

AC/4.8.18/RS 1



College of Arts,
Science &
Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022

(Autonomous)

Faculty: Science

Program: T.Y.B.Sc.

Subject: ZOOLOGY

Academic Year: 2018 – 2019

**Credit Based Semester and Grading System approved
by Board of Studies in Zoology to be brought into effect
from June 2018**

T. Y. B. Sc. Zoology Syllabus (Autonomous)
Semester V and Semester VI
(Credit Based Semester and Grading System, with effect from academic year 2018-19)

Preamble

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

Academic Autonomy entitles the institution with certain 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.

The key features of this revised syllabus are –

- ✓ *Animal classification – the essence of Zoology for appreciation of diversity of organisms*
- ✓ *Applied haematology, applied immunology and general pathology – that relate to the role played by science in daily life, society and the environment*
- ✓ *Human genetics – involving genetic disorders and their diagnosis, and survey of human traits following Mendelian inheritance*
- ✓ *Biostatistics and Bioinformatics – involving application of computers, to keep pace in this technologically-driven world*
- ✓ *Zoopharmacognosy – the novel science of animal self-medication for a curious eye to observe animal behavior in the wild*
- ✓ *Project component – seeking to fuel the spirit of curiosity of learners, who are problem solvers and scientific investigators in their own way*

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. The syllabus was approved by the Board of Studies (Ad hoc) in the meeting held on 16th June 2018 at the institution's department of Zoology.

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 (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)
Grid of Syllabus – Semester V

Theory				
Paper Code	Unit No.	Unit Name	Credits	Lectures/week
SIUSZO51	1	Levels of Organization	2.5	1
	2	Taxonomy of Phylum Protozoa to Phylum Nematelminthes		1
	3	Taxonomy of Phylum Annelida to Phylum Echinodermata		1
	4	Type study: Sepia		1
SIUSZO52	1	Basic Hematology	2.5	1
	2	Applied Hematology		1
	3	Basic Immunology		1
	4	Applied Immunology		1
SIUSZO53	1	Molecular Biology	2.5	1
	2	Genetic Engineering		1
	3	Human Genetics		1
	4	Tissue Culture		1
SIUSZO54	1	Integumentary System and its derivatives	2.5	1
	2	Endocrine Glands and their regulation		1
	3	Human Osteology		1
	4	Experimental and Chick Embryology		1
			10	16
Practical				
SIUSZOP51	Based on SIUSZO51 (Practical I)		1.5	4
SIUSZOP52	Based on SIUSZO52 (Practical II)		1.5	4
SIUSZOP53 + SIUSZOP54	Based on SIUSZO53 (Practical III) + SIUSZO54 (Practical IV) + Project Component		3	8
			6	16
Total			16	32

**T. Y. B. Sc. Zoology Syllabus (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)
Grid of Syllabus – Semester VI**

Theory				
Paper Code	Unit No.	Unit Name	Credits	Lectures/week
SIUSZO61	1	Minor Phyla and Protochordata	2.5	1
	2	Taxonomy of Subphylum Vertebrata - I		1
	3	Taxonomy of Subphylum Vertebrata - II		1
	4	Type study: Shark		1
SIUSZO62	1	Enzymology	2.5	1
	2	Homeostasis (Temperature and Ionic regulation)		1
	3	Histology		1
	4	General Pathology		1
SIUSZO63	1	Zoogeography	2.5	1
	2	Toxicology		1
	3	Biostatistics		1
	4	Bioinformatics		1
SIUSZO64	1	Environment Management	2.5	1
	2	Wildlife Management		1
	3	Bioethics, Bioprospecting and Zoopharmacognosy		1
	4	General Entomology		1
			10	16
Practical				
SIUSZOP61	Based on SIUSZO61 (Practical I)		1.5	4
SIUSZOP62	Based on SIUSZO62 (Practical II)		1.5	4
SIUSZOP63 + SIUSZOP64	Based on SIUSZO63 (Practical III) + SIUSZO64 (Practical IV) + Project Component		3	8
			6	16
Total			16	32

Semester V – Theory

Paper Code: SIUSZO51

Levels of Organization, Taxonomy of Invertebrates, Type Study

Learning Objectives

- To attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones by a study of the levels of organization in animal kingdom. Also, to know the different modifications the animal life has made for its survival, through taxonomical study.
- To study the anatomical complexity in animals through animal type study.

Unit 1: Levels of Organization

Lectures 15

1.1: Levels of Organization

1.1.1: Unicellularity, multicellularity, formation of colonies

1.1.2: Cellular grade of organization, tissue grade of organization, formation of germ layers

1.2: Symmetry

1.2.1: Evolutionary perspective and definition

1.2.2: Types –

a. Asymmetry – e.g. *Amoeba*

b. Radial – (1) Bi-radial – e.g. *Aurelia* (Jellyfish), (2) Penta-radial – e.g. *Asterais* (Starfish)

c. Bi-lateral – (1) Simple – e.g. *Planaria*, (2) Complex – e.g. *Mus* (Rat)

1.2.3: Significance and advantages

1.3: Coelom

1.3.1: Evolutionary perspective and definition

1.3.2: Development of Coelom -

a. Organization of tissues

b. Diploblastic and Triploblastic organization

1.3.3: Types –

a. Acoelomate – e.g. Platyhelminthes – *Planaria*

b. Pseudocoelomate – e.g. Nematoda – *Ascaris* (Round worm)

c. Coelomate – e.g. Annelida – *Pheretima* (Earthworm)

1.3.4: Significance and advantages

1.4: Segmentation (Metamerism)

1.4.1: Evolutionary perspective and definition

1.4.2: Theories of segmentation

1.4.3: Types of segmentation –

a. Homonymous – e.g. Annelida – *Pheretima* (Earthworm)

b. Heteronomous – e.g. Crustacea – *Panulirus* (Lobster)

1.4.4: Cephalization – e.g. Insecta – *Periplaneta* (Cockroach)

1.4.5: Tagmatization – e.g. Crustacea – *Panulirus* (Lobster)

1.4.6: Cephalothorax – e.g. Crustacea – *Penaeus* (Prawn)

1.4.7: Significance and advantages of segmentation

Unit 2: Taxonomy of Phylum Protozoa to Phylum Nematelminthes

Lectures 15

2.1: Principles of Taxonomy

Linnaean Hierarchy, Binomial Nomenclature, Five Kingdom classification

2.2: Phylum Protozoa

2.2.1: General characters and classification

2.2.2: Locomotion in Protozoa – amoeboid, flagellar, ciliary, gliding movements

2.2.3: Reproduction in Protozoa – asexual and sexual

2.2.4: Morphology, life cycle, pathogenicity and control measures of: *Entamoeba*, *Plasmodium*

2.3: Phylum Porifera

2.3.1: General organization and classification

2.3.2: Skeleton in sponges

2.3.3: Canal system in sponges

2.4: Phylum Cnidaria

2.4.1: General characters and classification

2.4.2: *Obelia* – Polymorphism, life cycle and alternation of generations

2.5: Phylum Platyhelminthes

2.5.1: General characters and classification

2.5.2: Life history of *Fasciola hepatica* and its parasitic adaptations

2.6: Phylum Nematelminthes

2.6.1: General characters and classification

2.6.2: Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 3: Taxonomy of Phylum Annelida to Phylum Hemichordata

