Survey techniques. Sampling preservation and enumeration. Nutrition, reproduction and growth. Physiological processes. Vertical migration and distributions. Succession and associations. Interaction with other marine organisms and relation to fisheries. Harmful Algal Bloom (HAB). Modeling of zooplankton dynamics

MASC 413: Marine Benthic Ecology Credits: 2
Basic concepts in benthic ecology. Morphology of major benthic groups. Larval ecology of benthic organisms. Marine benthic community structure. Disturbance, colonization and succession. Feeding ecology of benthic organisms. Adaptive mechanisms in benthic habitats. Value of the benthos. Benthic sampling techniques

LEVEL 400 SEM 2

FISH 400: Project Credits: 3
A supervised individual investigation in fisheries

FISH 412: Aquaculture Engineering and Practice Credits: 3
Global status and importance of aquaculture. Design and construction of aquaculture facilities e.g. ponds, cages. Fish feeds formulation, preparation, storage and feeding. Design, construction and operation of fish hatchery. Tilapia and African catfish culture. Constraints to production and their mitigation. Fish health management. Environmental impacts of aquaculture developments. Basic genetic principles (molecular genetics and cytogenesis. Tools for genetic engineering (triploidy, gynogenesis, androgenesis, monosex populations, inbreeding etc). Tools for breeding: hereditabiligy and monosex selection. Aquaculture as a business. Genetically modified organisms.

FISH 414: Fish Processing and Utilization Credits: 3
Principles of fish processing and preservation. Methods of fish processing and preservation by artisanal and industrial fisheries in the tropics. Types of fish products - chilled fish, dried fish, salted fish, smoked fish, fish oil, fish meal, fermented products. Fish handling and storage. Effects of bumper harvest. Fish spoilage. Fish utilization. Fish by-products. Fish marketing. Local and foreign markets for diversified fish products. Quality control and packaging.

FISH 418: Current Research in Fisheries Credits: 2

Acquaintance with current research in Fisheries through seminars, audio-visuals, article review etc. Experts in the subject will be invited to give presentations to students on selected topics.

FISH 422: Fish Chemistry and Toxicology Credits: 2

General introduction to aquatic toxicology, fish biochemistry, chemistry and toxicology. Molecular composition of fish- water, carbohydrates, lipids, proteins, nucleic acids. Chemistry of fish nutritional quality. Biochemical mechanisms of adaptations of fish to the marine environment. Special emphasis on the effects of pressure, temperature, salinity, dissolved oxygen and light on the physiology and biochemistry. Current and future impact of various pollutants and toxic substances on fish life; human health and the environment. General types of aquatic toxicants. Biotoxins. Toxic fishes. Impact of pesticide residues and oil spills, offshore mining, shipping, long-lived toxic organic compounds such as PCBs and heavy metals in fisheries; impacts of dumping of chemical slops in the marine environment. Chemistry of fish decay. Techniques for the assessment of toxicity in fish. Fish immunotoxicology, environmental genotoxicology and carcinogenicity tests.

FISH 424: Fish Trade and Marketing Credits: 2

Important species traded and marketed. Trader types and function (small and large scale). Trends in world fish trade; endangered species due to trading and marketing; the supply chain; transaction systems; distribution channels of fish; consumer needs and value adding to fish. Quality assurance - labelling and certification. WTO Agreements and COFI sub-committee on fish trade. Other institutional and legal frameworks.

FISH 426: Fisheries Governance and Institutional Framework Credits: 2

Complexities of fisheries management Integrated fisheries management, ecosystem and precautionary approach to fisheries. Definition of ‘governance’. Need for fisheries governance & institutional framework. Role of coastal states enshrined in UNCLOS (1982). Fisheries institutional implications of role enshrined in e.g. FAO CCRF, FAO Committee on Fishing (COFI), UN Fish Stocks Agreement. The EEZ. International, national, and local policy, legal and institutional framework. International instruments. Other important international organisations in fisheries governance. Regional fisheries bodies and international organizations. National governance of fisheries – formal and traditional. Fisheries Law of Ghana. Essential institutional features for effective fisheries management. Rights based fisheries. Small scale fisheries. Science in fisheries governance. Corruption and other constraints to effective fisheries governance. Structural change and adjustment in the fisheries sector to improve fisheries governance. Multi-stakeholder processes in governance for responsible fisheries. Case studies in self-governance in the fisheries sector.

FISH 428: Fisheries Practical IV Credits: 2

Practical covering all core courses in Second Semester.

MASC 400: Project Credits: 3

A supervised individual investigation in oceanography

MASC 402: Marine Pollution Credits: 2

Definition of pollution. Sources and nature of marine pollution-oil pollution, radioactive and thermal waste, ocean dumping, domestic, industrial and agricultural waste, marine debris, beach fouling, etc. Eutrophication. Organic pollutants. Impacts on individuals, populations and communities. Detecting pollution. Ecotoxicological tests. Water quality assessment. Control and monitoring of pollution. Remediation of polluted water bodies.

❖ **DEPARTMENT OF NUTRITION AND FOOD SCIENCE**

LEVEL 100 SEM 1

CHEM 110: Practical Chemistry Credits: 1

ABCS 101: Introductory Animal Biology Credits: 3

CHEM 111: General Chemistry I Credits: 3

Uncertainty in measurements, significant figures; Normal distributions, standard deviations; Precision, Accuracy; Propagation of errors in calculations;Bronsted-Lowry concept of acids and bases ($\geq 10^{-}6$ M); strong and weak acids/bases; levelling effect of water. pX scale. Hydrolysis of salts (cations and anions). Simple pH calculations for solutions of acids, bases and their salts. Indicators as weak acids/bases and their choice in acid/base titrations, including polyprotic acids/bases; Calculations of pH throughout such titrations;Redox systems: Oxidation states, formal charges. Balancing of Redox reactions; applications. ;Solubility, ionic product constants and Ksp; common-ion effect. Selective precipitation; principles of Mohr and Volhard titrations.

MATH 101: General Mathematics Credits: 3

Indices and Logarithms. Equations and inequalities. Functions and graphs. Arrangements and selections. Binomial theorem. Limits, differentiation and integration.

