AC/4.8.18/RS 1

SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022

(Autonomous)

Faculty: Science

Program: T.Y.B.Sc.

Subject: ZOOLOGY

Academic Year: 2020 – 2021

Credit Based Semester and Grading System approved by Board of Studies in Zoology to be brought into effect from June 2020

T. Y. B. Sc. Zoology Syllabus (Autonomous)

Semester V and Semester VI

(Credit Based Semester and Grading System, with effect from academic year 2020-21)

Preamble

"Educating the mind without educating the heart is no education at all."– Aristotle

Academic Autonomy entitles the institution with certains privileges, one of them being freedom to prescribe our own course and curriculum, and refine it to make it locally relevant. This academic freedom is a milestone for academic excellence.

Considering the aspiration levels of students that are changing under the overarching influences of technological revolution and globalization, educationists need to understand that students have to be provided with opportunities to share, discover and participate actively in the learning process. Thus, in this context, a well-designed syllabus can be an essential tool for effectively managing a course that will enable teachers pursue efforts to keep students abreast with advancements in their areas of specialization.

Some of the key features of this revised syllabus are –

- ✓ *Comparative anatomy – to appreciate it as an important tool which helps to determine the evolutionary relationships between organisms, to understand the similarities and differences in anatomy of different species besides its relevance in evolutionary biology and phylogeny.*
- ✓ *Haematology, Immunology and General Pathology – that relate to the role played by science in daily life, society and the environment*
- ✓ *Toxicology – involving relevance of toxicity studies and regulatory guidelines, ethics in animal studies, alternatives to animal models.*
- ✓ *Tissue culture – involving understanding of culture media and animal tissue cultures facilities, relevance of biosafety guidelines while working on mammalian cells under in vitro conditions.*
- ✓ *Field Biology – involving understanding about ecology, the diversity and evolution of various organisms, besides creating interest in field techniques and provide skills with respect to field related studies.*
- ✓ *Epidemiology – creating awareness through scientific, systematic and data-driven study of frequency and pattern of distribution and causes with risk factors of health-related diseases, states and events in specified populations.*

Striving efforts of the professors of Zoology at SIES College, Sion (West) and other board members from outside the institution have helped to bring this syllabus to its fruition and logical conclusion.

This syllabus is a holistic approach towards the science of Zoology that will prepare students to use scientific knowledge, skills and training to pursue further education and employment in biology related fields. We hope this syllabus will be a sanctioned arena for exploration for the students and thereby expect implementation of this syllabus to enhance the competencies of students.

Dr. Satish Sarfare
Chairman,
Board of Studies in the subject of Zoology

T.Y.B.Sc. Zoology Syllabus

Credit Based Semester and Grading System.

(To Be Implemented from the Academic Year 2020-2021 onwards)

Semester -V

Theory				
Course	Unit	TOPIC	Credits	L / Week
SIUSZO51	I	Genetics	2.5	1
	II	Comparative Chordate Anatomy - I		1
	III	Developmental Biology – I		1
	IV	Histology and Endocrinology-I		1
SIUSZO52	I	Haematology - I	2.5	1
	II	Immunology - I		1
	III	Physiology		1
	IV	General pathology		1
SIUSZO53	I	Molecular Biology-I	2.5	1
	II	Genetic engineering-I		1
	III	Toxicology-I		1
	IV	Animal tissue culture		1
SIUSZO54	I	Wildlife conservation and management	2.5	1
	II	Field biology		1
	III	Epidemiology-I		1
	IV	Zoogeography		1
			10	**16**
Practicals				
SIUSZOP51 **SIUSZOP52**		Practicals of Course SIUSZO51 Practicals of Course SIUSZO52	3	8
SIUSZOP53 **SIUSZOP54**		Practicals of Course SIUSZOP53 Practicals of Course SIUSZOP54	3	8
			06	**16**
Total			**16**	**32**

T.Y.B.Sc. Zoology Syllabus.

Credit Based Semester and Grading System.

(To Be Implemented from the Academic Year 2020-2021 onwards)

Semester -VI

Theory				
Course	Unit	TOPIC	Credits	L / Week
SIUSZO61	I	Evolution and paleontology	2.5	1
	II	Comparative Chordate Anatomy - II		1
	III	Developmental Biology – II		1
	IV	Histology and Endocrinology-II		1
SIUSZO62	I	Haematology – II	2.5	1
	II	Immunology –II		1
	III	Enzymology		1
	IV	Homeostasis and regulation		1
SIUSZO63	I	Molecular Biology-II	2.5	1
	II	Gene engineering-II		1
	III	Toxicology-II		1
	IV	Bioinformatics		1
SIUSZO64	I	Biodiversity and conservation	2.5	1
	II	Behavioural biology		1
	III	Epidemiology-II		1
	IV	Bioprospecting, Bioethics & Zoopharmacognosy.		1
			10	16
Practicals				
SIUSZOP61 SIUSZOP62		Practicals of Course SIUSZO61 Practicals of Course SIUSZO62	3	8
SIUSZOP63 + SIUSZOP64		Practicals of Course USZO603 Practicals of Course USZO604	3	8
			6	**16**
Total			**16**	**32**

Semester V – Theory
Paper Code: SIUSZO51
Paper title: Genetics, Comparative Chordate Anatomy, Developmental Biology, Histology and Endocrinology.

