AC/26.4.25/RS 1

College of Arts, Science & Commerce (Empowered Autonomous)

SIES

RISE WITH EDUCATION

NAAC REACCREDITED "A" GRADE

(*Empowered Autonomous*)

Faculty: SCIENCE

Program: T.Y.B.Sc

Subject: ZOOLOGY

Academic Year: 2025 – 2026

Revised Syllabus in Zoology
(As per National Education Policy)
under Choice Based Credit System (CBCS)
Approved by the Board of Studies in Zoology
Effective from Academic Year 2025 – 2026

Preamble

"Where the mind is without fear and the head is held high …."

The line is quoted from Nobel Laureate Rabindranath Tagore poem, which was his vision of a new and awakened India, it is mentioned here in the context of implementation of National Education Policy (NEP) in our institution. Our institution was one of the lead colleges, affiliated to University of Mumbai in implementing India's National Education Policy 2020 (NEP 2020) in academic year 2023-24. Moreover, we were also conferred with 'Empowered Autonomous Status' in 2023-24, which became all the more relevant, in terms of our contribution as an educational institution to fulfil the visionary and transformative objectives of National Education Policy. Although, under the aegis of academic autonomy, our institution has the privilege of 'academic freedom', however, we are also aware of the fact that 'freedom' comes with 'responsibility' and moreover, it needs to be justified with 'academic excellence'. Therefore, one of the ways to achieve this, is through restructuring and refining the curriculum, which is pivotal in shaping the educational outcomes of an academic institution. Thus, a modest attempt has been made to design an effective syllabus that will preserve the essence of the subject, besides inculcating critical thinking and attempting holistic development of students.

It is essential to note that under NEP pattern, there are students, who have opted for Zoology as a Major subject (subject of main focus) while choosing Chemistry, Biochemistry, Botany, Microbiology as their Minor subject; whereas there are few students who have chosen Zoology as a Minor subject (to gain broader understanding beyond their other subjects mentioned above chosen as Major subject). In terms of academics, it means that, students opting for Zoology as a Major subject will be studying more courses/papers and acquire more credits in comparison to students who have chosen Zoology as a Minor subject.

The current revised syllabus under NEP attempts to integrate along with the main/core courses in Zoology, few other courses such as Vocational Skill Course (VSC), Department Specific Elective (DSE), Field Project (FP), and On Job Training (OJT) or Internship with the rationale to encourage critical thinking, and equip students with the necessary skills in order to make them self-sufficient and also employable, Moreover, it will also inculcate interdisciplinary approach amongst student's besides facilitating holistic development of students.

The key topics from the Major Course of Zoology are as follows –

- ✓ *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.*
- ✓ *Developmental Biology and Animal Tissue culture – to understand the transformation of a single cell into a complex organism through molecular, genetic, and cellular processes; to understand culture media and animal tissue cultures facilities, relevance of biosafety guidelines while working on mammalian cells under in vitro conditions, 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.*
- ✓ *Endocrinology and Homeostasis & Regulation – to get insights of the mammalian endocrine system, to study the mechanism of hormone action and its role in homeostasis and regulation.*
- ✓ *Haematology and Immunology – to make students aware about a branch of medicine concerned with the study, diagnosis, treatment, and prevention of diseases related to the blood, and to know about the different diagnostic techniques; to acquaint with the body's defence system and its combat against intruders, invading pathogens, to apply this knowledge in medical science in vaccination, organ transplant and tumour treatment.*
- ✓ *Toxicology, Pathology & Epidemiology – to introduce the principles of Toxicology with emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing; to understand the relevance of toxicity studies and regulatory guidelines, ethics in animal studies, alternatives to animal models; to introduce basics of Pathology for understanding retrogressive, necrotic, circulatory, pathological conditions in the body; to create awareness through scientific, systematic and data-driven study of frequency and pattern of distribution and causes with risk factors of health-related diseases, and events in specified populations.*
- ✓ *Molecular Biology and Genetic Engineering – to unfold the beauty and wonder of DNA – the master molecule in cells encoding heritable information, and RNA – the molecular bridge between this information and proteins; to understand the magnitude of damage due to alterations in DNA molecule and to appreciate the importance of DNA repair mechanisms, to get acquainted with the vast array of techniques used to manipulate genes which can be applied in numerous fields like medicine, research, etc. for benefit of mankind.*
- ✓ *Bioprospecting & Zoopharmacognosy – to understand the novel science of animal self-medication for a curious eye, to observe animal behaviour in the wild.*
- ✓ *Department Specific Elective – inclusive of Clinical Embryology, Basic Concepts in Research, Biodiversity & Conservation, Genetic Counselling, Wildlife conservation & Management, Animal behaviour*
- ✓ *Vocational Skill Course in Ornamental Fishery – A course, which is aimed at providing hands-on training, competencies, proficiency to students to enhance their skills & employability.*
- ✓ *On Job Training / Industry Internship – A course requiring students to participate in a professional activity or work experience, with an entity external to the educational institution. Internship will involve working with local industry, government or private organizations, etc. to provide opportunities for students to actively*

engage in on-site experiential learning. Moreover, it will also strengthen academia- industry linkage and increase employability of students.

- ✓ *Field Project (FP): Course requiring students to participate in field-based learning or projects to study actual field situations regarding issues related to socio-economic development in rural and urban settings.*

This revised syllabus is a collective and constructive effort of the faculty, experts from research institutions, alumni and the board members whose valuable suggestions and expertise were instrumental in materializing this syllabus. The comments and recommendations of the contributors and reviewers have been carefully considered and incorporated wherever feasible. For effective teaching-learning, teachers are advised not to follow the syllabus too rigidly, but to exercise their professional discretion and judgment in implementing it. After all teaching is also about creating a conducive environment for learners to sustain enthusiasm about the subject. We sincerely hope that all stakeholders from faculty to learners exploring this course will appreciate the importance of a well-designed curricular framework in shaping educational outcomes.
In conclusion, we hope this syllabus will encourage and maximize learning among students to develop open, inquiring minds for holistic development, thereby justifying the essence and spirit of National Education Policy.