PHYS 101:Practical Physics I Credits: 1

PHYS 143: Mechanics and Thermal Physics Credits: 3

Mechanics

Properties of Vectors: Geometrical representation, multiplication (dot product and cross product), the three-dimensional Cartesian co-ordinate system, Components of a vector, Direction Cosines, Linear Independence, Magnitude of a vector, Geometrical methods of vector addition, The sine rule and the cosine rule, Vectors in two dimensions

Linear Momentum: Conservation Law, Direct and indirect collisions, The co-efficient of restitution

Motion: Newton's laws, equations of motion, Motion in one dimension, Parametric equations of motion, Motion in two dimensions, Projectile motion, Relative velocity

Force: Addition of Forces, Equilibrium, Impulse, Tension and the motion of connected masses, Friction

Circular motion: Uniform circular motion, Motion in a vertical circle, the conical pendulum

Work and Energy: Work done by a constant force, Work done by a varying force, Work and kinetic energy, Work and potential energy, Conservation of energy, Conservative and non-conservative forces – definition and examples

Rotational motion: Centre of mass, Moment of inertia, Angular momentum, Rotational kinetic energy, Torque

Gravitation: Kepler's laws, The law of Universal gravitation, Gravitational potential energy, Escape velocity

Thermal Physics

Microscopic and Macroscopic Definitions: Thermodynamic systems, Simple systems, Closed systems, Open systems, Isolated systems, Thermodynamic properties, States

Processes, Paths, Intensive and extensive quantities

Thermal Equilibrium: Temperature, Adiabatic walls, Diathermal walls, Thermometers and thermometric properties, Comparisons of thermometers, Thermometric scales and conversions, Zeroth law of thermodynamics

Work and Heat: Thermodynamic equilibrium – conditions, Chemical equilibrium, mechanical

equilibrium, thermal equilibrium, Effects of conditions not satisfied, Change of state, Quasi-static processes, Work done, Work depends on path, Isothermal processes, Isobaric processes, Isochoric (isovolumetric) processes, Adiabatic processes, Concept of heat, Internal energy, Heat capacity, Specific heat, Heat flow (Conduction, Radiation, and Convection)
First law of thermodynamics: Cyclic processes, Non-cyclic processes, Nature of stored energy, First law and its implications under (i) Isothermal processes (ii) Isobaric processes (iii) Isochoric processes
Application: Introduction to entropy
Gas Laws: Properties of an ideal gas, Charles Law, Boyle's Law, Gay Lussac Law, Kelvin temperature scale (absolute temperature)
Kinetic theory of Gases: Assumptions, Force exerted on the walls of the container, Pressure, Equation of state, Molecular velocities: (i) Mean velocity (ii) mean square velocity (iii) root mean square velocity, Equipartition of Energy

LEVEL 100 SEM 2

CHEM 110: Practical Chemistry Credits: 1

BOTN 104: Growth of Flowering Plants Credits: 3

CHEM 112: General Chemistry II Credits: 3
Short introduction to organic chemistry; what is meant by the structure of an organic molecule; Functional groups;Test for purity of organic molecules; Brief description of purification processes; Qualitative analysis; Quantitative analysis; Empirical formula; Molecular formula;Mention of the use of spectroscopic methods in determining structure; Alkanes and Cycloalkanes: Sources of hydrocarbons; fractional distillation of petroleum and uses of the different products; cracking, reforming; octane number; additives; Reactions of alkanes.Alkenes: Isomerism in alkenes; Preparation of alkenes; Reactions of alkenes; commercial uses of some polymers; alkynes: Lab preparation; Chemical reactions; Optical Isomerism; importance of stereoisomers in natural products, drugs etc.

PHYS 102: Practical Physics II Credits: 1
Basic Laboratory experiments to expose students to handling various measuring instruments and to data and error analysis.

PHYS 144: Electricity and Magnetism Credits: 3
Electricity
Electric Charge and Electric Field: Electric charge, Conductors, insulators and induced charges, Coulomb's law, Electric field and Electric forces, Charge distributions, Electric dipoles
Gauss' Law: Charge and electric flux, Gauss' Law, Application of Gauss' Law
Electrical Potential: Electric potential energy and work, electric potential
Capacitance and Dielectrics: Capacitors (parallel plate capacitors, spherical, and cylindrical shaped capacitors) and dielectrics, Capacitors in series and parallel, Charging and discharging a capacitor, time constant, Energy storage in capacitors
Electric Current, Resistance and Direct-current circuits: Electric current, Resistivity and Resistance, Electromotive force and electric circuits, Energy and power in Electric circuits, Resistors in series and Parallel, Kirchoff's Rules, Electrical measuring instruments
Magnetism
Magnetic Field and Magnetic Forces: Magnetic field, Magnetic field lines and Magnetic flux, Motion of charged particles in a magnetic field, Electric and magnetic fields acting together – application to velocity selectors, Magnetic force on a current-carrying conductor, Force and Torque on a current loop (a

magnetic dipole moment) Sources of Magnetic fields: Magnetic field of a moving charge, Magnetic field of a current element, Magnetic field of a straight current-carrying conductor, Force between parallel conductors, Magnetic field of a circular current loop, Ampere's law and its applications, Magnetic materials
Electromagnetic Induction: Faraday and Lenz's laws, Motional electromotive force, Induced electric fields, Eddy currents, Displacement current and Maxwell's equations
Inductance: Mutual inductance, Self-induced inductance, Inductors and magnetic-field energy, R-L and L-C circuits, L-R-C series circuits
Alternating current: Phasors and alternating current, Resistance and reactance, L-R-C series circuit, Band-Pass filters, Power in alternating-current circuits, Power factor, Resonance in alternating-current circuits, Transformer

LEVEL 200 SEM 1

BCMB 200: Practical Biochemistry I Credits: 3

Acid-Base Reactions: Titration; pH measurement; buffer preparation; determination of pK.
Acid-base reactions; buffers, chromatography, qualitative analysis of carbohydrates, proteins and lipids.
Quantitative analysis of proteins: methods for protein estimation (Folin-Lowry, Biuret, Ultraviolet absorption); determination of amino acids (ninhydrin method); preparation, purification and standardization of proteins (serum proteins, cytochrome C).
Separation Methods: Paper and gel electrophoresis; chromatography (Paper, TLC, column).
Quantitative analysis of carbohydrates: Estimation of glucose (Folin-Wu); isolation of glycogen, determination of rate of hydrolysis and chromatography of hydrolysis products.
Quantitative analysis of lipids: Solubility; emulsification; determination of iodine number and acid value; separation of serum lipids.

BCMB 201: Structure and Function of Biomolecules Credits: 3

Chemistry & Function of Biological Compounds: Biomolecules: - monomers; polymers; macromolecules; supramolecules. Carbohydrates: - mono-, di-, oligo- and polysaccharides (structural and storage); stereoisomerism; mutarotation; reactions of carbohydrates. Other derivatives of monosaccharides. Lipids: - classification (fatty acids, triacylglycerols, phospholipids, sphingolipids, steroids, cholesterol, eicosanoids); simple lipoproteins; glycolipids (cell-cell recognition, receptors etc). Proteins: - amino acids:- basic structure, classification, acid/base properties, essential & non-essential; peptides; protein structure- primary, secondary, tertiary and quaternary structures, classification and properties. Enzymes as proteins. Nucleic Acids: - nitrogenous bases, nucleosides, nucleotides, cyclic nucleotides and nucleic acids DNA and RNAs (brief review of replication, transcription, translation). Other cellular molecules: Porphyrins, Vitamins and co-enzymes alkaloids & inorganic ions.

BCMB 203: Principles of Biochemical Techniques Credits: 2

Chromatography: Partition coefficient and chromatographic systems.
Basis of separation: adsorption and partition (polarity); ion-exchange (ionic nature), exclusion/gel (molecular size and shape). Principles and applications (HPLC, FPLC, GLC, TLC, Paper, Chromatofocusing and two-dimensional electrophoresis). Analytical aspects: retention time and volume, capacity ratio, peak resolution theoretical plates/plate height, peak capacity, internal and external standardization and analyte quantitation.
Centrifugation: Basic principles of sedimentation, RCF value, relationship between v, s and G. Centrifuges and rotors (types and uses). Preparative centrifugation: differential and density gradient; preparation of gradients, recovery and monitoring of fractionates. Analytical centrifugation: determination of relative molar mass (sedimentation velocity and equilibrium methods), purity and shape of macromolecules.