Lectures 15

3.1: Phylum Annelida

3.1.1: General characters and classification

3.1.2: Diversity in habit and habitat

3.1.3: Adaptive radiation in class Polychaeta

3.2: Phylum Arthropoda

3.2.1: General characters and classification

3.2.2: Larval forms in class Crustacea; social life and moulting in class Insecta; vision in phylum Arthropoda

3.2.3: Affinities of class Onychophora

3.3: Phylum Mollusca

3.3.1: General characters and classification

3.3.2: Torsion and detorsion

3.4: Phylum Echinodermata

3.4.1: General characters and classification

3.4.2: Water vascular system

3.5: Phylum Hemichordata

General characters and classification, e.g. Balanoglossus

3.6:

Basic concepts of Phylogeny

Unit 4: Type study: Sepia

Lectures 15

4.1:

General characters and classification, habit and habitat, external characters, mantle cavity, locomotion, economic importance

4.2:

Digestive system, respiratory system, circulatory system, excretory system, nervous system, sense organs and reproductive system

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- Invertebrate Zoology – A functional evolutionary approach; Seventh Edition; Edward E. Ruppert, Richard S. Fox & Robert D. Barnes; Cengage Learning India Pvt. Ltd.; 2004

ADDITIONAL READING:

- *Biology – A Global Approach; Tenth Edition (Global Edition); Campbell, Reece, Urry, Cain, Wasserman, Minorsky & Jackson; Pearson Education Ltd., England; 2015*
- *Biology; Seventh Edition; Neil A. Campbell & Jane B. Reece; Pearson Education, Inc.; 2005*
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- *Biology – Concepts & Applications; Sixth Edition; Cecie Starr; Brooks/ Cole; 2005*
- *World Encyclopedia of Animals; English language edition; Elena Marcon & Manuel Mongini; Orbis Publishing Limited; 1984*

Semester V – Theory

Paper Code: SIUSZO52 Haematology and Immunology

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 1: Basic Hematology

Lectures 15

1.1: Composition of blood

Plasma and formed elements

1.2: Blood volume

Total quantity and regulation; haemorrhage

1.3: Plasma proteins

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

1.4: RBCs

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

1.5: 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)

1.6: WBCs

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

1.7: 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 2: Applied Hematology

Lectures 15

2.1: Introduction to Applied Hematology

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

2.2: Diagnostic techniques used in Hematology

2.2.1: Microscopic examination of blood: For detection of blood cancers (lymphoma, myeloma), infectious diseases (Malaria, Leishmaniasis), hemoglobinopathies (Sickle cell anaemia, Thalassemia)

2.2.2: Coagulopathies: Diagnostic methods (Hemophilia and Purpura)

2.2.3: Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB)

2.2.4: 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)

2.2.5: Blood Bank: Collection, storage and preservation of blood components

2.2.6: Blood transfusion: Cross matching, Transfusion of blood

Unit 3: Basic Immunology

Lectures 15

3.1: Introduction to Immunology and historical perspective

3.2: Components of Immune system

3.2.1: Innate immunity – Factors affecting innate immunity

Mechanisms of innate immunity – Physical barriers, chemical barriers and cellular barriers

3.2.2: Adaptive or Acquired immunity – Active Acquired immunity – Natural and Artificial;

Passive Acquired immunity – Natural and Artificial

3.3: Cells and Organs of Immune system

3.3.1: 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

3.3.2: Organs of immune system – Primary – Thymus and bone marrow

Secondary – Lymph node and spleen

3.4: Hypersensitivity, Autoimmunity and Immunodeficiency

3.4.1: Introduction to hypersensitivity, brief account of types of hypersensitivity

3.4.2: Introduction to autoimmunity, brief account of autoimmune diseases

3.4.3: Introduction to immunodeficiency, brief account of primary immunodeficiency, e.g. SCID; brief account of secondary immunodeficiency, e.g. AIDS

4.1: Antigens

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

4.2: Antibodies

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

4.3: 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

4.4: 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

4.5: Transplantation Immunology

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

4.6: Cancer and Immune system

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

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- Rapid Review of Hematology; Ramadas Nayak; Jaypee Brothers
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- *Molecular Cell Biology; Fifth edition; Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky & James Darnell; W.H. Freeman & Company, New York; 2004*

Articles on Haematology -

- *“India facing shortage of life-saving albumin serum”; written by Abantika Ghosh, New Delhi; The Indian Express, October 16, 2014, 2:25 am*
- *Articles on “Blood groups”; (1) The Indian Express, August 15, 2012/ Times of India, August 16, 2012; (2) Times of India, September 11, 2014*

Article on Immunology –

- *“Nanoparticle vaccine shows potential as immunotherapy to fight multiple cancer types”; UT Southwestern Medical Center; ScienceDaily, April 24 2017; <https://www.sciencedaily.com/>*

Semester V – Theory

Paper Code: SIUSZO53

Molecular Biology, Genetic Engineering, Human Genetics, 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 1: Molecular Biology

Lectures 15

1.1: Types of mutation

1.1.1: 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

1.1.2: Trinucleotide repeat expansions – Fragile X syndrome, Huntington's disease

1.1.3: Spontaneous mutation – tautomeric shifts, spontaneous lesions

1.2: Induced mutations/ mutagens/ mutagenic agents

1.2.1: Physical agents – Ionizing radiation (X-rays, α , β and γ rays), non-ionizing radiation (UV light)

1.2.2: 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 B₁)

1.3: Prevention of DNA damage and Repair mechanisms

1.3.1: Mechanisms that prevent DNA damage – Superoxide dismutase and catalase

1.3.2: Mechanisms that repair damaged DNA – Direct DNA repair (alkyl transferases, photoreactivation, excision repair)

1.3.3: Post replication repair – Recombination repair, mismatch repair, SOS repair, transcription-repair coupling

1.4: Eukaryotic gene expression

1.4.1: Regulatory proteins – Zinc fingers, helix-turn-helix domain and leucine zipper

1.4.2: DNA methylation

Unit 2: Genetic Engineering

Lectures 15

2.1: Tools in Genetic Engineering

2.1.1: 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

2.1.2: Vectors for gene cloning:

General properties, advantages and disadvantages of cloning vectors – Plasmid vectors, phage vectors, cosmid vectors, phasmid vectors, BAC vectors

2.2: Techniques in Genetic Engineering

2.2.1: 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

2.2.2: Transfection techniques:

Liposome mediated gene transfer, calcium phosphate precipitation method, electroporation, virus mediated gene transfer – Retrovirus

2.2.3: PCR:

Principle of Polymerase chain reaction (PCR); Applications of PCR

2.2.4: Sequencing techniques:

DNA sequencing: Sanger's method – Manual and automated methods

Protein sequencing: Sanger's method, Edman's method; Applications of sequencing techniques

2.2.5: Separation and detection techniques:

Blotting techniques: Southern blotting, Northern blotting and Western blotting; Applications of blotting techniques

2.2.6: Microarray techniques: ESTs, DNA microarray, Protein Chips and applications