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T.Y.B.Sc. Syllabus (Autonomous) in the Subject of Zoology
Choice Based Credit System (CBCS)
As per National Education Policy
(With effect from Academic Year 2025-26)

Grid of Syllabus – Semester V (*Course Type: Major-MJ*)

Theory					
Course Code	**Course Category**	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
SIUZOMJ311	Major 1	I	Comparative Chordate Anatomy - I	3	15
		II	Developmental Biology		15
		III	Endocrinology		15
SIUZOMJ312	Major 2	I	Haematology	3	15
		II	Immunology - I		15
		III	Molecular Biology - I		15
SIUZOMJ313	Major 3	I	Animal Tissue Culture	3	15
		II	Genetic Engineering		15
		III	Epidemiology		15
SIUZOEL311	Elective	I	Clinical Embryology	3	15
		II	Basic Concepts in Research		15
		III	Biodiversity and Conservation		15
SIUZOVS311	Vocational Skill Course (VSC)	**Course Name:** Ornamental Fishery		1	15
Practical					
		Course Name			
SIUZOMJP311	Practical in Major 1	Practicals based on SIUZOMJ311		1	15
SIUZOMJP312	Practical in Major 2	Practicals based on SIUZOMJ312		1	15
SIUZOMJP313	Practical in Major 3	Practicals based on SIUZOMJ313		1	15
SIUZOELP311	Practical in Elective	Practicals based on SIUZOEL311		1	15
SIUZOVS311		Practicals based on Ornamental Fishery		1	15

Grid of Syllabus – Semester VI (*Course Type: Major-MJ*)

Theory					
Course Code	**Course Category**	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
SIUZOMJ321	Major 1	I	Comparative Chordate Anatomy - II	3	15
		II	General Pathology		15
		III	Toxicology		15
SIUZOMJ322	Major 2	I	Applied Haematology	3	15
		II	Immunology - II		15
		III	Molecular Biology - II		15
SIUZOMJ323	Major 3	I	Enzymology	3	15
		II	Homeostasis and regulation		15
		III	Bioprospecting and Zoopharmacognosy		15
SIUZOEL321	Elective	I	Genetic Counselling	3	15
		II	Wildlife Conservation and Management		15
		III	Animal Behaviour		15
Practical					
		Course Name			
SIUZOMJP321	Practical in Major 1	Practicals based on SIUZOMJ321		1	15
SIUZOMJP322	Practical in Major 2	Practicals based on SIUZOMJ322		1	15
SIUZOMJP323	Practical in Major 3	Practicals based on SIUZOMJ323		1	15
SIUZOELP321	Practical in Elective	Practicals based on SIUZOEL321		1	15

SEMESTER V – THEORY

Course Name: Comparative Chordate Anatomy, Developmental Biology, Endocrinology
Course Code: SIUZOMJ311

Learning Objectives:

- To gain insight into chordate diversity and trace evolutionary relationships across different chordate groups by studying variations/ functional modifications in the basic anatomical structures, in this case, of the integumentary, digestive and circulatory systems.
- To analyse mechanisms of animal development to understand animal life at the molecular, cellular, and genetic levels; to investigate cancer biology.
- To understand the mammalian endocrine system and its function in homeostasis by a detailed study of endocrine glands and their hormones.

Unit	Course Outcome (CO)
Unit I: Comparative Chordate Anatomy - I	**CO1:** Through the comparative approach students will be able to relate how the structural features in different chordate groups are changed to suit their functioning in diverse environments, and understand the underlying evolutionary mechanism in chordates by anatomical study. It holds indirect application in human welfare through furthering in animal research.
Unit II: Developmental Biology	**CO2:** Realise the significance of studying developmental processes to understand abnormalities and diseased conditions like cancer, to advance/ improve in human health care.
Unit III: Endocrinology	**CO3:** Identify the major endocrine glands and learn about their location, working, and physiological effects of their chemical messengers-the hormones. Appreciate the intricate functioning of mammalian endocrine system in controlling/ regulating vital body processes as metabolism, growth and homeostasis, and realise how any imbalances affect the body through the disorders manifested. Insights into clinical significance of the endocrine system.

Unit I: Comparative Chordate Anatomy - I **15 Lectures**

1.1. Introduction to comparative chordate anatomy.

1.2. Structure of Integument and its derivatives

General structure of integument.

Comparative study of skin in different classes of vertebrates.

Study of derivatives of skin: epidermal derivatives, dermal derivatives and special derivatives.

1.3. Digestive System

Evolution of the digestive tube. Primary divisions of the tube.

Tooth structure and position; Teeth in different classes of vertebrates.
Morphology of gut wall.
Comparative study of Esophagus, Stomach and Intestine in chordates.

1.4. 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.

Unit II: Developmental Biology **15 Lectures**

2.1. Types of Placentae

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

2.2. Developmental Strategies

Sexual reproduction and metamorphosis; Apoptosis and its role in development.

2.3. Morphogenesis

Fate maps; Cell differentiation; Embryonic stem cells; Differential cell affinity; Cell adhesion; Morphogenetic movements; Induction and competence; Epithelial-mesenchymal interaction.

2.4. Cancer

Hallmarks of cancer; Types of cancer; Causes of cancer; Oncogenes; Tumour suppressor genes; Cell signaling in cancer. Precision medicine.

Unit III: Endocrinology **15 Lectures**

3.1. General organization

Mammalian Endocrine System.

3.2. Hormones

Classification, properties, mechanism of hormone action, hormone secretion and transport.

3.3. Endocrine glands

Histology, functions and disorders of:
Pituitary gland, Pineal gland, Thyroid gland, Parathyroid gland, Pancreas, Adrenal gland.

3.4.

Causes and Symptoms of *Madhumeha*
Hridaya (Heart) and *Dhamani* (Arteries): *Hridroga* (Heart Disease) and *Shira* (Head) linked to blood pressure.
Raktavahini (Blood circulation) and its disorders: *Srotorodha* (Blockages).
Nidana (Aetiological factors): *Lavana* (Excess salt intake), intake of alcohol, lifestyle.

Course Name: Haematology, Immunology, Molecular Biology
Course Code: SIUZOMJ312

Learning Objectives:

- Learn the functions, physical characteristics and composition of blood.
- Explain the origin of blood cells, and describe the structure, function and clinical significance of these formed elements.
- Understand the processes of blood clotting and blood typing, and explain their clinical significance.
- Explore the body's defence system – the immune system, through its historical perspective; distinction of its components (innate immunity and acquired immunity); comparing and contrasting the structure and function of the cells and organs of the immune system; describing antigen and antibody, explaining the relation of the two and its application in diagnostic tests.
- Explain the central dogma of molecular biology to learn about the roles of macromolecules – DNA and RNA in dissemination of the genetic information; insights into early research/ experiments to unveil the nature and properties of genetic material; compare the control of gene expression in prokaryotes and eukaryotes.

Unit	Course Outcome (CO)
Unit I: Haematology	**CO1:** Comprehensive understanding of blood as a circulating fluid with its myriad roles contributing to homeostasis; and a wonder fluid that can be actually analysed to determine health status and diagnose multitude of infections/ diseases. Build foundation of haematology for applicability in paramedical courses as DMLT (Diploma in Medical Laboratory Technology), etc.
Unit II: Immunology - I	**CO2:** Knowledge about the body's disease resistance and defensive ploys to remain healthy, by an introductory course of immunology with implications in medical science.
Unit III: Molecular Biology - I	**CO3:** Appreciate the breakthroughs-the key experiments in molecular biology that define the understanding of this branch of science. Comprehend the relevance of this branch in medicine, recombinant DNA technology/ biotechnology.

Unit I: Haematology **15 Lectures**

1.1. Introduction

Concept of *Rakta Dhatu (Lohita)*

Concept of *Rakta* (Blood)

1.2. Composition of Blood

Plasma and formed elements.

1.3. Blood Volume

Total quantity and regulation; Haemorrhage.

1.4. Concept of *Rasa* (Plasma)

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

1.5. Red Blood Cells (RBCs)

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

1.6. 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).