Electrophoresis: General principles. Low voltage thin sheets (paper, cellulose acetate, thin layer) and high voltage gels (agarose, polyacrylamide - native, gradient and SDS-PAGE). Applications; purity and molecular weight determination of proteins and nucleic acids, DNA sequencing. Iso-electric focusing and isotachophoresis.

CHEM 213: Physical Chemistry I — Credits: 2

Atomic structure: A qualitative treatment of the Quantum Mechanical Model of the atom; quantum numbers; shape of orbitals. Electronic configuration of atoms; chemical periodicity;Models of chemical bonding: Review of ionic and covalent (including dative) bonds; polar bonds; van der Waals forces, hydrogen bonding; Valence Bond concepts – orbital overlaps; electron-pair sharing; sigma- and pi-bonds; Hybridization (as mathematical combination of atomic orbitals LCAO); sp, sp2, sp3, dsp2, sp3d2 hybridized orbitals and the resulting molecular shapes; Resonance and canonical structures; Valence bond description of simple molecules;
VSEPR: Qualitative Molecular Orbital model (homogeneous and heterogeneous diatomic molecules only).;Chemical Reactions and equilibrium: Enthalphy, exothermic and endothermic reactions; heat capacities Cp, Cv. Born-Haber cycle (Hess' law); Bond energies, standard enthalpies of formation; effect of temperature on enthalpy changes; Simple ideas on Entropy; entropy as a driving force; (No calculations on entropy). Gibbs Free Energy and spontaneity, standard free energies. Relationship between free energy, enthalpy and entropy. Kinetics: differential rate law, rate constants, order of reactions, effects of concentration, temperature (Arrhenius equation); mechanical slope method (No integrated rate laws); concept of reaction mechanism.

CHEM 233: Organic Chemistry I — Credits: 2

Review of stereochemistry; Stereochemistry of compounds with more than one chiral centre; Racemic mixtures, and their resolution; Stereoisomerism in cyclic compounds.
Alkenes - ozonolysis; Preparation and reactions of Alcohols; Preparation and reactions of Ethers.

CHEM 271: Analytical Chemistry I — Credits: 2

Quantitative treatment of ampholytes, (salts and amino acids), Buffer solutions, and very dilute solutions ($\leq 10^{-}6M$) of Bronsted-Lowry acids and bases; the Method of Successive Approximations;
Electrochemistry - Electrode and galvanic cells; Nernst Equation; Concentration cells; applications of emf measurements in the determination of e.g. standard potentials, solubility and Ksp, dissociation constants; Potentiometric titrations; Conductance and applications of conductivity measurements.

FOSC 201: Fundamentals of Food Science and Technology — Credits: 2

Historical development of food science. An introduction to the multidisciplinary nature of Food Science, showing how the integration of knowledge from several traditional disciplines such as chemistry, physics, biology microbiology, and engineering can be applied to solving today's food problems. The course will provide an understanding of the basic principles and practice of Food Science and Technology in converting raw agricultural commodities into nutritious, safe, and economical food. products. Overview of food constituents, food deterioration and spoilage, food laws and regulations. Food Science and technology in relation to food security, and national development. Food control in World trade.

NUTN 201: Introductory Human Nutrition — Credits: 2

Major nutrients in foods and their food values: Carbohydrate, Proteins, Lipids, Vitamins and minerals; Breastfeeding; Food sources of nutrients, Food habits; Nutrition and disease; Population growth, Food production and nutritional status.

LEVEL 200 SEM 2

BCMB 200: Practical Biochemistry I Credits: 3

Acid-Base Reactions: Titration; pH measurement; buffer preparation; determination of pK.
Acid-base reactions; buffers, chromatography, qualitative analysis of carbohydrates, proteins and lipids.
Quantitative analysis of proteins: methods for protein estimation (Folin-Lowry, Biuret, Ultraviolet absorption); determination of amino acids (ninhydrin method); preparation, purification and standardization of proteins (serum proteins, cytochrome C).
Separation Methods: Paper and gel electrophoresis; chromatography (Paper, TLC, column).
Quantitative analysis of carbohydrates: Estimation of glucose (Folin-Wu); isolation of glycogen, determination of rate of hydrolysis and chromatography of hydrolysis products.
Quantitative analysis of lipids: Solubility; emulsification; determination of iodine number and acid value; separation of serum lipids.

BCMB 202: Cell Biology I Credits: 2

Cellular Compartments of Prokaryotes and Eukaryotes: Organization, Dynamics, and Functions; Cellular membrane systems (structure and transport); Nucleus (envelope and matrix), Mitochondria and chloroplasts (including biogenesis and evolution).
Cell Division, Differentiation, and Development: Bacterial division, Meiosis and gametogenesis; Eukaryotic cell cycles; mitosis, and cytokinesis; Fertilization and early embryonic development (including positional information, homeotic genes, tissue-specific expression, nuclear and cytoplasmic interactions, growth factors and induction, environment, and polarity); Differentiation of special cells in tissues of plants and animals.

BCMB 204: Enzymology Credits: 2

Introduction to Enzymes: Comparison of chemical and enzyme catalysis, Activation energy and transition state, Free energy change, Chemical equilibria, Active site, Substrate specificity, Enzyme classification, enzyme assays, linked or coupled.
Factors affecting Enzyme Activity: Reaction rate (v), Effect of [S], [E], T, pH on enzyme activity; coenzyme, prosthetic groups.
Enzyme Kinetics and Inhibition: Michaelis - Menten model, Graphical representation of data (e.g. Lineweaver - Burk and Hanes plots)
Enzyme inhibition: Reversible (Competitive, noncompetitive, uncompetitive) and irreversible
Control of Enzyme Activity: Feedback regulation, allosteric enzymes, isozymes, covalent modification, activation, regulation of synthesis and breakdown (eg. lac operon, tryptophan biosynthesis).
Enzyme Purification: Cell disruption techniques, general purification strategy, enzyme assays, units of enzyme activity.
Application of enzymes in health, agriculture and industry

BCMB 206: Spectroscopic And Radioisotopic Techniques Credits: 1

Molecular spectroscopy; molecular fluorescence; infra-red, atomic, electron spin resonance and nuclear magnetic resonance spectroscopy, mass spectrometry, X-ray diffraction and radioisotopic techniques in biochemistry, radio/fluorescent labeling (RIA, scintillation counting), autoradiography ELISA.