Learning Objectives
To know about the different integumentary structures and derivatives in vertebrates and to get acquainted with the special derivatives of epidermis.
To gain an insight of the mammalian endocrine system and its function in homeostasis.
To understand the processes involved in embryonic development with reference to chick as a model and to know about the genetic basis of development in animals.

Unit I: Genetics **15 Lectures**

Normal human karyotype: Karyotype preparation & banding techniques (FISH), band numbering scheme.

Chromosome non-disjunction& chromosomal anomalies: Deletions & duplications with examples; micro-deletion & micro-duplication with examples, translocation, Down's syndrome & other translocation; other abnormalities: Inversions, ring chromosomes, polyploidy and its types.

Inborn errors of metabolism: The concept of inherited metabolic diseases, genetics of human metabolic diseases: Phenylketonuria, alkaptonuria & albinism, maternal PKU, G6PD deficiency and variants of G6PD; complex traits in families: Diabetes mellitus.

Unit II: Comparative chordate anatomy-I **15 Lectures**

Structure of integument and its derivative:
General structure of integument.
Comparative study of skin in different classes
Study of derivatives of skin: Epidermal glands, Scales, Feathers, Hair, Beaks, Digital tips, Horns and antlers
Special derivatives of skin: whale bone, Rattle in snakes, Liliac callosities in langur/ macaque and kneepads in camel

Digestive system:
Evolution of digestive tube. Primary divisions of the tube.
Tooth structure & position, teeth in lower vertebrates, mammalian dentition.
Morphology of gut wall
Comparative study of Esophagus, Stomach and Intestine in chordates

Circulatory System:
Evolution of heart, Heart of gill breathing fishes, Heart of lung fishes and amphibians, Hearts of amniotes.
Arterial channels and its modification: Aortic arches in fishes, Aortic arches in tetrapods
Venous channels and its modification: Venous system in shark (Basic pattern) other fishes and tetrapods
Lymphatic system in the vertebrates.

Unit III: Developmental biology-I **15 Lectures**

Chick Embryology:

Development stages Hamilton Hamburger Stages- 5; 7; 12; 16; 19. Extra-embryonic membranes

Types of placentae:

Extra embryonic membranes in mammal, classification of placentae on the basis of external morphology and histology.

Developmental Strategies: Sexual reproduction and metamorphosis, Apoptosis and its role in development.

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Unit IV: Histology and Endocrinology-I **15 Lectures**

General organization: Mammalian endocrine system

Hormones: Classification, properties, mechanism of hormone action, hormone secretion and transport

Histology, functions and disorders of the following endocrine glands:

Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal.

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Paper Code: SIUSZO52

Paper title: Haematology, Physiology, Immunology and General pathology

Learning Objectives

To introduce Haematology, a branch of medicine concerned with the study, diagnosis, treatment, and prevention of diseases related to the blood, and to know about the diagnostic techniques used in Haematology.

To acquaint with the body's defense system (immune system) and its combat against intruders, the invading pathogens, and to apply this knowledge in medical science in vaccination, organ transplant and tumour treatment.

Unit I: Haematology-I **15 Lectures**

Composition of blood

Plasma and formed elements

Blood volume

Total quantity and regulation; haemorrhage

Plasma proteins

Inorganic constituents, respiratory gases, organic constituents other than proteins (including internal secretions, antibodies and enzymes)

RBCs

Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia; thalassemia

Hemoglobin
Structure, formation and degradation, role in transport of oxygen and carbon dioxide (Chloride shift and Bohr's effect); types of hemoglobin (foetal, adult and sickle)

WBCs
Types of leukocytes and function, total count and variation in number; leucopoiesis; leukemia and its types

Blood clotting
Thrombocytes; factors and mechanism of coagulation; anticoagulants; formation of blood platelets (thrombopoiesis); clotting mechanism; bleeding and clotting time; failure of clotting mechanism; Haemophilia and Purpura

Unit II: Physiology-I **15 Lectures**

Regulation of blood circulation: Vascular pumps: Suction pump in open circulation and pressure pump in closed circulation, Heart size (Heart mass-Hm) in vertebrates, heart rate frequency in vertebrates and invertebrates, Cardiac output, Pace maker, neurogenic and Myogenic hearts;
Electrical activity in heart muscles: Electrocardiogram; chemical and nervous regulation of heart.
Chemical Messengers: Introduction, concept and classification; Neurotransmitters ad Neurosecretory substance, Acetyl catecholamine, Gama-amino butyric acid (GABA), Aspartic acid, Purine ATP, Mode of working of transmitters; Neurosecretory substances and a brief account of Neurosecretory system.