1.7. White Blood Cells (WBCs)

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

1.8. Blood clotting

Concept of *Skandana* (Clotting), *Chaturvidha Rakta sthamhanpaya* (Techniques to control bleeding) Thrombocytes; Coagulation: factors and mechanism; Anticoagulants; Formation of blood platelets (Thrombopoiesis); Clotting mechanism; Bleeding and clotting time; Failure of clotting mechanism; Haemophilia and Purpura.

Raktamoksha (Blood letting): Leech therapy, Cupping and incision.

1.9. Blood groups and Blood typing

ABO system of blood grouping (typing), Rh system, Typing and Cross-Matching for transfusion, Clinical applications (example – Erythroblastosis foetalis or Hemolytic disease of the new born – HDN).

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

2.1. Concept of *Vyadhishatva* (ability to resist diseases and built immunity).

2.2. Introduction to Immunology and historical perspective

2.3. 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.

2.4. 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.

2.5. Antigens

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

2.6. Antibodies

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

2.7. 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 III: Molecular Biology - I **15 Lectures**

Central Dogma of Molecular Biology

3.1. Transcription in Prokaryotes: process of Initiation, elongation and termination; Differences in transcription between prokaryotes and eukaryotes.

3.2. Post-transcriptional modifications: Capping, tailing, splicing (intron and exon).

3.3. Translation in Prokaryotes: Chain initiation, chain elongation, chain termination.

3.4. Genetic code: Salient features, Wobble hypothesis, Hair pin and Cloverleaf model of t-RNA.

The Nature and Properties of Genetic material

3.5. DNA as Genetic material: Griffith's transformation experiment, Avery MacCleod and McCarty experiments, Hershey-Chase experiment.

3.6. RNA as Genetic material: Singer and Conrat experiment on TMV.

3.7. DNA Replication: Semiconservative nature of DNA replication, Meselson and Stahl experiment; replication; enzymes involved in DNA replication.

3.8. Gene regulation: Control of gene expression in prokaryotes- *Lac* Operon; Control of gene expression in eukaryotes; packaging of DNA, heterochromatin, euchromatin.

Course Name: Animal Tissue Culture, Genetic Engineering, Epidemiology
Course Code: SIUZOMJ313

Learning Objectives:

- Unfold a method of biological research - tissue culture, which endeavours to cultivate and study animal cells under artificial conditions.
- Know about its role in enabling numerous discoveries as identifying infections and chromosomal abnormalities, classifying tumours, formulating and testing drugs and vaccines, and replacement of animals in medical and toxicology experiments.
- To get acquainted with the vast array of techniques used to tamper genes which can be applied in numerous fields like medicine, research, livestock farming, etc. for human benefit.
- Introduction to the basic science of public health with a working principle that is data-driven and statistical, to better understand the characteristics of disease within and across populations.
- Realize its role in controlling outbreaks, and in implementing preventive measures in populations at high risk for a given disease (studying examples of few chosen diseases).

Unit	Course Outcome (CO)
Unit I: Animal Tissue Culture	**CO1:** Acquaint with animal tissue culture and its methodology (specific technical skills to carry out) facilitating understanding of its basics to its translational significance for instance, progress in therapeutics and regenerative medicine.
Unit II: Genetic Engineering	**CO2:** Enhanced understanding of theoretical and practical aspects of gene function and organization, and knowledge of the methods of recombinant DNA technology, having significance to improve public health.

Unit III: Epidemiology	**CO3:** Acquaint with an interdisciplinary science of epidemiology and its tools, that function to investigate disease in populations most basically by rates; plan new healthcare services to prevent public health problems, with an ultimate goal of well-being of populaces across the globe.

Unit I: Animal Tissue Culture **15 Lectures**

1.1. Definition, principle, and significance of tissue culture.
1.2. 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.
1.3. Culture Medium: Logic of formulation (natural media and synthetic media)
1.4. Methodology: i. Primary culture: Behaviour of cells, properties, utility. ii. Explant culture.
iii. Suspension culture.
1.5. Characteristics of cells in culture: Contact inhibition, anchorage independence/dependence, cell -cell communication, cell senescence.
1.6. Growth studies: Cell proliferation; Cell cycle; Mitosis in growing cells.
1.7. Organ culture: Methods; behaviour of organ explant; and utility of organ culture.
1.8. Organ transplants: Freeze storing of cells and transport of cultures.
1.9. Applications of tissue culture and diagnostic tests: Development and preparation of vaccines against infecting organisms, mammalian cloning.
1.10. 3D culture; Extracellular matrix; Introduction to Stem cell culture.

Unit II: Genetic Engineering **15 Lectures**

2.1. Enzymes involved in Genetic Engineering: Introduction, nomenclature and types with examples, working mechanism.
Ligases – *E.coli* DNA ligase, T4 DNA ligase
2.2. Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors – Plasmid vectors, phage vectors, cosmid vectors, phasmid vectors, YAC vectors.
2.3. Transfection techniques: Liposome mediated gene transfer, calcium phosphate precipitation method, electroporation, Biolistics (gene gun), somatic cell hybridization.
2.4. PCR: Principle of Polymerase chain reaction (PCR); Types (RT-PCR, qPCR, Droplet Digital ddPCR) and Applications of PCR.
2.5. Sequencing techniques: DNA sequencing: Sanger's method – Manual and automated methods; Protein sequencing: Sanger's method, Edman's method, Next Gen Sequencing.
2.6. Separation and detection techniques: Blotting techniques: Southern blotting, Northern blotting and Western blotting; Applications of blotting techniques. Capillary electrophoresis.
2.7. Microarray techniques: ESTs, DNA microarray and applications.

Unit III: Epidemiology **15 Lectures**

3.1. Understanding epidemiology with respect to disease frequency, distribution and determinants.
3.2. Epidemiological approach, and aims of epidemiology; Basic measurements in epidemiology, Tools of measurement.

3.3. Epidemiologic methods: Observational studies and experimental studies; Uses of epidemiology.
3.4. Infectious disease epidemiology.
3.5. Classification of diseases
Shonitaja Krumi (Blood borne); *Malaja Krumi* (Excreta borne); *Sleshmaja* (Phlegm borne); *Pureeshaja* (Feces borne).
3.6. *Aupasargikaroga* (Communicable diseases)
Kushta (Leprosy); *Vishamajwara* (Malaria); *Krimiroga* (helminth parasites); *Visarpa* (Herpes – Shingles).

Department Specific Elective (DSE)
Course Name: Clinical Embryology, Basic Concepts in Research, Biodiversity and Conservation
Course Code: SIUZOEL311

Learning Objectives:

- Understand principles underlying the techniques of Assisted Reproduction and Clinical Embryology – ever-evolving field in fertility research, facilitating human conception.
- Comprehend this science as a specialization in Laboratory Medicine with essential skills, stringent clinical practice guidelines and ethics, to avoid any medical errors.
- Internalize basic concepts and key aspects about Research Methodology; know about the translation of scientific discoveries in lab to meaningful benefits for society.
- Understand the role of Biodiversity, i.e., in supporting everything in nature that we need to survive, through learning about concepts of Private forests, Reserve forests, and with a detailed study of chosen examples of Sanctuaries and National Parks of India.
- Insights into the actions to be taken through study of various conservation methods, to create lasting solutions and protect the future of nature.