CHEM 234: Organic Chemistry II Credits: 2

Aldehydes and Ketones: Nucleophilic addition reactions; Carbanions. Carboxylic acids: Preparations and reactions. Carboxylic acid derivatives: Preparations;Amines: Preparations and Reactions

FOSC 202: General Microbiology (Theory & Lab) Credits: 3

An understanding of the basic principles of microbiology as well as the medical, agricultural, and other applied aspects of the field of microbiology. The structure, growth, nutrition, metabolism, genetics and diversity of microorganisms and methods used to study microorganisms, including safe handling, cultivation techniques, microscopy and other microbial identification methods. The laboratory will provide students with the basic laboratory skills of microbiology including techniques of sampling and isolation of bacteria from natural environments, safe handling and growing pure cultures of microorganisms, diluting, pipetting and enumerating microorganisms, microscopic techniques for identification of microbes. Recording, interpretation and reporting of microbiological data.

FOSC 204: Unit Operations in Food Processing I [Prerequisite CHEM 213, FOSC 201] Credits: 3

Overview of the laws of conservation of mass and energy and concepts of materials and energy balance in food processing. Transport phenomena - Theory and applications of fluid flow; Heat transfer theory and applications and equipment. Mechanical operations - Size reduction of solid and liquid foods, theory, applications and equipment; effects on physicochemical properties foods. Mechanical separation - centrifugation, filtration, expression, sieving; Mixing - mixing of liquids and solids, effect of mixing on functionality of foods.

NUTN 202: History of Nutrition and Concepts in Nutrition Credits: 2

Pre-scientific ideas about foods; investigation of carbohydrates, fats and albuminous substances; food utilization, experiments with gelatin; pioneers in nutrition; animal nutrition; respiration and calorimetry; chemical analysis of foods; The discovery of vitamins; inorganic elements; fatty acids. Definitions, Nutrition, Nutritional science, nutrition professionals (Nutritionists, Dieticians, Food Scientist etc), Nutrition and Health; foods and food values, levels of nutritional status, factors influencing food choices, under-nutrition, over nutrition, Double-burden of disease, Nutritional problems in Ghana, Assessing nutritional adequacy of diets, Nutrition in eating disorders, Nutrition for exercise and sports performance, Nutrition guidelines for health promotion; Plant based diets.

LEVEL 300 SEM 1

NUTN 300: Nutrition Internship Credits: 1

A 6-week practical attachment to an organization or projects that works on nutrition related issues. The chosen organization must be approved by the department. The student is visited at least once to aid in the evaluation. Report must be submitted for evaluation. This is done during the long vacation.

NUTN 301: Nutrients and their Metabolism I Credits: 2

Classification, metabolism and physiological functions, effects of deficiencies and trends in the consumption of carbohydrate, protein, and fat. Food as a source of energy, energy expenditure, measurement and factors influencing energy expenditure. Carbohydrate, protein and fat inter-relationships in meeting energy requirements, and their implications for health.

NUTN 303: Nutritional Physiology: Theory and Practical Credits: 3

The study of body systems associated with the delivery of food to the body. The structure of the digestive system in relation to its functions in digestion and absorption. Blood physiology: blood and other fluid compartments of the body in relation to the transfer of nutrients and metabolites. Cellular components of blood. Excretion. Laboratory experiments to illustrate the principles and techniques used in nutritional physiology. Digestive system, blood physiology, normal and abnormal components of urine. The lab accompanies the lectures in Nutritional Physiology.

NUTN 305: Nutrition, Sustainable Livelihoods and Extension Credits: 2

An overview of the sustainable livelihoods framework with emphasis on the interrelations between food security and nutrition and how nutrition influences..-5pecific components of the framework. The UNICEF malnutrition framework within the context of the sustainable livelihoods framework. Principles of extension and qualitative processes and methodologies for community diagnosis of nutrition problems and planning of community nutrition interventions. Review of Case-studies.

FOSC 300: Internship Credits: 1

A supervised 6-week (minimum) attachment to a food processing industry, food related research or regulatory organization or projects. A written report must be submitted for assessment.

FOSC 301: Food Chemistry I [Prerequisite CHEM 213, 233, 234] Credits: 2

The chemistry of water. Freezing and its effects on food quality. Water activity, sorption isotherms, and food storage and stability. Chemistry and application of food pigments and flavour components.

FOSC 303: Food Microbiology and Safety (Theory and Lab) [Prerequisite FOSC 202] Credits: 3

Cultural and morphological characteristics of microorganisms in food and water. Food ecosystem. Microbiological standards and control. Control of microorganisms in food. Microorganisms in food production, spoilage and safety. Food and water-borne diseases, Food infections and intoxications. The laboratory will provide hands-on knowledge of the techniques for the isolation, enumeration and identification, of microorganisms involved in food spoilage, food borne diseases and food fermentations.

FOSC 305: Biometry Credits: 2

Statistical Applications for Nutrition and Food Science data analysis. Students t-test, Chi-square, Analysis of variance, regression and correction. Non-parametric statistics. Introduction to the use of computer statistical packages

FOSC 307: Beverage and Sugar Processing Technology Credits: 2

Principles of beverage processing. Raw materials for beverage production. The chemistry and processing technologies of cocoa, tea, coffee and other beverages. Chocolate processing technology. Raw materials for sugar processing. Sugar processing technology - raw sugar manufacture, cane sugar refining.

BCMB 301: Intermediary Metabolism Credits: 3

Carbohydrates: Digestion of carbohydrates, glycolysis and fate of pyruvate in different organisms; tricarboxylic acid (TCA) cycle; pentose phosphate pathway and fate of reduced coenzymes; catabolism of monosaccharides other than glucose; gluconeogenesis, Calvin Benson cycle, Cori cycle, glyoxylate cycle; glycogenesis and glycogenolysis; regulation of carbohydrate metabolism; Diseases of carbohydrate metabolism.

Lipids: Digestion of triacylglycerols; the different lipases (lipoprotein lipase, hormone-sensitive lipase); fate of glycerol; beta-oxidation of fatty acids; fate of products (acetyl and propionyl CoA, ketone bodies, reduced coenzymes); synthesis of fatty acids triacylglycerol, cholesterol; regulation of metabolism.

Amino acids: Digestion of proteins, transamination, deamination and decarboxylation of amino acids and the fate of ammonia (urea cycle) and carbon skeleton; metabolism of specific amino acids (aromatic and sulphur-containing amino acids); synthesis of amino acids; in-born errors of amino acid metabolism; regulation of metabolism.

Energetics: Free energy and biochemical reactions (spontaneity, anabolic and catabolic reactions); metabolic reactions and ATP; energy of hydrolysis of ATP, ADP and phosphorylation products; ATP

production (substrate level and oxidative phosphorylation, photophosphorylation, C3, C4); coupling reactions; uncoupling agents.

BCMB 303: Molecular Biology I Credits: 2

Purine and pyrimidine biosynthesis: Regulation of biosynthesis. Structure and properties of nucleosides and nucleotides. Biosynthesis of deoxyribonucleotides; thymidylate biosynthesis. Salvage pathways.
DNA and chromosome structure: Evidence for DNA as carrier of genetic information. Primary and secondary (A, B and Z DNA) and tertiary structure of DNA. Elucidation of DNA structure. Watson and Crick double helix. Structural differences between RNA and DNA. Methods for sequencing DNA. Organisation of DNA in chromosomes, nucleosome structure.
DNA replication: Mechanism of replication (prokaryotic and eukaryotic). Evidence for semi-conservative replication. DNA replicating enzymes. Directionality of replication.
Transcription: Mechanism of transcription (prokaryotic and eukaryotic). Features of a typical transcription unit. Characteristics of different types of RNA. Modification and processing RNA. Reverse transcription.