Unit III: Immunology-I **15 Lectures**

Introduction to Immunology and historical perspective

Components of Immune system
Innate immunity – Factors affecting innate immunity
Mechanisms of innate immunity – Physical barriers, chemical barriers and cellular barriers
Adaptive or Acquired immunity – Active Acquired immunity – Natural and Artificial; Passive Acquired immunity – Natural and Artificial

Cells and Organs of Immune system
Cells of immune system – Lymphoid cells: B lymphocytes (Humoral immunity), T lymphocytes (Cell-mediated immunity) and Natural killer cells; Mononuclear phagocytes; Dendritic cells and Mast cells
Organs of immune system – Primary – Thymus and bone marrow
Secondary – Lymph node and spleen

Antigens

Immunogenicity versus Antigenicity, factors that influence immunogenicity, Epitopes, Haptens

Antibodies
Basic structure and function, Antibody classes and biological activities, Antigenic determinants on immunoglobulins

Antigen-Antibody interaction
General features of antigen-antibody interaction; Precipitation reactions: Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony method), Immunoelectrophoresis; Agglutination reactions: Haemagglutination, Agglutination inhibition; RIA, ELISA

Unit IV: General Pathology **15 Lectures**

Infectious diseases: Aetiology; infectious agents: viruses – hepatitis, fungi – skin diseases
Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)
Disorders of pigmentation: Endogenous: Normal process of pigmentation, melanosis, jaundice (causes and effects)
Necrosis: Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid
Gangrene: Definition and types – Dry, moist and gas gangrene
Circulatory disturbances: Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Oedema and Infarction
Inflammation: Definition and causes (pathogenic and immune); cardinals of inflammation; acute and chronic inflammation
Applied pathology: Anatomical, clinical and molecular; investigating methods: biopsy and surgery (for pathological examination of tissue)
Forensic pathology: Autopsy; Post-mortem changes – Algor mortis: body cooling, Rigor mortis – stiffening of limbs, state of decomposition – Autolysis (process of self-digestion) and putrefaction

Paper Code: SIUSZO53

Title: Molecular Biology, Genetic engineering Toxicology and Animal tissue culture

Learning Objectives
To understand the magnitude of damage due to alterations in DNA molecule and to appreciate the importance of DNA repair mechanisms helping to maintain cellular homeostasis.
To get acquainted with the vast array of techniques used to tamper genes which can be applied in numerous fields like medicine, research, etc. for human benefit.
To understand significance of cell culture as a tool in specialized areas of research and its applications in industries like biotechnology, in fields such as in vitro fertilization and

replacement of animals in medical and toxicology experiments.

UNIT- I: Molecular Biology-I **15 Lectures**

The nature & properties of the genetic material.

DNA as genetic material: Griffith's transformation experiment., Avery MacCleod & McCarty experiments, Hershey-Chase experiment

RNA as genetic material: Singer & Conrat expt. on TMV.

DNA Replication: Semiconservative nature of DNA replication , Meselson & Stahl experiment , prokaryotic & eukaryotic replication, semi-discontinuous replication preming, bidirectional & unidirectional replication, θ mode of replication in bacteriophages, enzymes involved in DNA replication.

Gene regulation: Control of gene expression in prokaryotes; Lac Operon, Trp Operon. Control of gene expression in eukaryotes; heterochromatin, euchromatin, transcriptional level control (transcription factors other than those involved in formation of initial complex; DNA binding domains, Helix turn helix, Zinc fingers, Leucine zipper, HLH (Helix – Loop – Helix) motif), Role of DNA methylation.

UNIT –II: GENETIC ENGINEERING –I **15 Lectures**

Enzymes involved in Genetic Engineering: Introduction, nomenclature and types with examples, working mechanism

Ligases – E.coli DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA and RNA polymerases, reverse transcriptase, terminal transferase

Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors – Plasmid vectors, phage vectors, cosmid vectors, phasmid vectors, YAC vectors

Cloning techniques: Cloning after restriction digestion – Blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cloning after homopolymer tailing, cDNA synthesis (Reverse transcription), genomic and cDNA libraries

Transfection techniques: Liposome mediated gene transfer, calcium phosphate precipitation method, electroporation, Biolistics (gene gun), somatic cell hybridization.