Unit	Course Outcome (CO)
Unit I: Clinical Embryology	**CO1:** Knowledge of clinical embryology as a clinical laboratory science with the rationale for conduct of good laboratory practice, rigorous training, strict quality control and ethical awareness. Ascertain its role in Reproductive Medicine – a hope for fertility patients/ couples to conceive for family-building.
Unit II: Basic Concepts in Research	**CO2:** Sparking the inquirer of science in students for a career in scientific research. Acquire knowledge and skills for presenting research work/ findings of field project/ on job training (part of TYBSc NEP syllabus) or of future research.

Unit III: Biodiversity and Conservation	**CO3:** Conceptualize that Biodiversity is resilient – lessen human impact, give it time, and the ecosystem will adapt/ recover by itself. Become aware of what government and local communities together can do in minimizing the present challenges facing biodiversity and thus is not impossible through application of sound science.

Unit I: Clinical Embryology **15 Lectures**

ART (Assisted Reproductive Technology)

1.1. Introduction to Assisted reproduction; Ovarian reserve test, antral follicle count, clomiphene citrate challenge test and anti-Müllerian hormone test; *In vitro* fertilization; Premature ovulation; Agonist and antagonist protocol; Individualised protocols.

1.2. Sperm retrieval procedure: PESA/ MESA, TESA/TESE.

Clinical Embryology techniques

1.3. Preimplantation genetics: Overview, indications; Sex linked disorders, Single gene defects, chromosomal disorders.

1.4. Biopsy procedures: Polar body biopsy; Cleavage-stage biopsy, Blastocyst biopsy, Cumulus cell analysis.

1.5. Genetic analysis techniques and diagnosis: FISH, PCR-comparative genomic hybridization, Next generation sequencing, Preimplantation genetic haplotyping.

1.6. Implications of Preimplantation genetics: PGD and religion, Legal aspects in India and rest of the world.

1.7. PGS (preimplantation genetic screening) and Aneuploidy screening.

1.8. Principles of Cryopreservation; History of cryopreservation; Principles of Cryobiology; cryoprotectants, cryofreezers; Factors affecting freezing; cryopreservation protocols.

1.9. Embryo cryopreservation: Slow freezing and thawing method, penetrating and non-penetrating cryoprotectants, Slow freezing method for embryos, vitrification and warming of embryos, Cryoprotectants used in vitrification, Vitrification devices, Freeze all strategy, Importance of embryo cryopreservation.

1.10. Oocyte cryopreservation: history, indications, method of cryopreservation of mature and immature oocytes, current status of oocyte vitrification.

1.11. Fertility preservation; Ovarian tissue cryopreservation; history, current status, prospects, *In vitro* culture of ovarian tissue, Ovarian tissue transplantation and outcome.

1.12. Cryopreservation of semen and testicular tissue, Storage of cryopreserved samples and its safety.

Unit II: Basic Concepts in Research **15 Lectures**

2.1. Introduction to Research Methodology.

2.2. Types of research: basic research, applied research, translational research.

2.3. Making observations, Forming and Testing hypothesis, Deductive and Inductive reasoning.

2.4. Experimental variables and controls: experimental tests, controlled experiments, identifying important variables.

2.5. Understanding formats of scientific writings: Research paper, Review paper, Scientific article, Dissertation and Thesis, Research proposal, Case studies.

Primacy of the research question, structure and components of research paper, common mistakes seen in manuscripts submitted to a journal.

Writing an abstract, selection of keywords, Citing references or bibliography (Numeric, Harvard and American Psychological Association [APA] style).
Peer review, Fundamental principle of high quality scientific publication.
2.6. Systematic approach for critiquing a manuscript: reviewing the manuscript, writing your critique, writing your comments.
2.7. Research ethics: significance and compliance, conflict of interest, plagiarism.
Overview of ethics in animal research or preclinical trials, Institutional Animal Ethics Committee (IAEC), Overview of ethics in clinical trials, Institutional Ethics Committee (IEC).

Unit III: Biodiversity and Conservation **15 Lectures**

3.1. Concept of Biodiversity.
3.2. General concepts of Private forests, Reserve forests.
3.3. Sanctuaries: Eagle nest wildlife sanctuary, Hoolongpar sanctuary, Bhimashankar wildlife sanctuary, Gahirmatha marine wildlife sanctuary, Point Calimere wildlife sanctuary, Pangolakha wildlife sanctuary.
3.4. National Parks: Sanjay Gandhi national park, Kaziranga national park, Marine/ Corbett/ Tadoba/ Sunderbans/ Silent valley/ Keoladeo Ghana/ Gir.
3.5. Coastal Regulation Zone.
3.6. *In situ* and *ex-situ* conservation.
3.7. Germ plasm, Gene banks, Seed banks, Frozen zoo, Ecotourism.

Vocational Skill Course (VSC)

THEORY

Course Name: Ornamental Fishery

Course Code: SIUZOVS311

Learning Objectives:

- Know the bare basics of keeping a fish aquarium.
- Acquaint with ornamental fishes and aquarium plants.
- To provide hands-on training on setting up of aquaria and its maintenance.
- To impart hands-on training on culture, breeding of commercially important ornamental fishes.

Unit	Course Outcome (CO)
Unit	**CO1:** Establish a foundation in aquarium science, and realize that it can grow into a hobby and an industry, providing both aesthetic and financial benefits. To encourage students for self-employment and entrepreneurship in the field of ornamental fish farming.

Topics/Modules to be covered (THEORY): **15 Lectures**

1. General fish anatomy, and introduction to ornamental fishes.
2. Water chemistry, nitrogen cycle, fish feed.
3. Aquarium plants; recent advances in tissue cultured aquatic plants.
4. Construction, setting and maintenance of Aquarium Setup.
5. Breeding and rearing of ornamental fishes.
6. Ornamental fish farming: Management aspects.

PRACTICAL

Course Name: Practicals based on SIUZOVS311 **15 Lectures**

1. Types of aquarium fishes.
2. Study of breeding in ornamental fishes.
3. Identify and describe the aquarium accessories with their use and maintenance.
5. Identify and describe fish food and its types.
6. Identify and describe aquarium plants.
8. Setting up of an aquarium.
9. Maintenance of an aquarium.
10. Aquarium fish diseases.

SEMESTER V – PRACTICAL

Course Name: Practicals based on SIUZOMJ311
Course Code: SIUZOMJP311

1. Animal Type Study (invertebrate): Earthworm.
2. Study of Digestive system of earthworm.
3. Study of Nervous system of earthworm.
4. Study of Reproductive system of earthworm.
5. Study of Setae, Blood gland in earthworm.
6. Study of Spermathecae, Sperm, Ovary in earthworm.
7. Preparation of media for fruit fly culture and maintenance.
8. Identification of sexes in fruit fly and crossing of fruit fly.
9. Study of development of chick embryo.
10. Observation of chick embryo at various stages.
11. Observation of Mammalian tissues w.r.t. to Endocrinology: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal.