BCMB 305: Biochemistry Of Hormones Credits: 2

General introduction: Coordination in multicellular organisms
Major classes of hormones: Mammalian, plants, insects.
Major endocrine glands: Hypothalamus, pituitary, adrenals, testes, ovaries, pancreas.
Biosynthesis and degradation of hormones: regulation of synthesis/secretion; major biochemical effects and actions. Hormone receptors: structure, relationship to binding to response, binding characteristics, segregation, auto-phosphorylation/cross-phosphorylation; internalization.
Types of post receptor mechanism: second messenger generation, hormone response elements, gene expression.

FOSC 307: Beverage and Sugar Processing Technology Credits: 2

Principles of beverage processing. Raw materials for beverage production. The chemistry and processing technologies of cocoa, tea, coffee and other beverages. Chocolate processing technology. Raw materials for sugar processing. Sugar processing technology - raw sugar manufacture, cane sugar refining.

BCMB 311: Practical Biochemistry II Credits: 3

Enzyme catalysed reactions: Time course of reaction; effects of various factors on reaction rate: enzyme concentration, pH, temperature, substrate concentration, activators and inhibitors; enzyme specificity; protease activity in plant extracts; purification of enzymes from plant juice; use of enzyme as an analytical tool (e.g. Estimation of urea in urine).
Mini project: Isolation, purification and characterisation of a known enzyme.

PSYC 307: Developmental Psychology Credits: 3

LEVEL 300 SEM 2

NUTN 300: Nutrition Internship Credits: 1

A 6-week practical attachment to an organization or projects that works on nutrition related issues. The chosen organization must be approved by the department. The student is visited at least once to aid in the evaluation. Report must be submitted for evaluation. This is done during the long vacation.

NUTN 302: Nutrients and their Metabolism II (Prerequisite: NUTN 301) Credits: 2

Functions and distribution of minerals in the human body. Dietary sources, deficiency symptoms, human requirements for minerals. Role of trace elements in human nutrition and requirements. Landmarks in the

discovery of vitamins, functions, metabolism, recommended intakes, dietary sources, effects of deficiencies of fat soluble and water soluble vitamins

NUTN 304: Food Analysis I (Prerequisites: NUTN 301, 302) Credits: 1

Sampling and sample preparation, glassware for laboratory analysis. Precision and accuracy, data reporting, report write-up. Principles behind food analysis methods. Comparative moisture analysis, ash, crude fat, crude protein and crude fiber analysis. Calorific value of foods. Determination of phosphorus, iron, calcium and vitamin C in foods.

NUTN 306: Methods in Nutrition Research I Credits: 2

Survey of physical, biochemical and physiological methods used in nutritional investigation, e.g. fluorometry, amino acid analysis, automated hematology. Questionnaire design, Qualitative and quantitative methods of data collection. Ethics in research as it applies to both human subjects and animals. Internal review board (IRB) The principle of confidentiality and data handling protocols.

NUTN 308: Animal Experimentation Credits: 2

Problems with human experimentation; advantages of animal experimentation; concerned societies and standards for animal experimentation; species of experimental animals; the experimental rat and disease; physical facilities for rat experimentation in Nutrition; rat models for human nutrition studies; effect of feeding different levels of nutrients e.g, iron, protein; nitrogen balance; digestibility; effect of diet on body functions.

NUTN 310: Professional Development Seminar I Credits: 1

Attachment to a Senior Member for supervised independent study. Training in literature search, and information gathering, writing and speaking skills. Presentation of a literature review on a given topic at a seminar. A term paper and regular attendance at department seminars are required.

NUTN 312: Foods and Social Factors in Nutrition Credits: 2

An overview of the socio-cultural factors that influence food acquisition, preparation and consumption across the world. Social and economic factors that determine food choices. Food classifications and food proscriptions and prohibitions within the context of their nutritional implications for different demographic groups, particularly women and children. Food fads and diets. The effect of globalization, westernization and urbanization on food choices and associated nutritional implications. Population growth and resources.

FOSC 300: Internship Credits: 1

A supervised 6-week (minimum) attachment to a food processing industry, food related research or regulatory organization or projects. A written report must be submitted for assessment.

FOSC 302: Food Chemistry II [Prerequisite CHEM 213, 233, 234] Credits: 2

Chemistry and functionality of food carbohydrates, proteins and lipids and the effect of processing on these. Enzymes in food processing.

FOSC 304: Unit Operations in Food Processing II [Prerequisite FOSC 204] Credits: 3

Physical phenomena: Dehydration - introduction, drying rate theory, equipment; Chilling and freezing - theory and applications, Equipment; Evaporation - theory and applications, equipment, industrial applications; Theory and application of Reverse osmosis. Extrusion - theory, equipment and operation, applications in food processing; Irradiation - theory, equipment and operation, applications in food processing; Traditional and modern applications of unit operations in food processing.

FOSC 306: Thermal Processing of Foods (Theory and Lab) [Prerequisite FOSC 202, 304] Credits: 3

Overview of the History of Canning Technology, Basis of the canning process and principles of canning technology. Sterilization systems and Heat transfer problems; Equipment and containers for thermal processing of foods. Heat Penetration determination and Thermal Process Calculations. Aseptic Processing - Principles and applications. Microwave Heating of Foods -Principles, Operations, and Industrial applications. Manufacturing Operations - Raw material preparation to warehousing, Practicals - Thermal processing equipment, design operations and safety factors; Laboratory exercises in canning, pasteurization and aseptic processes; Evaluation of the quality of thermal processed foods; Seam analysis; Application of thermal processing to selected food commodities; Industrial visits.

FOSC 308: Post-Harvest Science and Technology Credits: 2

Understanding the post-harvest system. The handling of food from harvest to consumption. The physiology and biochemistry of harvested produce. Harvesting, packing, haulage and transportation of fresh produce. Causes of deterioration in perishables and durables and factors that promote these deteriorations and their control. Handling, storage and conservation processes to manage harvested produce. Food loss vectors and their control. Field visits and evaluations.

FOSC 310: Professional Development Seminar Credits: 1

Attachment to a Senior Member for supervised independent study. Training in literature search, and information gathering, writing and speaking skills. Presentation of a literature review on a given topic at a seminar. A term paper and regular attendance at department seminars are required.

BCMB 304: Molecular Biology II Credits: 2

The genetic code: Deciphering the code. Universality and degeneracy of the genetic code. Wobble hypothesis, colinearity of gene polypeptide.
Translation: Ribosome structure. Activation of Amino acids. Initiation, elongation and termination. Eukaryotic and prokaryotic. Post-translational modifications; Polysomes, inhibitors of protein synthesis.
Control of gene expression: Inducible and repressible operons, (lac and trp operons).
Mutation: molecular basis of mutation. Point mutation – transitions, transversions, frameshift mutations. Site-directed mutagenesis, Radiation induced mutation. Chemically induced mutation. DNA repair mechanisms.
Recombinant DNA and genetic engineering: Restriction endonucleases, Methods for recombinant DNA production, transformation, amplification, screening for cloned DNA.