UNIT-III: Toxicology-I **15 Lectures**

Introduction to toxicology – History and scope of toxicology

Principles of toxicology – Different areas of toxicology, Classification of toxic agents

Characteristics of Exposure – Duration of exposure, frequency of exposure, site of exposure and routes of exposure

Dose Response relationship – Individual/ Graded dose response relationships, Quantal dose response relationships, shape of dose response curves, Concept of LD50, LC50, ED50, Therapeutic index, Margin of safety and exposure

Variation in toxic responses – Selective toxicity, Species differences
Descriptive animal toxicity tests – Acute toxicity testing, Skin and Eye irritations, Sensitization, Subacute (Repeat-Dose Study), Subchronic, Chronic, Developmental and Reproductive toxicity
Dose translation from animals to human – Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)
OECD guidelines for testing of chemicals (an overview)
CPCSEA guidelines for animal testing centre, ethical issues in animal studies (an overview)
Animal models used in regulatory toxicology studies (an overview)
Alternative methods in toxicology (*in vitro* tests) (an overview)

UNIT- IV: Animal tissue culture **15 Lectures**

Definition, principle and significance of tissue culture.
Animal tissue culture. Maintenance of sterility and use of antibiotics, Mycoplasma and viral contaminants. Various systems of tissue culture - their distinguishing features advantages and limitations.
Culture medium: Logic of formulation (natural media, synthetic media, and sera).
Methodology: i. Primary culture: Behaviour of cells, properties, utility. ii Explant culture. iii. Suspension culture.
Characteristics of cells in culture. Contact inhibition, anchorage in/dependence, cell-cell communication, cell senescence.
Growth studies: Cell proliferation, cell cycle, mitosis in growing cells.
Organ culture: Methods, behaviour of organ explant, and utility of organ culture.
Organ transplants. Freeze storing of cells and transport of cultures.
Applications of Tissue Culture
and diagnostic tests. Development and preparation of vaccines against infecting organisms, mammalian cloning.
Workings of a commercial laboratory (Design, aseptic techniques and control of contamination, quarantine, pathological indexing, packaging, cost analysis, marketing).

Paper Code: SIUSZO54

Title: Wildlife conservation and management, Field biology Techniques, Epidemiology and Zoogeography

Learning Objectives
To introduce a branch of science dealing with the geographic distribution of animals and to know how and why different animal species are distributed around the globe and techniques to study animals in field.

Unit-I: Wildlife conservation & management **15 lectures**

Acts and regulations:
Wildlife protection Act of India, CITES, TRAFFIC, RED Data Book.

Measures to control poaching & wildlife trade.
Dealing with Human –Wildlife conflicts.
Compensating losses.
EIA studies; role of pollution control boards- central and Maharashtra.

Threats to Wildlife: Diseases (zoonosis and reverse zoonosis), competition, hunting, poaching, encroachment, deforestation, tourism, overgrazing, human animal conflict and climate change.
Community Conservancies: Snow Leopard Conservancy in India
Community-based Nature Conservancy (CNC) in Tadoba.

Unit-II: - Field biology techniques **15 Lectures**

Field note book and its records
Qualitative & Quantitative data
Field kit and its usage
Cameras, binoculars, field scopes, camera traps etc.
Different methods of recording field observations
Use of rings / tags, Color codes, Colour marking on animals
Studying & analyzing Animal Tracks & signs
Scat analysis and evaluation of food, feeding and health

Unit-III: Epidemiology-I **15 lectures**

Understanding Epidemiology with respect to disease frequency, distribution and determinants.

Epidemiological approach and aims of epidemiology. Basic measurements in epidemiology, Tools of measurement.

Epidemiologic methods: Observational studies and Experimental studies. Uses of epidemiology
Infectious disease epidemiology
Dynamics of disease transmission
Disease prevention and control

Unit-IV: Zoogeography-I **15 lectures**

Distribution of animals**:** In space – Horizontal or superficial, In time – Geological or durational
Patterns of animal distribution: Continuous, discontinuous, isolation and bipolarity
Theories of animal distribution
Barriers of distribution of animals**:**Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habits, homing instinct
Means of dispersal – Land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies
Zoogeographical Realms
Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic

SEMESTER V PRACTICAL

Practical Paper Code: SIUSZOP51

Based on SIUSZO51

1. Study of various model organisms used in genetic studies.
2. Preparation of media for fruit fly culture aseptically.
3. Preparation and comparison of different types of media for fruit fly culture.
4. Identification of sexes in fruitflies & Crossing of fruit fly.
5. Identification of contrasting characters in fruit fly w.r.t. genetics.
6. Study of development of Chick Embryo - up to 48 hrs of incubation.
7. Study of dentition in animals and its type. (Using Dental formula).
8. Study of neurogenic heart, myogenic heart and types of circulatory fluid.
9. Observation and analysis of types of feathers in birds.
10. Observation of Mammalian tissues: pituitary, adrenal, thyroid and pancreas
11. Observation of chick embryo at various stages.
12. Calculation and analysis of cephalic index, arm span to body ratio, leg-to-body ratio and intra-limb ratio in a random population (different age groups) and make a report.

Practical Paper Code: SIUSZOP52

Based on SIUSZO52

Enumeration of erythrocytes – Total count.

Determination of Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method.
Estimation of haemoglobin by Sahli's acid haematin method.
Enumeration of leucocytes –Total Count.
Differential count of WBC.
Determination of serum LDH.
Estimation of total plasma proteins by Folin's method.
Estimation of serum/ plasma total triglycerides by Phosphovanillin method.
Latex agglutination test – Rheumatoid Arthritis; Slide test for pregnancy.
Study of T.S. of lymphoid organs: Thymus, spleen and lymph nodes, and leukemic cells from permanent slides.