Course Name: Practicals based on SIUZOMJ312
Course Code: SIUZOMJP312

1. Enumeration of Erythrocytes/ Red Blood Cells (RBCs) – Total Count.
2. Determination of Erythrocyte Sedimentation Rate (ESR) by suitable method – Westergren method.
3. Estimation of haemoglobin by Sahli's acid haematin method.
4. Enumeration of Leucocytes/ White Blood Cells (WBCs) –Total Count.
5. Differential Count of Leucocytes/ White Blood Cells (WBCs).
6. Determination of serum LDH (Lactate Dehydrogenase).
7. Estimation of total plasma proteins by Folin's method.
8. Estimation of serum/ plasma total triglycerides/ lipids by Phosphovanillin method.
9. Latex agglutination test – Rheumatoid Arthritis; Slide test for pregnancy.
10. Study of T.S. of lymphoid organs: Thymus, spleen, lymph nodes; leukemic cells from permanent slides.

Course Name: Practicals based on SIUZOMJ313
Course Code: SIUZOMJP313

1. Isolation of genomic DNA and checking its purity by horizontal electrophoresis.
2. Study of the effect of food additive/ drug/ naphthalene balls on the chromosomes of onion root tips and calculation of the mitotic index.
3. Problems based on molecular biology and genetic engineering.

4. Isolation of cells from the given tissue by trypsinization and checking its viability.
5. Isolation of PMNs (Polymorphonuclear leukocytes) by density gradient from blood.
6. Mounting of mouth parts of Mosquito.
7. Problems in Epidemiology.
8. Identification of instruments used in ATC.

Course Name: Practicals based on SIUZOEL311 (DSE)
Course Code: SIUZOELP311

1. Study of different banding techniques.
2. Cytogenetic test report.
3. Semen analysis.
4. Study of sperm morphology.
5. Study of the density of animal population by Capture-recapture methods.
6. Identification of National parks.
7. Identification of Sanctuaries.
8. Identification of biosphere reserves.
9. Identification of representative animals.
10. Study of Bibliography, Referencing and citation using Software.
11. Submission of literature review with reference to field biology.
12. Abstract writing.

SEMESTER VI – THEORY

Course Name: Comparative Chordate Anatomy, General Pathology, Toxicology
Course Code: SIUZOMJ321

Learning Objectives:

- To gain insight into chordate diversity and trace evolutionary relationships across different chordate groups by studying variations/ functional modifications in the basic anatomical structures, in this case, of the respiratory system, nervous system and the urinogenital system.
- Gain an overview of a medical discipline, General Pathology, dedicated to provide diagnostic information to patients and clinicians.
- Know the basic mechanisms of disease at cellular and tissue levels by study of some diseases like infections, disorders of pigmentation, necrosis, gangrene, some circulatory disturbances, etc. Also gain insight into forensic pathology that specializes in determining the cause of death.
- Introduce the principles of Toxicology with emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing; to understand the relevance of toxicity studies and regulatory guidelines, ethics in animal studies, alternatives to animal models.
- Know about animal venom, and toxic effects of pesticides.

Unit	Course Outcome (CO)
Unit I: Comparative Chordate Anatomy - II	**CO1:** Through the comparative approach students will be able to relate how the structural features in different chordate groups are changed to suit their functioning in diverse environments and understand the underlying evolutionary mechanism in chordates by anatomical study. It holds indirect application in human welfare through furthering in animal research.
Unit II: General Pathology	**CO2:** Comprehend how disease manifestation occurs at different levels of biological organization viz., cellular, tissue, organ, organ system, ultimately to affect the organism (here, human body) as whole. Realize this knowledge is integral to the patient care decision-making process.
Unit III: Toxicology	**CO3:** Comprehend the basics of a multidisciplinary field that investigates mechanisms underlying adverse consequences of toxin exposure, and thus put light on the health risks related to toxins. Knowledge of which can help in monitoring environmental pollutants such as pesticides, and in drug development for treatment, for example, as in cancer research.

Unit I: Comparative Chordate Anatomy - II **15 Lectures**

1.1. Respiratory System

Gills in Agnathans, Cartilagenous fishes, Bony fishes; Larval gills.

Air breathing bony fishes.

Swim bladder and origin of lungs.

Development of lung.

Amphibian lungs, Reptilian lungs, Lungs and their ducts in birds, Mammalian lungs.

1.2. Nervous system

Development and differentiation of primary brain vesicles and their cavities, flexures of brain.

Evolution of cerebral hemispheres, cerebellum.

Cranial nerves and Autonomic nervous system with reference to shark, frog, lizard, pigeon and rabbit.

1.3. 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 II: General Pathology **15 Lectures**

2.1. Concept of Dhatu samya (Tissues equilibrium) and its types.
[*Rasa* (Plasma), *Rakta* (Blood), *Mamsa* (Muscle), *Meda* (Fat), *Asthi* (Bone), *Majja* (Bone marrow) and *Shukra* (Semen)].
Concept and significance of *Agni samya* (Digestive fire).
2.2. Infectious diseases: Aetiology; infectious agents: viruses – hepatitis, fungi – skin diseases.
2.3. Retrogressive changes: Definition; Cloudy swelling, Degeneration: fatty, mucoid and amyloid (causes and effects).
2.4. Disorders of pigmentation: Endogenous: Normal process of pigmentation, melanosis, jaundice (causes and effects).
2.5. Necrosis: Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid.
2.6. Gangrene: Definition and types – Dry, moist, and gas gangrene.
2.7. Circulatory disturbances: Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Oedema and Infarction.
2.8. Inflammation: Definition and causes (pathogenic and immune); cardinals of inflammation; acute and chronic inflammation.
2.9. Applied pathology: Anatomical, clinical and molecular; Investigating methods: biopsy and surgery (for pathological examination of tissue).
2.10. 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.

Unit III: Toxicology **15 Lectures**

3.1. Principles of Toxicology – Different areas of toxicology.
3.2. Characteristics of Exposure – Duration of exposure, frequency of exposure, routes of exposure.
3.3. Dose Response relationship – Individual/ Graded and Quantal dose response relationships, Concept of LD_{50}, LC_{50}, ED_{50}, Therapeutic index.
3.4. Types of toxicity tests – Acute toxicity testing, Skin and Eye irritation study (Draize test), Subacute (Repeat-Dose Study).
3.5. OECD guidelines/CPCSEA guidelines for animal testing, ethical issues in animal studies, Animal models used in regulatory toxicology studies, Alternatives to animal models.
3.6. Dose translation from animals to human – Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake).
3.7. Overview of absorption, distribution, metabolism/ biotransformation and excretion of toxicants
3.8. Concept of *Jangama Visha* (Animal Venom) and its types:
Sarpa Visha (Snake Venom), *Vrushchik Visha* (Scorpion Venom), *Keeta Visha* (Insect venom), *Luta Visha* (Spider venom).
3.9. Toxic effects of Pesticides – Mechanism of action of insecticides and rodenticides.