BCMB 306: Integration and Control of Metabolism Credits: 3

Metabolic control: Design of metabolic pathways. Regulatory enzymes fine control (allosteric, substrate/product feed- back and feed-forward controls, covalent modification) and coarse control (induction and repression of enzyme synthesis).
Regulation of fuel metabolism: glycolysis, gluconeogenesis, glyceroneogenesis, glycogenolysis and glycogenesis, Krebs cycle, lipogenesis and lipolysis, β-oxidation, ketogenesis, amino acid metabolism. Role of hormones (e. g. insulin, glucagon, epinephrine) and DNA binding proteins (e. g. Cyclic AMP response element binding protein (CREB), Carbohydrate response element binding protein (ChREBP), Sterol regulatory element binding protein (STREB)).
Integration of metabolism: Glucose homeostasis and glucose transpoters. Interrelationships between carbohydrate, lipid, and protein metabolism. Enzyme profiles of tissues and organs. Interorgan relationships (liver, brain, muscle, adipose tissue) in different physiological states: e. g. Fed, fasted, running athlete and pregnancy.

BCMB 308: Bioenergetics Credits: 2

Overview of chemical thermodynamics: Internal, energy, enthalpy, entropy, Gibb's free energy, laws of thermodynamics; Spontaneous and non-spontaneous processes; Free energy changes in biochemistry.
Principles of thermodynamics and their application to the energetics of the cell: Redox systems, electron donors and acceptors, redox couples, redox potentials, electromotive force, protonmotive forces.
The concept of high energy compounds: phosphoric acid anhydrides, phosphoric-carboxylic acid anhydrides, phosphoguanidines, enolphosphates and thiol esters; basis for the high standard free energy of hydrolysis; the central role of ATP; (phosphate) group transfer potentials; substrate-level phosphorylation; energetics of coupled reactions.
ATP synthesis: review of structure of mitochondrion and chloroplast; sources of energy; redox complexes for electron transport in mitochondria and in chloroplasts; establishment of proton gradients; coupling of ATP synthesis to dissipation of proton gradient; H+ -ATPase; couplers (thermogenesis). ATP utilization for the performance of cellular work; active membrane transport and mechanical work such as muscle contraction.

BCMB 314: Membrane Biochemistry Credits: 2

Introduction: Membrane types and functions; chemical composition (lipids, proteins and carbohydrates); amphipatic nature of lipids (formation of monolayers, bilayers/liposomes, and micelles); Reactions of phospholipases.
Structure and properties: Models (Dawson and Danielli, Singer and Nicholson); integral (glycophorin A, anion channel ban 3, bacteriorhodopsin), lipid-anchored and peripheral (cytoskeleton of erythroid and non-erythroid cells) proteins; plasma membrane glycocalyx, antigenic properties (RBC M and N, blood group O, A and B); evidence for asymmetric, dynamic and fluid-like character of biomembranes; cell-cell recognition and fusion (eg flu virus and HIV infections); membrane biogenesis (synthesis and transport of membrane lipids).
Preparation and study: Physical, chemical and biochemical methods of study (lipid bilayer and vesicles of eukaryotic and prokaryotic cells).
Transport: Thermodynamics; modes (uniport, symport and antiport systems) and types (simple diffusion, passive-mediated, active, Na/K pump, co-tranport – Na/glucose pump of kidney/intestine, galactose permease of E. coli, exocytosis and endocytosis); channels (ligand gated and voltage-gated) and pores; ionophores (valinomycin, gramicidin A and nigericin).

LEVEL 400 SEM 1

NUTN 400: Nutrition Project Credits: 6

A supervised individual investigation in any topical issue directly or indirectly impacts on nutrition. A written project report in the form of a dissertation would be required. A minimum of 13 hours contact with the supervisor is an essential part of this course.

NUTN 401: Assessment of Nutritional Status I (Prerequisites: NUTN 301-303) Credits: 2

Indices used in assessing nutritional status of individual and groups in health and disease: dietary intakes, anthropometric measurements, Nutritional surveillance and growth monitoring.

NUTN 403: Assessment of Nutritional Status II (Prerequisites: NUTN 301-303) Credits: 2

Indices used in assessing nutritional status of individual and groups in health and disease: biochemical assessment, clinical and functional appraisal of nutritional status, vital statistics.

NUTN 405: Nutrient Inter-relationships and Needs (Prerequisite: NUTN 301,302 Credits: 2
Inter-relationships among the macro and micro-nutrients; anti-vitamins and anti-metabolites. Concept of nutritional adaptation. Principles and methods of determination of nutrient needs; Proteins, amino acids, macro-minerals, trace elements, vitamins, fatty acids and fats. Laboratory on the techniques of determining nutrient needs and diagnosing nutrient deficiencies. Balance studies.

NUTN 407: Community Assessment I (Prerequisite: NUTN 401,403) Credits: 2
Identification of a community for needs assessment. This field work will include community entry techniques, transient walk and the applications of rapid appraisal and observations in needs identification. Nutritional assessment protocol to collect information on dietary, biochemical, clinical, socio-economic and anthropometric measures will be carried out in a chosen community. Interviewing skills, inter- and-intra personal relationships and working with people from diverse backgrounds and settings are incorporated in this course.

NUTN 409: Methods in Nutrition Research II Credits: 2
Quality Control for laboratory and Field data collection: General principles, setting up a quality control chart for the laboratory. Using the chart to identify questionable data; monitoring field data quality. Data analysis using software (Access, Epi-Info, WHO Anthro, FPro, Etc.)

NUTN 411: Human Growth and Development (Prerequisite: NUTN 401. 403) Credits: 2
Effects of nutrition on growth and development, regulatory growth mechanisms, measurement of growth, reference standards in growth measurement. Influence of nutrition on body composition. Estimation of human energy requirements; concepts of energy balance, factors influencing energy balance in obesity. Adaptation to low energy intakes In man. Energy, work capacity and
performance.

NUTN 413: Food and Nutrition Advocacy Credits: 2
Definition of advocacy. Identifying policy issues; Selecting an advocacy objective; Researching audiences; Developing and delivering messages; Understanding the Decision-making process; Building alliances; making effective presentations; Funding for advocacy; Improving your advocacy; Profiles software.

FOSC 400: Food Science Project Credits: 6
Individual research on relevant topics of interest in Food Science conducted under the supervision of an academic staff member. A written project report in the form of a dissertation would be required.

BCMB 401: Protein Chemistry I Credits: 2
Primary structure: amino acid composition of proteins, determination of amino acid sequence, importance of primary structure synthesis of peptides, covalent modification of polypeptides.
Secondary structure (regular arrangement of the polypeptide backbone): peptide bond and its structural implications; random polymers; Ramachandran Plot. Regular conformation of --pleated sheets, other helices (310- helix), super-secondary structures (coiled---keratins, silk fibroin, collagen.
Tertiary structure (folded conformation of globular proteins): determination of protein structure by X-ray crystallography, evidence for folding, re-turns) super-secondary structures (motifs), domains, interiors and exteriors, unfolding and folding. Example: Myoglobin.
Quaternary structure (aggregation of globular proteins). Example: haemoglobin.
Physical forces responsible for maintaining structure.