Practical Paper Code: SIUSZOP53

Based on SIUSZO53

1. Estimation of RNA by the Orcinol method.
2. Estimation of DNA by the Diphenylamine method.
3. Isolation of genomic DNA and checking its purity by horizontal electrophoresis.
4. Study of the effect of food additive/ drug/ naphthalene balls on the chromosomes of onion root tips and calculation of the mitotic index.

5. Problems based on molecular biology and genetic engineering.
6. Estimation of the concentration of cell suspension by serial dilution of stock cell suspension and checking its viability.
7. Isolation of cells from the given tissue by trypsinization and checking its viability.

Practical Paper Code: SIUSZOP54

Based on SIUSZO54

1. Use of GPS in designing a working area for field study/ report making.
2. Analysis of Qualitative and Quantitative data with respect to field biology.
3. Analysis of community by working out ecological indices (frequency/importance probability, rarity, fidelity, constancy, species diversity and Shannon-Wiener Indices) Using transect method and quadrate method.
4. Study of chemical properties of water: BOD, COD, Nitrate-Nitrogen and Nitrite Nitrogen, Phosphate phosphorus, Acidity and Alkalinity of water sample.
5. Identification of field equipment.
6. Identification of rings, tags, colour codes and colour markings on animals.
7. Identification and analysis of animal signs and tracks.
8. Analysis of scat with the help of key.
9. Study of tracing of pug marks of wildlife.
10. Identification of various Zoogeographical regions on a map and animals in zoogeographical realms.

Semester-VI-Theory

Paper Code: SIUSZO61

Paper title: Evolution, Comparative Chordate Anatomy, Developmental Biology, Histology and Endocrinology

Learning Objectives

To know about the different integumentary structures and derivatives in vertebrates and to get acquainted with the special derivatives of epidermis.
To gain an insight of the mammalian endocrine system and its function in homeostasis.
To understand the processes involved in embryonic development with reference to chick as a model and to know about the genetic basis of development in animals.

Unit I: Evolution & Paleontology: 15 Lectures

Geological Timescale

Invertebrate Palaeontology:
Ichnofossils – modes of preservation, Classifications and Ichnofacies.
Evolutionary trend and geological history of Ammonoidea and Trilobita.
General account of Gondwana vertebrates, Siwalik Mammals and possible cause of their extinction. Dinosaurs and their extinction.
Evolutionary trends in Equidae, Proboscidae and Hominidae.
Molecular evolution: Molecular evolutionary clock, Heterochrony in evolutionary lineage.

Unit II: Comparative Chordate Anatomy: II

2.1: Respiratory system:
Gills: Agnathans, Cartilageonus fishes, Bony fishes, Larval gills
Air breathing bony fishes, Nares and nasal canals in chordates.
Swim bladder and origin of lungs
Amphibian lungs, Reptilian lungs, Lungs and their ducts in birds, Mammalian lungs.

2.2: Nervous system:
Development and differentiation of primary brain vesicles and their cavities, flexures of brain, Evolution of cerebral hemispheres, cerebellum
Cranial nerves & autonomic nervous system with reference to shark, frog, lizard, pigeon & rabbit.

2.3 Urinogenital System:
Archinephros, pronephros, mesonephros, metanephros,
Structure of nephron
Urinogenital ducts, urinary bladder.
Testes and male genital duct, Intromittent organs.
Ovaries and female genital ducts. Types of uteri in chordates.

Unit III: Developmental Biology II: 15 Lectures

Morphogenesis: Fate maps, cell differentiation, embryonic stem cells, differential cell affinity, cell adhesion, morphogenetic movements. Induction and competence, epithelial-mesenchymal interaction

Developmental abnormalities: Congenital abnormalities: Fetal Alcohol syndrome and Spinal bifida (Man/ animal model)

Cancer: Hallmarks of cancer, Types of Cancer, Causes of Cancer, Oncogenes, Tumour suppressor genes, cell signaling in cancer. Precision medicine

Unit IV: Histology and Endocrinology II : 15 Lectures

Histology: Histological structures and functions of the following mammalian organs: stomach, intestine, liver, kidney, testis, ovary.

Paper Code: SIUSZO62

Paper title: Hematology, Enzymology, Immunology and Homeostasis and regulation

Learning Objectives

To familiarize with the concept of haematology, homeostasis and to comprehend the adaptive responses of animals for thermoregulation and maintaining water and ionic balance.
To study Histology to comprehend the architecture of various organs in the body.
To introduce the basics of General pathology to know about the retrogressive, necrotic, circulatory, neoplastic pathological conditions in the body.