Unit 3: Human Genetics

Lectures 15

3.1: Non-disjunction during mitosis and meiosis – Chromosomal aberrations

3.1.1: Structural:

Deletion: types, effects and disorders

Translocation: types: Robertsonian and non-Robertsonian, disorders

Inversion: types, effects and significance

Duplication and their evolutionary significance (multigene families)

3.1.2: Numerical:

Aneuploidy and Polyploidy (Autopolyploidy and Allopolyploidy)

3.2: Genetic Disorders

3.2.1: Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism, Niemann Pick syndrome

3.2.2: Single gene mutation: Cystic fibrosis, Muscular dystrophy

3.2.3: Multifactorial: Breast Cancer, Ischemic heart

3.2.4: Uniparental disomy: Angelman syndrome, Prader Willi syndrome

3.3: Diagnosis

3.3.1: Prenatal Diagnosis: Amniocentesis and Chorio-villus sampling – Ultrasound scanning and Fetoscopy, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT), Single Nucleotide Polymorphism and its applications

3.3.2: Principles and strategies in identifying the abnormal genes (position independent and dependent), use of abnormalities, confirming a candidate gene

3.3.3: Genetic counselling: Psycho-social aspects for the individual and the family in connection with genetic investigations

Unit 4: Tissue Culture

Lectures 15

4.1: Introduction to Animal cell culture

4.1.1: Advantages of tissue culture – Control of the environment, characterization and homogeneity of sample, economy, scale and mechanization, *in vitro* modeling of *in vivo* conditions

4.1.2: Limitations of tissue culture – Expertise, quantity, dedifferentiation and selection, origin of cells, instability

4.2: Aseptic techniques

4.2.1: Objectives of aseptic techniques – Maintaining sterility

4.2.2: Sterilization – Basic principles of sterilization, importance of sterility in cell culture

4.2.3: Sterile handling – Swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring

4.3: Culture media

4.3.1: Physicochemical properties – pH, CO₂ and bicarbonate, buffering, O₂, osmolality, temperature, viscosity, surface tension and foaming

4.3.2: Types of media – An overview of natural and artificial media

4.3.3: Serum – Protein, growth factors, hormones, nutrients and metabolites, lipids, minerals and inhibitors

4.3.4: Balanced Salt Solutions

4.3.5: Complete Media– Amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics

4.4: Primary culture and establishment of cell lines

4.4.1: Establishment of primary cultures from various sources – Normal ‘versus’ tumour, adult ‘versus’ embryo, human ‘versus’ animal

4.4.2: Isolation of cells – Enzyme digestion, perfusion, mechanical disaggregation, explants cultures

4.4.3: Substrate for attachment

4.4.4: Culture conditions – Selection against some cell types, conditioned medium, feeder cells

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Semester V – Theory

Paper Code: SIUSZO54

Integumentary System, Endocrine Glands, Human Osteology, Chick Embryology

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 introduce students to human osteology, the knowledge of which can be applied for research, medical investigations and identification of vertebrate remains.*
- *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 1: Integumentary System and its derivatives

Lectures 15

1.1: Basic structure of integument

Epidermis and dermis; classification of keratinized and non-keratinized derivatives

1.2: Epidermal derivatives of Vertebrates

Hair, hoof, horn, claw, teeth, beak, epidermal scales (large scales, small scales, modified scales - spine), glands - types and functions (mucous, serous, ceruminous, poison, uropygial, salt), feathers

1.3: Dermal derivatives of Vertebrates

Scales in fishes; scutes in reptiles and birds; dermal scales in mammals – Indian Pangolin; Antler – Spotted Deer/ Sambar

1.4: Special derivatives of integument (epidermal)

Wart in toad; rattle in snake; horny beak in turtle, birds, monotremes; spur in male birds – jacana, fowl; whale bone – baleen whale; liliac callosities – langur/ macaque; kneepads – camel

Unit 2: Endocrine Glands and their regulation

Lectures 15

2.1:

General organization of mammalian endocrine system

2.2:

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

2.3:

Histology, functions and disorders of the following endocrine glands: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovaries

Unit 3: Human Osteology

Lectures 15

3.1: Introduction

Cartilage and bone structure; physical properties, chemical composition and functions of bone, and cartilage

3.2: Axial skeleton

3.2.1: Skull: General characteristics of skull bones – 1) Cranial bones 2) Facial bones

3.2.2: Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacral and coccygeal)

3.2.3: Ribs and sternum (thorax): General structure of ribs and sternum

3.2.4: Hyoid bone: General structure

3.3: Appendicular skeleton

3.3.1: Pectoral girdle and pelvic girdle

3.3.2: Forelimbs and hindlimbs

3.4: Sexual dimorphism of human skeleton

3.4.1: Sternum

3.4.2: Sacrum

3.4.3: Pelvis

Unit 4: Experimental and Chick embryology

Lectures 15

4.1: Introduction to Experimental Embryology

4.1.1: Germ plasm theory, Mosaic theory, Regulative theory, Gradient theory, Spemann's theory of organizers

4.1.2: Basic concept and principles of experimental embryology – Morphogenesis and organogenesis, fate maps, cell adhesion, cell affinity and differentiation

4.2: Development of Chick

Structure of chick embryo – 24 hours, 36 hours, 48 hours, 72 hours

4.3: Signaling pathways and intercellular communication during development

Induction and competence, epithelial-mesenchymal interaction

4.4: Recent trends in Developmental Biology

Methods to determine the role of genes during development (transgenic and chimeric mouse, “knockout” experiments); Genes contributing to developmental defects (oncogenes); multipotent and pluripotent stem cells and their niche

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Semester V – Practical (SIUSZOP51)

Practical I based on SIUSZO51

1. Levels of Organization

a) Symmetry:

- i. Asymmetry, e.g. Sponge
- ii. Radial: Bi-radial, e.g. Comb jelly
Penta-radial, e.g. Adult Brittle star
- iii. Bi-lateral, e.g. Larva of Brittle star; Human

b) Coelom:

- i. Acoelomate, e.g. Tapeworm
- ii. Pseudocoelomate, e.g. *Ascaris*
- iii. Coelomate, e.g. Frog

c) Segmentation:

- i. Homonymous, e.g. *Nereis*
- ii. Heteronomous, e.g. Cockroach

d) Cephalization:

- i. Cephalization, e.g. Honey bee
- ii. Cephalothorax, e.g. Crab

2. Taxonomy of Protozoa to Hemichordata

a) Phylum Protozoa:

- i. Class Rhizopoda, e.g. *Amoeba* - amoeboid locomotion, asexual reproduction – binary fission
- ii. Class Ciliophora, e.g. *Vorticella* - ciliary locomotion, sexual reproduction – conjugation
- iii. Class Flagellata, e.g. *Noctiluca* - flagellar locomotion
- iv. Class Sporozoa, e.g. *Monocystis* - gliding locomotion

b) Phylum Porifera:

- i. Class Calcarea - Canal system, e.g. Scypha - Sycon type; Leucosolenia - Ascon type
- ii. Class Demospongia - Canal system, e.g. Spongilla larva - Rhagon type, adult - Leuconoid type
- iii. Class Hexactinellida - Observation of sponge spicules (permanent slide/ photograph), e.g. Hyalonemma

c) Phylum Cnidaria:

- i. Class Hydrozoa, e.g. *Vellela*
- ii. Class Scyphozoa, e.g. *Rhizostoma*
- iii. Class Anthozoa, e.g. *Corallium* (Red coral)

d) Phylum Platyhelminthes:

- i. Class Turbellaria, e.g. *Planaria*
- ii. Class Trematoda, e.g. Liver fluke
- iii. Class Cestoda, e.g. Tape worm (*Taenia*)

e) Phylum Nematelminthes, e.g. *Trichinella*

f. Phylum Annelida:

- i. Class Polychaeta, e.g. *Arenicola/ Nereis*
- ii. Class Oligochaeta, e.g. Tubifex/ Earthworm
- iii. Class Hirudinea, e.g. *Pontobdella/ Leech*

g) Phylum Arthropoda:

- i. Class Merostomata, e.g. *Limulus* (King crab)
- ii. Class Crustacea, e.g. *Balanus*
- iii. Class Insecta, e.g. *Coccinella* (Ladybird beetle)
- iv. Class Arachnida, e.g. Scorpion
- v. Class Myriapoda, e.g. *Scolopendra* (Centipede)
- vi. Class Onychophora, e.g. *Peripatus*
- vii. Observation and identification of planktonic crustaceans

h) Phylum Mollusca:

- i. Class Aplacophora, e.g. *Chaetoderma*
- ii. Class Polyplacophora, e.g. *Tonicella/ Chiton*
- iii. Class Monoplacophora, e.g. *Neopilina*
- iv. Class Scaphopoda, e.g. *Dentalium*
- v. Class Gastropoda, e.g. *Achatina*
- vi. Class Pelecypoda, e.g. *Donax/ Unio*
- vii. Class Cephalopoda, e.g. Octopus

i) Phylum Echinodermata:

- i. Class Asteroidea, e.g. Starfish
- ii. Class Ophiuroidea, e.g. Brittle star
- iii. Class Echinoidea, e.g. *Echinus*
- iv. Class Holothuroidea, e.g. *Holothuria* (Sea cucumber)
- v. Class Crinoidea, e.g. Crinoid (Sea lily)

j) Phylum Hemichordata (Acorn worms):

- i. Class Enteropneusta, e.g. *Saccoglossus/ Balanoglossus*
- ii. Class Pterobranchia, e.g. *Rhabdopleura*
- iii. Class Planctosphaeroidea, e.g. *Planctosphaera*

Note: Visit a local fish market, local zoo or other local places/ institutes of educational value to study available invertebrates.

Semester V – Practical (SIUSZOP52)

Practical II based on SIUSZO52

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

Semester V – Practical (SIUSZOP53 + SIUSZOP54)

Practicals III and IV based on SIUSZO53 and SIUSZO54

1. Extraction and estimation of RNA by Orcinol method (formula method and standard graph).
2. Extraction and estimation of DNA by Diphenylamine method (formula method and standard graph).
3. Separation of proteins by SDS-PAGE from the given sample (plasma proteins).
4. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and structural variations in chromosomes (no cutting of chromosomes):
 - a) Turner syndrome
 - b) Klinefelter syndrome
 - c) Down syndrome
 - d) Cri-du-chat syndrome
 - e) D-G translocation
 - f) Edward syndrome
 - g) Patau syndrome
5. Problems in genetics based on abnormalities in chromosomes:
 - a) Interpret the following formula: 46, XY, t (2;5) (q21; q31)
Answer: Total number of chromosomes present = 46, male; Reciprocal translocation between chromosomes 2 and 5. Breakage and reunion has occurred between long arm of 2nd chromosome, band 21 and long arm of 5th chromosome, band 31.
 - b) Duplication: 46, XX, dup (1) (q22q25)
Answer: Total number of chromosomes = 46, female; Duplication on chromosome number 1, long arm between band 1q22 and 1q25
 - c) Turner Syndrome: 45, X
 - d) Klinefelter Syndrome: 47, XXY
6. Survey of human traits that follow Mendelian Inheritance:
Hair on back of hand, Bent little finger, widow's peak, tongue rolling, ear lobe and cephalic index. Preparation of report.
7. Identification of contrasting traits in *Drosophila* using photographs.
8. Sterilization technique for tissue culture (Autoclave, Workplace, Chemicals, Biological samples); Packaging of glassware and aseptic transfer.
9. Trypsinization and vital staining using Trypan blue stain.
10. To study epidermal glands: Mucous, sebaceous, sweat, poison, uropygial.
11. To study special integumentary derivatives.

12. To study histology of glands: T.S. of pituitary, thyroid, pancreas, adrenal, ovary, testis

13. To study human skeleton:

(A) Axial skeleton –

1. Skull bone

2. Ossicles of middle ear

3. Hyoid bone

4. Rib cage

5. Sternum

6. Vertebral column –

I. Cervical vertebrae

a) Typical cervical vertebrae (3-6)

b) Atlas or 1st cervical vertebra

c) Axis or 2nd cervical vertebra

d) 7th cervical vertebra

II. Thoracic vertebrae (8-19)

III. Lumbar vertebrae (20-24)

IV. Sacral vertebrae (25-29) and coccyx (synsacrum) (30-33)

(B) Appendicular skeleton –

1. Pectoral and pelvic girdles

2. Forelimbs and hindlimbs

14. Preparation and observation of temporary mounting of chick embryo of 18/ 24/ 36/ 48/ 72 hours; identification of the age of the embryo by Hamilton-Hamburg method.

Semester VI – Theory

Paper Code: SIUSZO61

Minor Phyla, Taxonomy of Chordates, Type Study

Learning Objectives

- To attempt to gain an insight of the hierarchy of life forms from the simplest to the most complex ones and to know the different modifications the animal life has made for its survival, through taxonomical study.
- To study the anatomical complexity in animals through animal type study.

Unit 1: Minor Phyla and Protochordata

Lectures 15

1.1: Minor Phyla

General features:

- a) Acoelomate – Phylum Acanthocephala, e.g. *Macracanthorhynchus*, *Moniliformis*
- b) Coelomate – Phylum Chaetognatha, e.g. *Sagitta*

1.2: Protochordata

1.2.1: General overview, characteristics and salient features of urochordates and cephalochordates

- a) Subphylum Urochordata, e.g. *Ascidia*
- b) Subphylum Cephalochordata, e.g. *Branchiostoma*

1.2.2: Retrogressive metamorphosis in ascidian

1.2.3: Phylogeny of urochordates and cephalochordates

Unit 2: Taxonomy of Subphylum Vertebrata - I

Lectures 15

2.1: Division – Agnatha

2.1.1: Classification of living Agnatha up to classes

2.1.2: General characters of the jawless fishes, e.g. *Petromyzon* (lamprey) and *Myxine* (hagfish)

2.2: Division – Gnathostomata: Superclass – Pisces

2.2.1: General characters and classification up to order – Placodermi, Chondrichthyes and Osteichthyes

2.2.2: Examples:

- a) Armoured fish, e.g. *Bothriolepis*
- b) Sharks, e.g. *Sphyrna* (Hammer-headed shark)
- c) Skates and rays, e.g. *Pristis* (Sawfish), *Dasyatis* (Stingray)
- d) Chimeras, e.g. *Hydrolagus* (Spotted rat fish)
- e) Lung fish, e.g. *Lepidosiren* (Australian lungfish)
- f) Flying fish, e.g. *Exocoetus*

2.3: Superclass Tetrapoda: Class Amphibia

2.3.1: General overview, classification, characteristics and salient features up to orders

2.3.2: Examples of each order namely:

- a) Limbless amphibian, e.g. *Ichthyophis*
 - b) Tailed amphibian, e.g. *Tylotriton* (Himalayan newt)
 - c) Tailless amphibian, e.g. *Hyla*
- 2.3.3: Neoteny in Amphibia, e.g. Axolotl larva

Unit 3: Taxonomy of Subphylum Vertebrata - II

Lectures 15

3.1: Class Reptilia

3.1.1: General overview, classification, characteristics and salient features of subclasses and orders

3.1.2: Examples of each order namely:

- a) Aquatic reptile, e.g. *Chelone*
- b) Extinct reptile, e.g. *Ichthyosaurus*
- c) Living fossil, e.g. *Sphenodon*
- d) Arboreal reptile, e.g. *Chameleon*

3.2: Class Aves

3.2.1: General overview, classification, characteristics and salient features of orders

3.2.2: Examples of each order in accordance to groups:

- a) Arboreal birds, e.g. *Treron* (Green pigeon)
- b) Terrestrial birds, e.g. *Gallus* (Jungle fowl)
- c) Swimming/ diving birds, e.g. *Pelicanus/ Phalacrocoracidae* (Pelican/ Cormorant)
- d) Shore birds and wading birds, e.g. *Scolopacidae* (Sandpiper), *Ardeola grayii* (Pond heron)
- e) Birds of prey, e.g. *Strigiformes* (Owl), *Accipitriformes* (Eagle)

3.3: Class Mammalia

3.3.1: General overview, classification, characteristics and salient features (habitat types, feeding habits, taxonomical differences) of orders: Monotremata, Marsupialia and Placentalia

3.3.2: Examples of each order in accordance to groups:

- a) Egg-laying mammals, e.g. *Ornithorhynchus anatinus* (Duck-billed platypus)
- b) Pouched mammals, e.g. *Macropus* (Kangaroo)
- c) Insect eating mammals, e.g. *Sorex araneus* (Common shrew)
- d) Toothless mammals, e.g. *Folivora* (Sloth)
- e) Gnawing mammals, e.g. *Sciuridae* (Squirrel)
- f) Aquatic mammals, e.g. *Delphinus* (Dolphin)
- g) Primates, e.g. *Lemuroidea* (Lemur); *Lorisidae* (Slow and Slender Loris)

Unit 4: Type study: Shark

Lectures 15

4.1:

Habit and habitat, distribution, external characters, classification and economic importance

4.2:

Skin, exoskeleton, endoskeleton, digestive system, respiratory system, blood vascular system, nervous system, receptor organs, urinogenital system, copulation, fertilization and development

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Semester VI – Theory

Paper Code: SIUSZO62

Enzymology, Homeostasis, Histology, General Pathology

Learning Objectives

- *To study enzymes, the biocatalysts in living systems and to know about their application in medicine and industry.*
- *To familiarize with the concept of 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 1: Enzymology

Lectures 15

1.1:

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

1.2:

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

1.3:

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

1.4:

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

1.5:

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

1.6:

Clinical significance and industrial application of enzymes

Unit 2: Homeostasis (Temperature and Ionic regulation)

Lectures 15

2.1: Homeostasis

External and internal environment; Acclimation and acclimatization

Control systems in biology: Feedback mechanisms – Negative feedback and positive feedback mechanisms and examples of each

2.2: 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

2.3: 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

Unit 3: Histology

Lectures 15

3.1: Vertical section (V.S.) of skin

Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors

3.2: Digestive System

3.2.1: Vertical section (V.S.) of tooth – Hard tissue – Dentine and enamel; Soft tissue – Dentinal pulp and periodontal ligaments

3.2.2: Transverse section (T.S.) of tongue – Mucosal papillae and taste buds

3.2.3: Alimentary canal – Basic histological organization with reference to transverse section (T.S.) of oesophagus, stomach, duodenum, ileum and rectum of mammal

3.2.4: Glands associated with digestive system – Histology with reference to transverse section (T.S.) of salivary glands, liver, pancreas

3.3: Respiratory system

Respiratory organs – Transverse section (T.S.) of trachea and lungs

Unit 4: General Pathology

Lectures 15

4.1: Infectious diseases

Aetiology; infectious agents: viruses – hepatitis, bacteria – tuberculosis, fungi – skin diseases

4.2: Retrogressive changes

Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)

4.3: Disorders of pigmentation

Endogenous: Normal process of pigmentation, melanosis, jaundice (causes and effects)

4.4: Necrosis

Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid

4.5: Gangrene

Definition and types – Dry, moist and gas gangrene

4.6: Circulatory disturbances

Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Oedema and Infarction

4.7: Inflammation

Definition and causes (pathogenic and immune); cardinals of inflammation; acute and chronic inflammation

4.8: Applied pathology

Anatomical, clinical and molecular; investigating methods: biopsy and surgery (for pathological examination of tissue)

4.9: 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

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Semester VI – Theory

Paper Code: SIUSZO63

Zoogeography, Toxicology, Biostatistics, Bioinformatics

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.*
- *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 Biostatistics as an important tool for data analysis.*
- *To introduce Bioinformatics – a computational approach to learning the structure and organization of genomes, phylogeny, metabolism and immunology.*

Unit 1: Zoogeography

Lectures 15

1.1: Introduction

- 1.1.1: Origin of oceans and continents
- 1.1.2: Plate tectonics and continental drift

1.2: Distribution of animals in space and time

- 1.2.1: In space – Horizontal or superficial
- 1.2.2: In time – Geological or durational
- 1.2.3: Patterns of animal distribution – Continuous, discontinuous, isolation and bipolarity
- 1.2.4: Theories of animal distribution

1.3: Barriers of distribution of animals

- 1.3.1: Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habits like homing instinct
- 1.3.2: Means of dispersal – Land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies

1.4: Zoogeographical Realms

Palaearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic

Unit 2: Toxicology

Lectures 15

2.1: Basic Toxicology

- 2.1.1: Introduction to toxicology – History, different areas of toxicology, principles and scope of toxicology
- 2.1.2: Toxins and Toxicants – Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins), Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom)
- 2.1.3: Characteristics of Exposure – Duration of exposure, frequency of exposure, site of exposure and routes of exposure

2.1.4: Types of toxicity – Acute toxicity, subacute toxicity, subchronic toxicity, chronic toxicity, immediate toxicity, delayed toxicity, reversible toxicity, irreversible toxicity, local toxicity, systemic toxicity

2.1.5: Concept of LD₅₀, LC₅₀, ED₅₀

2.1.6: Dose Response relationship – Individual/ Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety

2.1.7: Dose translation from animals to human – Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)

2.2: Regulatory Toxicology

2.2.1: OECD guidelines for testing of chemicals (an overview)

2.2.2: CPCSEA guidelines for animal testing centre, ethical issues in animal studies