Course Name: Applied Hematology, Immunology, Molecular Biology
Course Code: SIUZOMJ322

Learning Objectives:

- Gain understanding of the plethora of diagnostic tests for examination of blood, through applied haematology, to get informed about a wide range of blood-related conditions.
- Further learning in immunology with aspects as hypersensitivity, autoimmunity, immunodeficiency; and realize and learn the application of immunology in transplantation, cancer treatment and vaccine production.
- Describe the various types of mutations, know about the action of different agents responsible for mutation, and learn about the mechanisms to prevent damage to and repair DNA that safeguard the integrity of an organism's genetic material, essential to keep at bay cell death or disease development.

Unit	Course Outcome (CO)
Unit I: Applied Hematology	**CO1:** Enhanced understanding about the liquid connective tissue – blood and its significance, when trying to determine the cause of different diseases, monitoring treatment effectiveness, etc.; exemplifying the multifaceted role of haematology in healthcare.
Unit II: Immunology - II	**CO2:** Knowledge of the concepts of immunology and their application, with an immunological approach to the development of life-saving medical advancements such as transplantations, vaccines and immunotherapies.
Unit III: Molecular Biology - II	**CO3:** Awareness regarding the various types of mutations and their repercussions in organisms; and an appreciation of the impressive innate power of the living cell in preventing and fixing any lesions on the DNA; a knowledge of productive use in establishing therapies to treat cancer.

Unit I: Applied Hematology **15 Lectures**

Introduction to Applied Hematology

1.1. Concept of *Prakriti* and *Vikara*.

1.2. *Rakta pariksha* and its significance.

1.3. *Naadi pariksha* and its significance.

1.4. Definition, scope and brief introduction of basic branches: Clinical, Microbiological, Oncological and Forensic hematology.

Diagnostic techniques used in Hematology

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

Thalassemia).
1.6. Coagulopathies: Diagnostic methods (Hemophilia and Purpura).
1.7. Microbiological examination of Blood: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB-Tuberculosis).
1.8. 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).
1.9. Blood bank: Collection, storage and preservation of blood components.
1.10. Blood transfusion: Cross matching, Transfusion of blood.

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

2.1. Hypersensitivity, Autoimmunity and Immunodeficiency
Introduction to hypersensitivity; types of hypersensitivity: Type-I, Type-II, Type-III and Type-IV (one example of each type).
Introduction to autoimmunity, organ specific and systemic autoimmune diseases (at least one example of each type).
Introduction to immunodeficiency, primary immunodeficiency, e.g. SCID; secondary immunodeficiency, e.g. AIDS.
Concept of *Panchagavya Chikitsa*.
Therapeutic value of *Gomuthra*: Anti-epileptic, Immunomodulatory, Anti-inflammatory.
2.2. Transplantation Immunology
Introduction to transplantation; Immunological basis of graft rejection; Clinical manifestations of graft rejection; General immunosuppressive therapy.
2.3. Cancer and Immune system
Oncogenes and cancer induction; Tumour antigens; Cancer immunotherapy.
2.4. Vaccines and Vaccination
Vaccination: Development and challenges; comparison of inactivated and attenuated vaccines; whole organism vaccines, subunit vaccines, peptide vaccines, recombinant vector vaccines, DNA vaccines
Neural tissue rabies vaccine developed by Pasteur Institute of India.
Covaxin developed by Bharat Biotech.
Hepatitis B, Swine flu and Cholera vaccines from India.

Unit III: Molecular Biology - II **15 Lectures**

3.1. Types of mutations
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.
3.2. 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).

3.3. 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.

Course Name: Enzymology, Homeostasis and regulation, Bioprospecting and Zoopharmacognosy

Course Code: SIUZOMJ323

Learning Objectives:

- Learn about the key role of enzymes as catalyst in biochemical reactions; know how enzymes are classified according to the type of biochemical reaction that they catalyze; understand the basic concepts revolving around enzyme catalysis/ activity, and an introduction to industrial products and processes involving enzymes.
- Understand how the study of physiology relates to biology at large, by learning about homeostasis and its machinery-the control systems in biology-the feedback mechanisms; and exemplify the influence of temperature and water relations of animals in their form (anatomy) and function (physiology).
- Introduce the science and applications of bioprospecting- defined as the exploration and evaluation by integrating various approaches to discover new natural compounds/ pharmacologically active compounds/ potential as therapeutic agents, from diverse sources such as plants, animals, and microbial species.
- Illustration of zoopharmacognosy-the self-medication behaviour of animals- disease treatment and protection from parasites by natural resources which essentially provide molecules for metabolism and growth.

Unit	Course Outcome (CO)
Unit I: Enzymology	**CO1:** Appreciate the extraordinary utility of enzymes in coordinating the metabolic machinery of the cell, by a comprehensive understanding of enzyme activity. Approach an improved understanding of mechanism of enzyme action for commercialization of enzymes.
Unit II: Homeostasis and regulation	**CO2:** Gain perspective on the adaptive significance of animal features-advantageous/ favored by natural selection-that are employed by animals (related and unrelated species) to carry out bodily functions in similar and dissimilar environments, here with an emphasis on thermoregulation, and ionic and osmoregulation.

Unit III: Bioprospecting and Zoopharmacognosy	**CO3:** Articulate bioprospecting as a sustainable development from nature or a means to commercialize biodiversity – with purpose in academics, pharmaceuticals, biotechnology companies, agriculture, and other industrial prospects. Appreciate the medical discoveries animals have made from natural resources like certain plants that they eat, which have become useful knowledge for humans in traditional medicine since ancient times and in use till date.

Unit I: Enzymology **15 Lectures**

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.
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. Ribozymes and their significance.
1.7. Clinical significance and industrial application of enzymes.

Unit II: Homeostasis and regulation **15 Lectures**

2.1. Equilibrium of *Doshas*: *Vatta, Pitta* and *Kapha*.
Vatta: Regulation of movement.
Pitta: Regulation of metabolism.
Kapha: Regulation of structure and moisture.
2.2. Concept of *Lok-Purush samyata*; *Lok* (External environment) and *Purush* (Internal environment)
2.3. Homeostasis: External and internal environment; Acclimation and acclimatization
2.4. Control systems in Biology: Feedback mechanisms – Negative feedback and positive feedback mechanisms, and examples of each.
2.5. Thermoregulation
Heat, temperature, range of environmental temperature; Energy exchange between organism and environment; thermoregulatory taxonomy.
Poikilothermy (ectothermy): a) Variation in metabolic rate with temperature, temperature coefficient, Q_{10}; b) Behavioural thermoregulation; c) Effects of cold/ freezing.
Endothermy: a) Thermoneutral zone (TNZ)/ thermoneutrality; b) Heat production – Shivering and non-shivering thermogenesis, Brown fat – special thermogenic tissue in mammals; c) Mechanisms of heat loss; d) Adaptive response to temperature – Controlled hypothermia: daily torpor, hibernation, aestivation.