Unit-I: Hematology-II 15 Lectures

Introduction to Applied Hematology

Definition, scope and brief introduction of basic branches: clinical, microbiological, oncological and forensic hematology

Diagnostic techniques used in Hematology

Microscopic examination of blood: For detection of blood cancers (lymphoma, myeloma), infectious diseases (Malaria, Leishmaniasis), hemoglobinopathies (Sickle cell anaemia, Thalassemia)
Coagulopathies: Diagnostic methods (Hemophilia and Purpura)
Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB)
Biochemical examination of blood:
Liver function tests: AST, ALT, Total bilirubin, Prothrombin time/ International normalized ratio (PT/ INR), LDH and Alkaline phosphatase
Kidney function tests: Serum creatinine, blood urea nitrogen (BUN)

Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated hemoglobin test
Other biochemical tests: Blood hormones (Thyroid, FSH, LH), Cancer Antigen test (CA124 or CA125)
Blood Bank: Collection, storage and preservation of blood components
Blood transfusion: Cross matching, Transfusion of blood

Unit II: Enzymology **15 lectures**

Definition, nomenclature and classification (based on Enzyme Commission) of enzymes; cofactors and coenzymes; the concept and properties of active site

Factors affecting enzyme activity – pH and temperature; concept of activation energy; Enzyme structure (lysozyme and serine protease)

Enzyme kinetics, concept of steady state, derivation of Michaelis-Menten equation and Lineweaver-Burk plot, enzyme assay, concept and significance of k_m, V_{max} and k_{cat}; modulation of enzyme activity with reference to GDH

Enzyme inhibitors – Competitive and non-competitive inhibitors and their kinetics, therapeutic applications of enzyme inhibitors

Regulation of enzyme activity; Hill equation; allosteric regulation and regulation by covalent modification of enzymes; zymogens (pepsinogen and proelastase); isozymes (LDH)

Clinical significance and industrial application of enzymes

Unit III: Immunology-II **15 Lectures**

3.1: Hypersensitivity, Autoimmunity and Immunodeficiency

Definition of Hypersensitivity; Classification of hypersensitivity reactions: Type-I, Type-II, Type-III and Type-IV (one example of each type)
Introduction to hypersensitivity, brief account of types of hypersensitivity
Introduction to autoimmunity, brief account of autoimmune diseases
Introduction to immunodeficiency, brief account of primary immunodeficiency, e.g. SCID; brief account of secondary immunodeficiency, e.g. AIDS

Transplantation Immunology

Introduction to transplantation; Immunological basis of graft rejection; Clinical manifestations of graft rejection; General immunosuppressive therapy

Cancer and Immune system

Oncogenes and cancer induction; Tumour antigens; Brief account of cancer immunotherapy

Vaccines and Vaccination

Introduction to vaccines, Vaccination: Development and challenges; Brief account of designing vaccines for active immunization: Whole organism vaccines, Purified macromolecules as vaccines, Recombinant vector vaccines, DNA vaccines, Subunit vaccines

UNIT IV: Homeostasis and regulation **15 Lectures**

Homeostasis: External and internal environment; Acclimation and acclimatization
Control systems in biology: Feedback mechanisms – Negative feedback and positive feedback mechanisms and examples of each
Thermoregulation: Endothermy, ectothermy (relation between temperature and biological activities); temperature balance; heat production – shivering and nonshivering thermogenesis; brown fat – special thermogenic tissue in mammals; mechanisms of heat loss; adaptive response to temperature – daily torpor, hibernation, aestivation
Osmotic and Ionic regulation: Maintaining water and electrolyte balance; ionic regulation in iso-osmotic environment; living in hypo-osmotic and hyper-osmotic environment; problems of living in terrestrial environment; water absorption, salt water ingestion and salt excretion, salt glands, role of kidney in ionic regulation, metabolic water

Paper Code: SIUSZO63

Paper title: Molecular biology, Genetic engineering, Toxicology & Bioinformatics

Learning objectives:
To introduce the principles of Toxicology with particular emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing; to develop an introductory understanding of regulatory affairs in toxicology and also to develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas.
To familiarize with genetic engineering.
To introduce Bioinformatics – a computational approach to learning the structure and organization of genomes, phylogeny, metabolism and immunology.

UNIT- I: Molecular biology-II **15 Lectures**

Types of mutation
Point mutations – Substitution, deletion and insertion mutations
Substitution mutations – Silent (same-sense), missense and nonsense mutations, transition and transversion
Deletion and Insertion mutations – frameshift mutations
Trinucleotide repeat expansions – Fragile X syndrome, Huntington's disease
Spontaneous mutation – tautomeric shifts, spontaneous lesions
Induced mutations/ mutagens/ mutagenic agents
Physical agents – Ionizing radiation (X-rays, α, β and γ rays), non-ionizing radiation (UV light)
Chemical agents – Base analogs (5-bromouracil, 2-aminopurine), intercalating agents (acridine dyes, ethidium bromide and ICR compounds), deaminating agents (bisulfite compounds and nitrous acid), hydroxylating agents (hydroxylamine), alkylating agents (ethylmethane

sulphonate, ethylethane sulphonate, mustard gas, polycyclic aromatic hydrocarbons), aflatoxin (aflatoxin B_1)