2.2.3: Animal models used in regulatory toxicology studies

2.2.4: Alternative methods in toxicology (*in vitro* tests)

Unit 3: Biostatistics

Lectures 15

3.1: Probability Distributions

Normal, Binomial and Poisson distribution; Z-transformation, p-value

Probability: Addition and multiplication rules and their applications

3.2: Measures of Central Tendency and Dispersion

Variance, standard deviation, standard error

3.3: Parametric and non-parametric tests

Parametric tests: Two-tailed Z-test and t-test

Non-parametric test: Chi-square test and its applications

3.4: Regression and Correlation

Simple linear regression: Main features, applications

Correlation coefficient and its significance

3.5: Testing of Hypothesis

Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis

Levels of significance and testing of hypothesis

Unit 4: Bioinformatics

Lectures 15

4.1: Introduction

4.1.1: Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, ExPASy, OMIM, PubMed, OMIA)

4.1.2: Applications of Bioinformatics

4.2: Databases – Tools and their uses (Biological databases)

4.2.1: Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ); Protein sequence databases (UniProt, KB, PIR, PDB)

4.2.2: Secondary sequence databases: Derived databases – PROSITE, BLOCKS, Structure databases and bibliographic databases

4.3: Sequence alignment methods

4.3.1: BLAST, FASTA

4.3.2: Significance of sequence alignment

4.3.3: Pairwise sequence alignment

4.3.4: Multiple sequence alignment (CLUSTALW)

4.4: Predictive applications using DNA and protein sequences

4.4.1: Evolutionary studies: Concept of phylogenetic trees, Parsimony and Bayesian approaches, synonymous and non-synonymous substitutions, convergent and parallel evolution

4.4.2: Pharmacogenomics: Discovering a drug – Target identification

4.4.3: Metabolomics: Concept and applications

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Semester VI – Theory

Paper Code: SIUSZO64

Environment and Wildlife Management, Bioethics, Bioprospecting and Zoopharmacognosy, General Entomology

Learning Objectives

- *To understand the different factors affecting environment, their impact and laws governing environmental management.*
- *To understand the importance of wildlife conservation.*
- *To introduce the concept of ethics and prospecting in Biology and the importance of pharmacognosy.*
- *To understand the role of useful and harmful insects in human life.*

Unit 1: Environment Management

Lectures 15

1.1: Natural resources and their classification

Forest resources, water resources (surface and ground), mineral resources, food resources, energy resources: Renewable and non-renewable resources

1.2: Exploitation and modification of natural resources

Impact on climate, flora, fauna and mineral resources

1.3: Sustainable development

Ex situ conservation (zoos, botanical gardens, cryogenics, seedbank, germplasm, gene bank);
In situ conservation (Bioreserves, Sanctuaries and National parks)

1.4: Waste Management

3 Rs (Reduce, Reuse and Recycle) of solid waste, e-waste, hazardous waste

1.5: Water management

Rain water harvesting, watershed management, effluent treatment, recycling plants, control and treatment of water

1.6: Laws governing environment

Environment Protection Act, Air Prevention and Control of Pollution Rules – 1982, Water Prevention and Control of Pollution Rules – 1978, Hazardous Wastes Management and Handling Rules – 1989, EIA (Environmental Impact Assessment), ISO18001, Role of government, NGOs, International treaties and conventions in environmental protection and conservation

Unit 2: Wildlife Management

Lectures 15

2.1: Habit, habitat, territory and niche of animals

Herbivores, carnivores; solitary, pack and herd

2.2: Threats to Wildlife

Diseases (zoonosis and reverse zoonosis), competition, hunting, poaching, encroachment, deforestation, tourism, overgrazing, human animal conflict and climate change

2.3: Techniques and methods of Wildlife Conservation

Wildlife Census, conservation of Wildlife – Frozen zoo, schedules, rules, national and international conservation bodies: IUCN, UNDP, FAO, ESA, INCPEN, CITES, CEEDS, WWF

Unit 3: Bioethics, Bioprospecting and Zoopharmacognosy

Lectures 15

3.1: Bioethics

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

3.2: Bioprospecting

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

3.3: Zoopharmacognosy

3.3.1: Definition, history and types

3.3.2: Self-medication and its mechanism

3.3.3: Methods of self-medication through – Ingestion: ants and mammals, Geophagy
invertebrates and birds

3.3.4: Absorption and adsorption

3.3.5: Topical application – Birds and mammals

3.3.6: Applications of Zoopharmacognosy – Social and transgenerational zoopharmacognosy

3.3.7: Value to humans

Unit 4: General Entomology

Lectures 15

4.1: Introduction and Scope of Entomology

Agricultural, Medical, Forest, Forensic and Industrial

4.2: Mouth parts of insects

Bitting and chewing type, e.g. Cockroach

Chewing and lapping type, e.g. Honey bee

Piercing and sucking type, e.g. Mosquito

Sponging type, e.g. Housefly

Siphoning type, e.g. Butterfly

4.3: Development of insects (Metamorphosis)

Types and hormonal control of metamorphosis

4.4: Insect pheromones, bioluminescence and sound production

Definition, types, significance

4.5: Economic significance of insects

4.5.1: Beneficial insects (study w.r.t. composition and uses of insect products), e.g. Honey bee, silk moth, lac insect

4.5.2: Insect pests of plants (study w.r.t. damage and control measures), e.g. Bollworm, rice weevil, flour moth, locust

4.5.3: Insect pest of man/ medical pest/ insect vector (study w.r.t. damage and control measures), e.g. Housefly

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Semester VI – Practical (SIUSZOP61)

Practical I based on SIUSZO61

1. Levels of Organization: Minor Phyla

- a) Acoelomate: Phylum Acanthocephala (Spiny-headed worms), e.g. *Echinorhyncus*
- b) Coelomate: Phylum Chaetognatha (Arrow worms), e.g. *Sagitta*

2. Taxonomy of Phylum Chordata

a) Subphylum Urochordata (Sea squirts):

- 1. Class Larvaceae, e.g. *Oikopleura*
- 2. Class Ascidiacea, e.g. *Ciona/ Herdmania*
- 3. Class Thaliacea, e.g. *Salpa/ Doliolum*

b) Subphylum Cephalochordata:

Class Leptocardii, e.g. *Branchiostoma (Amphioxus)*

c) Subphylum Vertebrata:

I. Group Agnatha:

- 1. Class Ostracodermi, e.g. *Pharyngolepis*
- 2. Class Cyclostomata, e.g. *Petromyzon*

II. Group Gnathostomata:

i. Superclass - Pisces:

- 1. Class Placodermi (Armoured fishes), e.g. *Bothriolepis*
- 2. Class Elasmobranchi (Chondrichthyes), e.g. *Rhinobatos*
- 3. Class Holocephali (Chimaera), e.g. Rabbit fish/ Rat fish
- 4. Class Dipnoi (Lung fishes), e.g. *Protopterus* (African lungfish)
- 5. Class Teleostomi, e.g. *Latimeria* (Coelacanth), Catfish

ii. Superclass - Tetrapoda:

A) Class Amphibia:

- a) Order Apoda, e.g. *Siphonops/ Ichthyophis*
- b) Order Anura, e.g. *Alytes* (Midwife toad)
- c) Order Urodela, e.g. Triton (Semi-aquatic salamander)