2.6. Ionic and Osmotic Balance

Maintaining water and electrolyte balance – Osmoregulation, osmosis and osmolarity;
Ionic regulation in iso-osmotic environment; living in hypo-osmotic and hyper-osmotic environment; problems of living in terrestrial environment; water absorption, metabolic water, salt water ingestion and salt excretion.
Osmoregulatory organs: a) Kidneys – Role of non-mammalian vertebrate kidneys in ionic regulation; homeostatic regulation of osmoregulatory function of mammalian kidney – Antidiuretic hormone, the Renin-Angiotensin-Aldosterone system, and Atrial Natriuretic Peptide (ANP).
b) Extrarenal osmoregulatory organs in reptiles and birds – Salt glands.
Dramatic adaptations of particular species: the dromedary camel, kidney function in vampire bat.

Unit III: Bioprospecting and Zoopharmacognosy **15 Lectures**

3.1. Bioprospecting

Traditional prospecting; Modern bioprospecting; Chemical prospecting; Genetic prospecting; Bionic prospecting; Economic value and benefit sharing; Bioprospecting and conservation; Pros and cons of bioprospecting.

3.2. 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.

3.3. Concept of Self-medication

Dogs eating grass to induce vomiting; Carnivores eating grass to resolve digestive problems; Pregnant animals eating specific plants to maintain reproductive health and also to induce parturition;
Consumption of clay from termite mounds to cure diarrhoea and stomach upset as recorded in modern day observation on tapir and elephants.

3.4. Wound Healing

Leech therapy and suturing using black ants.

Department Specific Elective (DSE)

Course Name: Genetic Counselling, Wildlife Conservation and Management, Animal Behaviour

Course Code: SIUZOEL321

Learning Objectives:

- Create a conceptual framework of cytogenetics - the study of chromosome structure, morphology, function, and behavior; and the underlying principles of its techniques for insights into the genetic conditions and their risks, as an assistance in genetic counselling.
- Study of wildlife conservation and management through various acts and regulations, learning about the threats to wildlife, and unfold the vital role of community involvement in this context.
- Exploration of the complexity of animal behaviour with an understanding that it demands long-term field observations (observations of animals in their natural settings), combined with lab studies.

Unit	Course Outcome (CO)
Unit I: Genetic Counselling	**CO1:** Appreciate the insightful guidance of genetic counselling ensuring the knowledge to make confident, personalized decisions relating to inherited health risks by individuals and families.
Unit II: Wildlife Conservation and Management	**CO2:** Awareness regarding the functional significance of wildlife in supporting the overall planetary health, and glimpses of human efforts to protect this vital natural resource upon which lies the very existence of human species.
Unit III: Animal Behaviour	**CO3:** Appreciate the purposefulness of animal actions, and which hold importance in managing long-standing concern of wildlife-human conflicts, and in animal welfare.

Unit I: Genetic Counselling **15 Lectures**

1.1. Cytogenetics Technology and Nomenclature

An international system for human cytogenetic nomenclature, cytogenetic technology, Differential and selective banding techniques, high-resolution banding. Chromosome mapping - somatic cell hybridization, and its clinical application. The techniques: CGH, CGH array, and their applications. Microscopy (Light, TEM, SEM) and imaging, computer-assisted image processing systems, flow cytometer, PCC.

1.2. Prenatal diagnosis

Chromosome abnormalities and pregnancy loss; Prenatal diagnosis techniques: Amniocentesis, chorionic villus sampling, cordocentesis, non-invasive techniques-Preimplantation genetic diagnosis and *in vitro* fertilization.

1.3. Genetic counselling

Population screening, carrier detection and genetic counselling, types of genetic counselling; Genetic testing; Consanguinity in the human population.

1.4. Ethical issues

Ethical issues and related problems; Bioethics and human population genetic research; Reproductive rights.

Unit II: Wildlife Conservation and Management **15 Lectures**

2.1. Acts and regulations

Wildlife protection Act of India; Management plans and working plans for forest and protected areas in India; CITES, TRAFFIC, RED Data Book.

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. Community Conservancies

Snow Leopard Conservancy in India; Community-based Nature Conservancy (CNC) in Tadoba.

2.4. People in Conservation

Tribes of India (Andaman Nicobar and Arunachal); Societies in conservation in India (e.g., Bishnoi); Ethnobiological knowledge in nature conservation.

Unit III: Animal Behaviour **15 Lectures**

3.1. Development of Behaviour

Ontogeny of behaviour; Environmental influence on behaviour; Sensitive periods during development; Juvenile behaviour; Innate behaviour.

3.2. Learning and Cognition

Types of learning: Habituation, classical conditioning, operant conditioning.

3.3. Communication in Animals

Visual, auditory, chemical, and tactile communication; Evolution of language in primates.

3.4. Animal Behaviour

Habitat selection; Food selection; Dispersal; Homing; Ritualization; Courtship; Territoriality; Aggression.

3.5. 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.

SEMESTER VI – PRACTICAL

Course Name: Practicals based on SIUZOMJ321

Course Code: SIUZOMJP321

1. Animal Type Study (vertebrate): Fish.
2. Study of External morphology of fish.
3. Study of Digestive system of fish.
4. Study of Brain of fish.
5. Study of Aortic arches of fish.
6. Study of placoid, cycloid and ctenoid scales of fish.
7. Study of nerve cells, muscle fiber and chromatophore in fishes.
8. Observation and analysis of types of feathers in birds.
9. Comparative urine analysis of herbivore and omnivore.
10. Effect of CCl_4 (Carbon tetrachloride) on the level of enzyme activity in serum acid and alkaline phosphatase, aspartate and alanine aminotransferase.
11. Effect of salt of a heavy metal/ nicotine/ alcohol on the heartbeat of Daphnia.

Course Name: Practical's based on SIUZOMJ322
Course Code: SIUZOMJP322

1. Serological diagnosis using Widal's Test.
2. Estimation of Blood Glucose.
3. Estimation of Blood Urea.
4. Estimation of Bilirubin.
5. Estimation of Creatinine.
6. Study and interpretation of pathological reports: Blood, urine and stool (faeces).
7. Microscopic examination of Blood for detection of blood cancers and infections.
8. Study of various biological databases (Literature, Nucleotide and Amino acid sequence databases).
9. Construction of Phylogenetic trees using nucleotide and amino acid sequence data.
10. To design a nucleotide primer for PCR.

Course Name: Practical's based on SIUZOMJ323
Course Code: SIUZOMJP323

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/ PAGE.
6. To study the effect of enzymes (and/ drugs) in detergents.
7. Study of IPR and drafting of Patents.
8. Study of impact of anoxic stress on opercular movement of fish.

Course Name: Practical's based on SIUZOEL321 (DSE)
Course Code: SIUZOELP321

1. Pedigree Analysis.
2. Study of Karyotyping.
3. Study of animal behavior using live models: *Betta spp.*
4. Identification of various wildlife adaptations.
5. Report submission on behavioural biology.
6. Study of grooming behavior of housefly.
7. Study of IUCN status of Indian wildlife.
8. Preparation of ethogram using BORIS software.
9. Analysis of bird calls using software.
10. Submission of Excursion report.