Prevention of DNA damage and Repair mechanisms

Mechanisms that prevent DNA damage – Superoxide dismutase and catalase
Mechanisms that repair damaged DNA – Direct DNA repair (alkyl transferases, photoreactivation, excision repair)
Post replication repair – Recombination repair, mismatch repair, SOS repair, transcription-repair coupling

UNIT- II: Genetic Engineering-II **15 Lectures**

PCR: Principle of Polymerase chain reaction (PCR); Applications of PCR
Sequencing techniques: DNA sequencing: Sanger's method – Manual and automated methods. Protein sequencing: Sanger's method, Edman's method; Applications of sequencing techniques
Separation and detection techniques: Blotting techniques:Southern blotting, Northern blotting and Western blotting; Applications of blotting techniques. Capillary electrophoresis.
Microarray techniques: ESTs, DNA microarray and applications

UNIT-III: Toxicology-II **15 Lectures**

Absorption, Distribution and Excretion of toxicants – Overview of absorption of toxicants by gastrointestinal tract, lungs, skin; overview of volume of distribution of toxicants, storage of toxicants in tissues, blood brain barrier, passage of toxicants through placenta; overview of urinary excretion, fecal excretion, other routes of elimination of toxicants.
Biotransformation of xenobiotics – Overview of general principles, xenobiotic biotransformation by Phase I enzymes and Phase II reactions (examples of carbon tetra chloride and acetaminophen).
Target organ toxicity – overview of toxic responses of liver and kidney.
Toxic effects of pesticides – Overview of toxic effects of insecticides and rodenticides
Toxic effects of metals – Factors impacting metal toxicity, Biomarkers of metal exposure, overview of toxic effects of major toxic metals (Arsenic, Chromium, Lead, Mercury)
Properties and Toxicities of animal venoms: Properties of animal toxins, toxin from arachnids (scorpion/spider), toxin from ants (bees/wasps), toxin from reptiles (lizards/snakes), Antivenom and potential clinical applications of venoms

UNIT-IV: Bioinformatics **15 Lectures**

DNA databases and protein databases, primary & secondary data bases,
FASTA & BLAST (Basic Local Allignment Search Tool), Uniprot, Clustal omega,
Literature data base: PubMed (Public Medline);
Construction and analysis of a phylogenetic trees.
Applications of bioinformatics.
Immunoinformatics, OMIM, metabolomics

Paper Code: SIUSZO64

Paper title: Biodiversity and Conservation, Behavioral Biology, Epidemiology, Bioprospecting & Bioethics.

Unit-I: Biodiversity and Conservation **15 lectures**

Concept of Biodiversity.
General concepts of Private forests, Reserve forests, Sanctuaries (Eagle nest wildlife sanctuary, Hoolongpar sanctuary, Bhimashankar wildlife sanctuary, Gahirmatha marine wildlife sanctuary, Point calimere wildlife sanctuary, Pangolakha wildlife sanctuary), National Parks (Sanjay Gandhi national park, Kaziranga national park, Marine/ Corbett/ Tadoba/ Sunderbans/ Silent valley/ Keoladeo Ghana/ Gir),
Wildlife reserves, Coastal Regulation Zone.
In situ and *ex-situ* conservation.
Germ plasm, Gene banks, Seed banks, frozen zoo, Ecotourism.

Unit-II: Behavioral Biology **15 lectures**

Animal Behaviour: Habitat selection; Food selection; dispersal, homing, ritualization, courtship, territoriality, aggression.
Social Behaviour: Schooling in fish, herding in mammals; Group selection. Kin selection, Altruism, Reciprocal Altruism, Inclusive Fitness; Social organization in insects and Primates. Parental care in animals, Hamilton's rule in behavior biology.

Unit-III: Epidemiology-II **15 lectures**

Prevention and control of communicable diseases: Notification, isolation, quarantine, disinfection; concurrent, terminal, precurrent/ prophylactic methods of disinfection: natural, physical, chemical, immunization; general measures, health education in India.

Epidemiology of communicable diseases: Diagnosis, transmission, prevention, control measures and treatment of-

a) Diseases of viral origin- SARs, Dengue
b) Diseases of bacterial origin- TB, national TB control programme.
c) Diseases of protozoan origin- Malaria, national malaria control programme.

Epidemiology of non communicable diseases: Diabetes and cancer
International Health organizations: WHO, UNICEF,UNDP,FAO.ILO, World Bank
Non Governmental and other agencies: Rockfellar foundation, Ford foundation, CARE, International Red Cross, Indian Red Cross.