BCMB 403: Molecular Biotechnology and Applications — Credits: 2

Tools of molecular biology: Agarose and polyacrylamide gel electrophoresis; Northern and Southern blots and hybridization analysis; Western blots and protein detection; PCR and RAPD, RFLP.
Purification and characterization of nucleic acids: Principles for extraction and purification; concentration and molecular weight determination; species differentiation (RNA/DNA, single/double stranded nucleic acids).
Modifying enzymes: Restriction endonucleases; other nucleases (DNAse, RNAse); ligases; polymerases.
Recombinant DNA technology: Cloning and expression vectors, recombinant molecules and transformation systems (prokaryotic and eukaryotic hosts); colony screening, plasmid isolation and characterisation; transduction and conjugation.
Nucleotide sequencing and mutagenesis: Sequencing of end labelled DNA by base specific chemical cleavage (Maxam and Gilbert) and analysis of primed enzymatic synthesis (Sanger); deletion and insertion mutagenesis.
Gene expression detection: principles of RT-PCR, real time RT-PCR, microarrays.
Applications: medicine, agriculture and industry.

BCMB 411: Clinical Biochemistry — Credits: 2

Introductory practical clinical biochemistry: Laboratory investigations; specimen collection, analytical methods and standardization (calibration standards, precision, accuracy, sensitivity, specificity etc); review of analytical and separation methods used in clinical biochemistry for metabolites, ions and enzymes; report and result interpretation; reference values and factors affecting them.
Organ function disorders and tests: gastrointestinal, liver, kidney, heart, pituitary, pancreas, thyroid, adrenal and gonadal.
Body fluid composition and abnormalities: water and electrolyte balance, acid-base disorders and O2 transport.
Disorders of metabolism (in-born errors of metabolism): lipids, carbohydrates, amino acids, proteins, purines and porphyrins.
Industrial visits to Clinical Labortaories.

FOSC 401: Food Chemistry and Analysis Laboratory [Prerequisite: FOSC 301, 302, NUTN 304] — Credits: 3

Food Analysis laboratory practice. Chemical, physical and microscopy techniques for the analysis of food products. Sampling methods. Reporting of analytical data. Official methods of food analysis.
Appreciation of the principles of analytical techniques for Moisture, Proteins, lipids, carbohydrates and colour analysis of foods. Chemical analysis of water quality. Instrumental methods of food analysis. Applications of spectroscopy.
Laboratory experience in Food Chemistry. Protein, carbohydrate, lipids properties, colour and flavour measurement of selected processed foods. Analysis of browning systems.

FOSC 403: Food Packaging — Credits: 2

Forms and levels of packaging. Food packaging materials,- their structure, properties,functionality and uses and conversion processes. Interactions between packaging materials and food. Relation of packaging to preservation and shelf life of foods. Food labeling. Packaging applications for specific food commodities. Safety, environmental and legal issues related to food packaging.

FOSC 405: Sensory Analysis of Foods [Prerequisite FOSC 305] — Credits: 2

Food Quality assessment using sensory responses. Principles of sensory analysis as a scientific method. The senses and basic sensory characteristics (aroma, taste and texture) of food. Organisation of sensory evaluation facilities, sensory test methods and their applications in testing various attributes of foods.

Consumer testing for product acceptability. Analysis of sensory data. Application of sensory evaluation in the food industry.

FOSC 407: Plant Products Processing Technology [Prerequisite FOSC 308] Credits: 2
The structure, chemical and nutritional composition, of plant food commodities. Preservation, processing and product characteristics of fruits and vegetables, roots and tubers, cereals, legumes, oil seeds and spices of importance in Ghana. Use of industrial as well as indigenous technologies and characteristics of traditional plant food products.

FOSC 409: Animal Products Processing Technology Credits: 2
The characteristics of conversion of muscle to meat; Characteristics of fish and fish products, milk and milk products; Industrial and traditional technologies for processing and preservation of fish and meat. Technologies for milk products processing and processing of eggs. Public health issues in relation to animal products.

FOSC 411: Food Commodity Processing Technology Laboratory (Prerequisites: FOSC 409,411) Credits: 1
Practical course on processing various food commodities.- cereals, legumes, roots and tubers, fruits and vegetables, oil seeds, fish, meat, dairy. The course involves practicals in the laboratory with an aim to understanding and improving traditional food processing technologies as well as industrial visits to small scale as well as multinational large scale food processing industries.

FOSC 413: Food Additives and Chemical Toxicology Credits: 2
Classes of food additives including direct and indirect additives; Objectives of use of additives Principles guiding use and non-use of additives, regulation and control additives. Chemistry and properties, Modes of action; Fundamentals of toxicology, Current methodologies in toxicological studies and examination. Classification and sources of toxicants. Risk analysis and risk management of toxic substances in foods.

BCMB 405: Cell Signaling Credits: 2
Types of cellular regulation: endocrine, paracrine, autocrine, direct cell-to-cell communication
Primary signalling molecules: growth factors, hormones, neurotransmitters
Structure and properties of receptors: Cell surface and intracellular receptors, G-protein coupled receptors, receptor tyrosine kinases. Conserved domains, ligand recognition, binding characteristics, receptor dimerization and phosphorylation, docking sites and substrate interactions.
Guanine nucleotide binding-protein switches: Heterotrimeric and monomeric, G-protein regulators - GTPase activating proteins and guanine nucleotide exchange factors e.g. Son of sevenless, neurofibromin.
Second messenger generation: cyclic AMP, cyclic GMP, inositol trisphosphate, diacylglycerol, Ca2+.
Examples of major cascades: Ras-mitogen activated protein kinase pathway, phosphatidylinositol-3-kinase and Akt pathway, Janus kinase and Signal transducer and Activator of Transcription pathway (JAK-STAT), Nitric oxide-guanylyl cyclase signaling. Effectors, transcription factors, amplification, signal diversity, cross-talk and signal termination.

LEVEL 400 SEM 2

NUTN 400: Nutrition Project Credits: 6
A supervised individual investigation in any topical issue directly or indirectly impacts on nutrition. A written project report in the form of a dissertation would be required. A minimum of 13 hours contact with the supervisor is an essential part of this course.

NUTN 402: Applied Nutrition and Food Policies Credits: 2

Applied Nutrition programs, their implementation and evaluation; Effects of socio-economic factors on nutrition. Urbanization and nutrition. Nutrition education and methods of delivery of nutrition information to the public. Role of national and International organizations in combating hunger and malnutrition. Nutrition in emergency situations. Types of Food and Nutrition policies (FNP); Food importation and prices, income and quality of life, economic factors; necessary infol111ation for formulating FNP, efforts towards developing FNP for Ghana. FNP of other countries; food security; right to food.

NUTN 404: Community Assessment II Credits: 2

Analysis of data collected from field survey. Dietary, biochemical, clinical, socio-economic and anthropometric analysis using various computer software and laboratory techniques. Preparation and writing of report.