B) Class Reptilia:

- a) Order Synapsida, e.g. *Dimetrodon*
- b) Order Parapsida, e.g. *Chasmosaurus* (Dinosaur)
- c) Order Anapsida, e.g. *Geochelone* (Indian star tortoise)
- d) Order Diapsida, e.g. *Mabuya* (Skink)

C) Class Aves:

- a) Subclass Archaeornithes, e.g. *Archaeopteryx*

- b) Subclass Neornithes
- Superorder Paleognathae (Flightless birds), e.g. Emu, Penguin
- Superorder Neognathae (Flying birds), e.g. Flamingo, Vulture

D) Class Mammalia:

- a) Subclass Prototheria (Egg-laying mammals), e.g. Duck-billed platypus
- b) Subclass Theria
- Infraclass – Metatheria (Marsupials/ Pouched mammals), e.g. *Dasyurus* (Tiger cat)
- Infraclass – Eutheria (Placental mammals), e.g. Gangetic dolphin, Gorilla

3. Study of endoskeleton of shark:

- a) Axial (skull and vertebral column)
- b) Appendicular (pelvic and pectoral fins, pelvic and pectoral girdles)

Note: Visit a local fish market, local zoo or other places/ institutes of educational value to study available vertebrates.

Semester VI – Practical (SIUSZOP62)

Practical II based on SIUSZO62

1. Effect of pH on activity of enzyme Acid Phosphatase.
2. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase.
3. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase.
4. Effect of inhibitor (drug as an enzyme inhibitor) on activity of enzyme Acid Phosphatase.
5. Study of separation of LDH isozymes by agarose gel electrophoresis.
6. To study the effect of enzymes (and/ drugs) in detergents.
7. 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
8. Identification of following diseases or conditions (from slides or pictures):
Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis
9. Vidal's Test
10. Study and interpretation of pathological reports: Blood, urine and stool (faeces).

Semester VI – Practical (SIUSZOP63 + SIUSZOP64)

Practicals III and IV based on SIUSZO63 and SIUSZO64

1. To estimate phosphate phosphorus from water sample.
2. To estimate BOD from water sample.
3. To estimate COD from water sample.
4. To estimate nitrite nitrogen and nitrate nitrogen from water sample.
5. To study the intensity of sound by Decibel meter and prepare a survey report.
6. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein.
7. To study the effect of CCl_4 on the level of enzyme activity of aspartate and alanine amino transferase in liver (*in vitro* approach).
8. To study the effect of paracetamol on the level of enzyme activity of aspartate and alanine amino transferase in liver (*in vitro* approach).
9. Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) and manually:
 - a. From the given data derive mean, standard deviation
 - b. Correlation, regression analysis using given data
 - c. Problems based on Z test
 - d. Problems based on t test
 - e. Problems based on Chi square test
 - f. Problems based on ANOVA
10. Exploring the integrated database system at NCBI server and querying:
Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT).
11. Exploring tools on ExPASy:
Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT).
12. Exploring BLAST tool (nucleotide sequence comparison).
13. Exploring Uniprot tool (protein sequence comparison).
14. Exploring bibliographic database PubMed: Data mining – Downloading a research paper on the subject of interest, use of operators (AND, OR & NOT)

15. Indicate the distribution of genus/ species/ subspecies in the given world map w.r.t. to its realm and comment on the pattern of distribution.

16. Indicate the realms and the fauna found in that realm on the given world map; justify.

**Practical Pattern with Project Component
(For students opting for 6 units of Zoology)**

Practical Pattern for Semester V

Course Code	Practical	Marks
SIUSZOP51	Practicals based on SIUSZO51 (Paper I)	50
SIUSZOP52	Practicals based on SIUSZO52 (Paper II)	50
SIUSZOP53 + SIUSZOP54	Practicals based on SIUSZO53 and SIUSZO54 (Papers III and IV)	50
	Project component * (for details refer to the note below)	50
		Total = 200

Details of Project component* for Semester V are as follows:

1. In Semester V, students will submit an outline/ scheme of the project proposal.
2. Actual execution/ practical work of this project is to be done in semester VI. But taking into account the short duration of Semester VI, the preliminary work can start in Semester V.
3. A teacher from the department will act as a project mentor to a group of students (not more than five students in a group).
4. It will be the duty of the mentor to assign to the group a topic related to a particular theme covered in the UG syllabi/ interdisciplinary topics. For example, if the common theme for a group is 'Hydrology', then within this group, each student will present a project proposal based on different parameters of hydrology (such as one student doing a study involving dissolved oxygen and carbon dioxide; whereas another student doing a study involving phosphates and silicates).
6. The mentor will prepare, guide and supervise the group by giving orientation/ instructions about writing the project proposal.
7. The outline/ scheme of the project proposal will include literature search/ survey, introduction, objectives, purpose and rationale, materials and methods, expected outcomes/ results, relevance of the project and bibliography.
8. The student will prepare a hard copy of the project proposal which will have titles discussed as above.

Evaluation of Project Proposal during practical examination for Semester V will be as follows:

1. Although the students would have prepared the project proposal as a group in Semester V, they are expected to submit the project proposal individually.
2. Each student will submit a project proposal (hard copy) during practical examination.

3. The soft copy of this project proposal can be kept in the department for documentation and record.

4. The project proposal will be evaluated by **internal examiner** (preferably the mentor) as per the evaluation criteria given below:

Title	Marks
Literature search/ survey	04
Objectives, Purpose and Rationale	04
Materials and Methods	04
Expected outcome/ hypothesis	03
Work plan with milestones/ timeline	03
Overall approach and conduct	07
Total	25

5. The project proposal will also be evaluated by **external examiner** as per the evaluation criteria given below:

Title	Marks
Literature search/ survey	04
Objectives, Purpose and Rationale	04
Materials and Methods	04
Expected outcome/ hypothesis	03
Bibliography	03
Viva voce based on the proposal	07
Total	25

Practical pattern for Semester VI

Course Code	Practical	Marks
SIUSZOP61	Practicals based on SIUSZO61 (Paper I)	50
SIUSZOP62	Practicals based on SIUSZO62 (Paper II)	50
SIUSZOP63 + SIUSZOP64	Practicals based on SIUSZO63 and SIUSZO64 (Papers III and IV)	50
	Project component * (for details refer to the note below)	50
		Total = 200

Details of Project component* for Semester VI are as follows:

1. In semester VI students will actually execute their respective project submitted in Semester V. However, it should be noted that due to the constraints of the shorter duration of Semester VI, the preliminary/ pilot work should have commenced in Semester V.
2. Actual execution may involve laboratory/ table work and/ or field work and/ or survey (the approach for the project work can be *in vitro/ in vivo/ in silico*, among others) as per the specifications mentioned in their project proposal.
3. The mentor for the respective group will keep a track of the actual execution of the project.
4. After completion of the practical work the student will prepare a '**Dissertation**' which will have an abstract/ synopsis, brief introduction, materials and methods, observations, interpretation of results, conclusion and discussion, future plans/ extension of work.
5. The student will also give a '**Power point presentation**' about the project (not more than 7 slides and not more than 7 minutes per presentation).