Unit IV: Bioethics, Bioprospecting and Zoopharmacognosy 15 Lectures

Bioethics

Intellectual property rights and patenting; forms of protection – Patents, copyrights, trade secrets, trademarks; patenting biological materials – Live forms, genes and DNA sequences

Bioprospecting

Traditional prospecting, Modern bioprospecting, Chemical prospecting, Genetic prospecting, Bionic prospecting, Economic value and benefit sharing, Bioprospecting and conservation, pros and cons of bioprospecting

Zoopharmacognosy

Definition, history and types, Self-medication and its mechanism, Methods of self-medication through – Ingestion: ants and mammals, Geophagy invertebrates and birds, Absorption and adsorption, Topical application – Birds and mammals, Applications of Zoopharmacognosy – Social and transgenerational zoopharmacognosy Value to humans.

SEMESTER VI –PRACTICAL
Practical Paper Code: SIUSZOP61

Based on SIUSZO61

Paper 1 Semester 6

1. Study of natural selection.
2. Study of convergent and divergent evolution with appropriate tools.
3. Construction of phylogenetic trees w.r.t. evolution.
4. Study of types of fossils.
5. Study of cartilage and bone structure.
6. Study of Placoid, cycloid and ctenoid scales of fish.
7. Study of types of nerve cells.
8. Observation of Permanent slides of Mammalian Tissues: liver, kidney, testis, ovary, stomach and intestine.
9. Comparison of digestive tubes of fishes, aves and mammals
10. Comparative analysis of urine of herbivore and omnivore.
11. Compare and Analyze the evolution of any one organ in human (or any animal) body and make a report.

Practical Paper Code: SIUSZOP62

Based on SIUSZO62

Effect of pH on activity of enzyme Acid Phosphatase.
Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase.
Effect of varying substrate concentration on activity of enzyme Acid Phosphatase.
Effect of inhibitor (drug as an enzyme inhibitor) on activity of enzyme Acid Phosphatase.
Study of separation of LDH isozymes by agarose gel electrophoresis/PAGE.
To study the effect of enzymes (and/ drugs) in detergents.
Study of mammalian tissues:
i. V.S. of Skin
ii. V.S. of Tooth
iii. T.S. of Stomach
iv. T.S. of Ileum
v. T.S. of Liver
vi. T.S. of Pancreas
vii. T.S. of Lung

Identification of following diseases or conditions (from slides or pictures):
Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis

Vidal's Test

Study and interpretation of pathological reports: Blood, urine and stool (faeces).

Practical Paper Code: SIUSZOP63

Based on SIUSZO63

1. Problems based on molecular biology
2. Problems based on genetic engineering
3. Demonstration of Western Blotting technique using teaching kit
4. Extraction of DNA from Human blood and checking its purity using teaching kit
5. Effect of CCl_4 on the level of enzyme activity in serum acid and alkaline phosphatase, aspartate and alanine aminotransferase.
6. Effect of salt of a heavy metal/ nicotine/ alcohol on the heartbeat of Daphnia
7. Determination of LC_{50} for a suitable pollutant (anyone salt of a heavy metal dissolved in water) on Daphnia by Probit analysis.
8. Problem-solving in bioinformatics
9. Report preparation in bioinformatics
10. To design a nucleotide primer for PCR

Practical Paper Code: SIUSZOP64

Based on SIUSZO64

1. Identification of sanctuaries, national parks, and wildlife reserves on map
2. Study of behavioural patterns of *Betta splendens*
3. Study of bird acoustic
4. Identification of calls of wildlife
5. Identification of various wildlife adaptation
6. Study of venomous/ poisonous animals /plants
7. Identification and mounting of mouthparts of the mosquito
8. Problems based on biostatistics
9. Study of the density of animals population by Capture-recapture methods
10. Rapid field test to estimate nitrates, base deficiency and sulphates in soil samples
11. Estimation of carbonates, organic content, moisture content ,texture analysis and pH of soil
12. Excursion Report submission based on -Tourism based conservation activity, ecological adaptation, ill effects of tourism
13. Report submission on behavioural biology

Scheme of Examination

The performance of learners will be evaluated in two parts for the Theory component of the Course:
1. Internal Assessment with 40% marks
2. Semester End Examination (written) with 60% marks
The Practical component of the Course will be evaluated by conducting Semester End Practical Examination of 50 marks.

Internal Assessment Theory (40%)
It is the assessment of learners on the basis of continuous evaluation as envisaged in the Credit Based System by way of participation of learners in various academic and correlated activities (poster presentations, debates, discussions, skits, seminars, etc) in the given semester of the program.

Marks: 40
1. Class test (Centralized Examination): **20 Marks**
2. At the departmental level evaluation will be conducted on the basis of review submitted by the student of any research paper/ article relevant to each paper: **20 Marks**

Semester End Assessment Theory (60%)

Marks: 60
Duration: 2 hours
Theory question paper pattern:

- There shall be five questions of 12 marks each. On each unit there will be one question and the 5^{th} question will be based on the entire syllabus.
  OR
  There shall be four questions of 15 marks each, each question based on one unit.
- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weightage of the topic.

Semester End Assessment Practical

Marks: 50
Duration: 5 hours

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