NUTN 406: Diet and Disease (Prerequisite: NUTN 301. 302) Credits: 2

Global trends of diet related diseases. A study of nutrition in the treatment and prevention of disease: Diabetes mellitus, protein-energy malnutrition, obesity, peptic ulcers, gout, hypertension, renal, cardiovascular diseases, cancer; Nutrition and dental health. Diet and Stress. Interrelationship between diet, physical activity and non-communicable diseases.

NUTR 408: Nutrition of Vulnerable Groups and in Emergency Situation (Prerequisites: NUTN 401, NUTN 403) Credits: 2

Study of the nutritional requirements in pregnancy, lactation, infancy, childhood, adolescence and in the aged. Relationship between maternal diet and pregnancy outcome. Breast feeding, weaning, nutrition of premature infants Complementary feeding, Alternative feeding in special conditions. Nutrition in emergencies. This course will discuss emergency situations that threaten food security and nutrition. A historical perspective on where and when nutritional emergencies occur will with reflection on the most nutritionally vulnerable groups during emergencies. Types of responses to nutritional emergencies

NUTN 412: Professional Development Seminar II Credits: 1

The course will include improving the communication skills of students within the scientific context and lay public on nutrition facts. Writing an educational feature and publishing in any of the local mass media for the general populace and writing scientific report for publication; Presentation skills; Critiquing of published material. Seminar attendance is required.
Pass/Fail grade.

FOSC 400: Food Science Project Credits: 6

Individual research on relevant topics of interest in Food Science conducted under the supervision of an academic staff member. A written project report in the form of a dissertation would be required.

BCMB 402: Protein Chemistry II Credits: 2

Protein-ligand Interactions: Binding sites of haemoglobin and myoglobin, binding of oxygen and carbon monoxide, micro-environment of the haem iron, the Hill Plot. Protein engineering.
Allostery: interaction between binding sites. Theoretical models; the Mond-Wyman-Changeux (MWC) concerted mechanism, the Koshland-Nemethy-Filmer (KNF) sequential model. Allosteric properties of haemoglobin; molecular mechanism of cooperative binding of oxygen to haemoglobin, the Bohr effect, binding of 2, 3-bisphosphoglycerate (BPG).
Mechanism of Enzyme Catalysis: General acid-base catalysis and covalent catalysis. Catalysis by

coenzymes; pyridoxal phosphate, thiamine pyrophosphate, ATP, coenzyme A, NAD(P)+ , FAD/FMN. Structure and mechanism of action of selected enzymes. Examples; dehydrogenases, proteases, ribonuclease, lysozyme, glycolytic enzymes such as phosphofructokinase (PFK).

BCMB 404: Immunology and Immunochemistry — Credits: 2

Defense systems: self and non-self; innate and acquired; cells and organs involved; humoral and cell-mediated.
Antigens: Immunogenicity and antigenicity; chemical nature (bacterial, viral and synthetic)
Antibodies: Structure and function of immunoglobulins; theories of antibody production; polyclonal antibody production; monoclonal antibody production (hybridoma Technology).
Antigen-antibody interactions: Agglutination and precipitation; immunoassays.
The complement system: components, activation (classical and alternative pathways); regulation.
Vaccines: Current methods for development. Immune regulation and tolerance; immunopathology (hypersensitivity, immunodeficiency, autoimmunity); transplantation immunology (mechanisms involved in tissue rejection).
Cytokines: General properties; biological activities of selected cytokines.
Immunology of diseases of public health interest: HIV/AIDS, Malaria, Schistosomiasis.

BCMB 408: Entrepreneurship for Innovation In Biosciences — Credits: 2

General Principles of Entrepreneurship: Nature and Importance; The Individual Entrepreneur; Technology Entrepreneurism; Characteristics of Successful Technology Based Businesses; Technical Risk Assessment; Alternative Technology Assessment; Entrepreneurial Process; Entrepreneurial Decision Making; Creativity and the Business Idea; Product Planning and Development System; Resource Needs; Alternative Financing Models; Intellectual Property Protection; Patents, Trademarks, and Copyright in Technology Venturing; Preparing for Venture Launch; Managing Growth and Expansion.
Innovation in Biosciences: Medicine (Diagnosis, Therapeutics, etc); Food & Agriculture (Quality, Safety, Production Efficiency and Processing); Environment (Remediation, Conservation and Restoration); Value added Natural Products;

BCMB 410: Seminar Presentation and Scientific Writing — Credits: 1

Review of language structure and usage.
Types of scientific reports: Seminars, research papers, proposals, posters.
Structure of scientific reports: Title, authors, abstract/summary, Table of content, Glossary; Introuction (context, focus, justification); Materials and Methods; Results; Discussion; Conclusion; References; Appendixes.
Writing style and Rules: Dos and Don’ts; Plagiarism.
In addition, students are required to attend all departmental seminars, (presented by either internal or external speakers), present journal articles (journal club), research proposal and project seminars.

FOSC 402: Food Processing Plant Operations and Sanitation — Credits: 2

Principles and practices of the organisation and management of plant operations. Plant lay-out and flow patterns. Plant and warehouse siting and design. Pilot operations and optimization. Cleaning operations; use of detergents and sanitizers, water use, waste disposal and pollution control; Public Health Acts and Regulations. Environment issues in food processing. Industrial visits.
FOSC

FOSC 404: Food Quality Assurance, Laws and Regulations — Credits: 3

Principles of quality control, quality assurance and introduction to total quality management Food quality and food safety management systems. Organization of food industry quality programmes. Quality

characteristics of foods and their measurements. Sampling and sampling plans for quality control. Statistical quality control processes and procedures including reporting and recording. Food Standards and specifications Codex Alimentarius.; procedures for elaboration of food standards. Food legislation and regulatory agencies; Legal issues in food science and technology.

FOSC 406: Principles of Food Product Development Credits: 2

An introduction to the sequence of events leading to Food product development from concept to product launch. Prototype development, product optimization and testing. Logistics for product development. Economics of product development and marketing issues. The course involves the integration and application of the basic concepts and principles of food science and will allow students to bring their knowledge of these to bear in the conceptualization of new food products. As part of the course students will be required to submit a written report on a new food product.

FOSC 408: Industrial Microbiology and Food Biotechnology Credits: 2

Industrial microbiology, Industrial microorganisms, Products of industrial interest, Principles of Industrial fermentation processes, Chemical and microbiological changes occurring during industrial fermentation, Typical processes of Industrial fermentation. Production of African fermented foods.

FOSC 410: Special Topics in Food Science/Independent Study Credits: 1

Supervised independent study on new and emerging technologies/ processes and innovations in any area of Food Science and Technology. Students will be given selected readings each week to guide their study. These reading may be given by one or more School members. A term paper will be required for assessment.

FOSC 412: Professional Development Seminar II Credits: 1

The course aims at improving the communication skills of students within the scientific context, Topics will include scientific report writing and presentation skills. Critiquing of published material and presentation of a researched topic at a seminar. Seminar attendance is required. Pass/Fail grade.