Evaluation of Project Proposal during practical examination for Semester VI will be as follows:

1. The external examiner will evaluate the '**Dissertation**' carrying **30** marks as per the evaluation criteria given below:

Title	Marks
Abstract/ synopsis	05
Materials and Methods	05
Observations	05
Interpretation of results	05
Conclusion and Discussion	05
Relevance of work	05
Total	30

2. The external examiner will evaluate the ‘**Power point presentation**’ carrying **20** marks as per the evaluation criteria given below:

Title	Marks
Content of the presentation	05
Quality of the presentation	05
Presentation skills	05
Viva/ Question-Answer session	05
Total	20

**Practical Examination Question Paper Pattern
Semester V – Practical (SIUSZOP51)**

Practical I based on SIUSZO51

Time: 5 hours

Marks: 50

Q.1 Identify and describe	06
a) Identify and describe w.r.t. levels of organization	
b) Identify and classify giving reasons	
Q.2 Identify and describe w.r.t. phylogeny and adaptations	12
a) Protozoa/ Porifera/ Cnidaria	
b) Platyhelminthes/ Nematelminthes	
c) Annelida/ Arthropoda	
d) Mollusca/ Echinodermata	
Q.3 Identify and describe w.r.t. phylogeny and adaptations Hemichordata	03
Q.4 Identify and describe	09
a) Locomotion/ Reproduction in Protozoa	
b) Canal system in Sponges/ Metamorphosis in insects	
c) Spicules in sponges/ Planktonic crustaceans	
Q.5 Field report and viva based on theory paper	10
Q.6 Journal	10

**Practical Examination Question Paper Pattern
Semester V – Practical (SIUSZOP52)**

Practical II based on SIUSZO52

Time: 5 hours

Marks: 50

Q.1 Enumeration of erythrocytes – Total count	15
OR	
Q.1 Enumeration of leucocytes – Total count	
OR	
Q.1 Differential count of leucocytes	
Q.2 Estimation of serum/plasma total proteins by Folin’s method	10
OR	
Q.2 Estimation of serum/plasma total triglycerides by Phosphovanillin method	
OR	
Q.2 Determination of serum LDH	
Q.3 Estimation of haemoglobin by Sahli’s acid haematin method	10
OR	
Q.3 Estimate Erythrocyte Sedimentation Rate by suitable method	
Q.4 Latex agglutination test – Rheumatoid Arthritis	05
OR	
Q.4 Slide test for pregnancy	
Q.5 Viva	05
Q.6 Journal	05

**Practical Examination Question Paper Pattern
Semester V – Practical (SIUSZOP53 + SIUSZOP54)**

Practicals III and IV based on SIUSZO53 and SIUSZO54

Time: 5 hours

Marks: 50

- Q.1** Isolation and estimation of RNA by Orcinol method. **15**
OR
Q.1 Isolation and estimation of DNA by Diphenylamine method.
OR
Q.1 Trypsinization and vital staining using Trypan blue stain.
- Q.2** Separation of proteins by SDS-PAGE from the given sample. **10**
OR
Q.2 Demonstrate packaging of glassware for sterilization and demonstrate transfer of liquids between burners aseptically.
OR
Q.2 Make a temporary mounting of chick embryo and identify the age of the embryo by Hamilton-Hamburg method.
- Q.3** Problems in genetics (Idiogram – 2 marks; Calculations – 3 marks) **05**
- Q.4** Identification **15**
a) Based on histology
b) Based on histology
c) Based on osteology – human axial skeleton
d) Based on osteology – human appendicular skeleton
e) Based on osteology – human axial/ appendicular skeleton
- Q.5** Submission of report (based on human traits following Mendelian Inheritance) **05**

**Practical Examination Question Paper Pattern
Semester VI – Practical (SIUSZOP61)**

Practical I based on SIUSZO61

Time: 5 hours

Marks: 50

- Q.1** Identify and describe **06**
a) Identify, classify and describe
(Any one example from Urochordates/ Cephalochordates/ Ostracodermi/ Cyclostomata/ Minor Phyla)
b) Identify and classify giving reasons (Any one example from Superclass Pisces or Tetrapoda)
- Q.2** Identify and describe w.r.t. phylogeny and adaptations **15**
a) Pisces
b) Amphibia/ Reptilia
c) Aves/ Mammalia
- Q.3** Identify, sketch and label/ Identify and label marked portion in the given diagram **09**
a) Skull or vertebra of shark
b) Fin of shark (Pectoral/ Pelvic)
c) Girdle of shark (Pectoral/ Pelvic)
- Q.4** Field report and viva based on it **10**
- Q.5** Journal and viva based on theory **10**

**Practical Examination Question Paper Pattern
Semester VI – Practical (SIUSZOP62)**

Practical II based on SIUSZO62

Time: 5 hours

Marks: 50

Q.1 Demonstrate the effect of _____ on the activity of Acid phosphatase **15**
(Substrate concentration/ pH variation/ Enzyme concentration/ Inhibitor concentration)

Q.2 Study of separation of LDH isozymes by agarose gel electrophoresis. **10**

OR

Q.2 To study the effect of enzymes in detergents.

OR

Q.2 Perform Vidal test and give the clinical significance of the result.

Q.3 Identify and describe a, b, c, d, e (3 marks each) **15**

a) and b) Mammalian tissues: V.S. of Skin, V.S. of Tooth, T.S. of Stomach, T.S. of Ileum, T.S. of Liver, T.S. of Pancreas, T.S. of Lung

c) and d) Diseases or conditions (from slides or pictures): Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis

e) Interpret the pathological report of blood/ urine/ stool

Q.4 Viva **05**

Q.5 Journal **05**

Practical Examination Question Paper Pattern
Semester VI – Practical (SIUSZOP63 + SIUSZOP64)

Practicals III and IV based on SIUSZO63 and SIUSZO64

Time: 5 hours

Marks: 50

Q.1 Demonstrate the effect of CCl₄ on the level of enzyme activity of aspartate/ alanine amino transferase in liver (*in vitro* approach). **15**

OR

Q.1 Demonstrate the effect of paracetamol on the level of enzyme activity of aspartate/ alanine amino transferase in liver (*in vitro* approach).

Q.2 Estimate Phosphate Phosphorus/ Nitrite Nitrogen and Nitrate Nitrogen/ acidity/ alkalinity /COD/ BOD from sample water. **10**

OR

Q.2 Using Bioinformatics tools, explore the given DNA/ protein sequences.

Q.3 Indicate the distribution of genus/ species/ subspecies in the given world map w.r.t. to its realm and comment on the pattern of distribution. **05**

OR

Q.3 Indicate the realms and the fauna found in that realm on the given world map; justify.

Q.4 Problems in Biostatistics **06**

Q.5 Identification **06**

- a) Types of mouthparts
- b) Types of metamorphosis
- c) Identify and describe w.r.t. economic importance of insects

Q.6 **08**

- a) Report (based on sound/ noise measurements using sound meter) **02**
- b) Excursion report **03**
- c) Journal **03**

**T. Y. B. Sc. Zoology Syllabus (Autonomous)
Credit Based Semester and Grading System
(With effect from academic year 2018-19)**

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 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 5th 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