T.Y.B.Sc. Syllabus (Autonomous) in the Subject of Zoology
Choice Based Credit System (CBCS)
As per National Education Policy
(With effect from Academic Year 2025-26)
Grid of Syllabus – Semester V and VI (*Course Type: Minor-MN*)

Theory						
Semester	**Course Code**	**Course Category**	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
V	**SIUZOMN311**	Minor	I	EIA and CRZ	2	15
			II	Planktology		15
VI	**SIUZOMN321**		I	Fish By-products and Value added products	2	15
			II	Fish Preservation and Processing		15

SEMESTER V
Course Name: Introduction to EIA and CRZ, Planktology
Course Code: SIUZOMN311

Learning Objectives:

- Introduction to EIA and CRZ – promoting sustainable practices and resource conservation, ensuring development considers environmental consequences early.
- Introduction to Planktology, classification, identification, and methods of collection of planktons; and their significance in the ecosystem.

Unit	Course Outcome (CO)
Unit I: EIA and CRZ	**CO1:** Awareness about EIA and CRZ - key component of environmental management for identifying the future consequences of a current or proposed action, in order to protect ecosystems and ultimately human health.
Unit II: Introduction to Planktology	**CO2:** Understanding about planktons, as organisms forming essential base of most pelagic ecosystems, and serving as ecosystem health indicators, and as major contributors to global biogeochemical cycling; helping scientists monitor pollution, and impacts of climate change on aquatic environments.

Unit I: EIA and CRZ **15 Lectures**

1.1. Introduction to EIA (Environmental Impact Assessment); types of EIA: rapid EIA, comprehensive EIA; Environmental clearance process; Coastal regulation zone; Baseline studies - collection of primary and secondary data.

1.2. Zonation of Sea: Vertical zonation and Horizontal zonation.

1.3. Anticipated environmental impact and mitigation: Environmental Monitoring Programme – methods and techniques of impact identification and prediction.

Unit II: Introduction to Planktology **15 Lectures**

2.1. Introduction to Planktology, Classification of planktons.
2.2. Phytoplankton: Classification, identification, and methods of collection.
2.3. Zooplankton: Classification, identification, and methods of collection.
2.4. Phytoplankton-Zooplankton interrelationships - food chain.

SEMESTER VI

Course Name: Fish By-Products and Value added products, Fish Preservation and Processing

Course Code: SIUZOMN321

Learning Objectives:

- Introduction to the fisheries sector to know about the myriad products that can be obtained other than fresh fish for consumption/ other utility.
- Learn about the various methods of fish preservation and processing - essential steps in increasing the keeping quality/ durability of fish, thus maintaining nutritive level and consumption quality, helping in creating a sustainable market for the fishery industry.

Unit	Course Outcome (CO)
Unit I: Introduction to Fish by-products and Value added products	**CO1:** Acquaintance about various fish by-products and value added products, their preparation; and realize their significance in creating new revenue streams in the fisheries sector other than being a source of nutrition for the living world.
Unit II: Fish Preservation and Processing	**CO2:** Understanding of the principles of the techniques/ methods employed in preservation and processing of fish; and realize the need of a large workforce for this operation, generating employment opportunities crucial in economic growth of the nation.

Unit I: Introduction to Fish by-products and Value added products **15 Lectures**

1.1. Introduction to by-products –
Fish protein concentrate, Fish maws/ Isinglass, Fish hydrolysates, Chitin, Chitosan, Glucosamine hydrochloride, Gelatin, Fish silage, Surimi and Imitation products.
1.2. Value addition – Different types of value added products from fish and shell fish – Fish /Prawn pickle, Fish wafers, Prawn (*Acetes indicus*) chutney, Fish soup powder, Fish/ Crab steaks.

Unit II: Fish Preservation and Processing **15 Lectures**

2.1. Need and significance of preservation; Long term and short term preservation.
2.2. Traditional methods of icing, drying, salting and their modifications.
2.3. Introduction to refrigeration: Types and properties of refrigerants, types of freezers –Brine, air blast, tunnel, contact plate and cryo-quick.
2.4. Principle and steps involved in canning of fish and prawns in various media.
2.4. Fish smoking.

Field Project (FP)
(T.Y.B.Sc. Syllabus with effect from Academic Year 2025-26)

- There will not be any theory paper for Field Project, but there will be **2 Credits** based on Field visit/work.
- To be completed in Semester V.
- 2 Credits is equivalent to 50 marks (1 Credit = 25 marks).

On-the-Job Training (OJT) as per NEP 2020
(T.Y.B.Sc. Syllabus with effect from Academic Year 2025-26)

Based on the guidelines issued by the University of Mumbai for On-the-job training (OJT). According to the UGC guidelines, in an internship program, students are required to participate in work experience or professional activity, or cooperative education activity with an entity external to the education institution, under the supervision of an expert from the given external entity. A prime aspect of the internship is induction into actual work situations.
Internships and OJTs include:
working with government or private organizations, educational institutions, research and development labs/research organizations/non-government organizations, enterprises, centres involved in research, innovativeness and entrepreneurship, business organizations, local industry, farmers-producer organizations and similar other entities for providing opportunities to students for active engagement in on-site experiential learning.

1. Credits and Duration of OJT:

a) OJT will carry a weightage of **4 Credits** equivalent to 100 marks.
b) Each student is required to complete a minimum of 120 clock hours of OJT.
c) For UG students, the OJT program must be completed before the conclusion of Semester VI. In case of non-completion of OJT, the student will be declared unsuccessful in that course. (In the event that students are unable to fulfill their obligation to report to their designated organization on a particular day due to medical or other critical reasons, they are required to promptly notify both their department and the organization.)

2. Evaluation Scheme of OJT:

Evaluation during the OJT program involves two key components:

- External Evaluation: 50% (50 marks out of 100)
- Internal Evaluation: 50% (50 marks out of 100)

The following is the two-fold pattern of evaluation:

1. External/ Host Organization Evaluation: The host organization will assess students based on criteria such as punctuality, completion of hours, and proficiency in required skill sets. They will also provide feedback on the students' overall performance.
2. Internal/Department Mentor Evaluation: Additionally, students will be evaluated by their department mentor based on their weekly reporting, written report, and viva voce/presentation.

3. Evaluation grid for assessment:

External (OJT Supervisor)	***Completion of 120 Hours***	***Punctuality & Regularity***	***Performance/ proficiency in required skill sets***	***Total***
	20 marks	10 marks	20 marks	50 marks
Internal (Department Mentor	***Weekly Reporting***	***Written Report***	***Viva-Voce /Presentation***	***Total***
	15 marks	20 marks	15 marks	50 marks
Total Marks				100

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- Introduction to Bioinformatics; First Edition; T.K. Attwood, D.J. Parry-Smith; Pearson Education, Eleventh Reprint; 2005
- Bioinformatics; First Edition; C.S.V. Murthy; Himalaya Publishing House; 2003
- Bioinformatics - Sequence and Genome analysis; David W. Mount; Cold spring harbor laboratory press; 2004
- Basic Bioinformatics; S. Ignacimuthu, s.j.; Narosa Publishing House; 1995
- An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MIT Press, First Indian Reprint; 2005
- Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003
- Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce S. Lieberman; Wiley-Blackwell; 2011
- Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Edward C. Holmes; Well Publishing; 1998
- Essential Bioinformatics; Jin Xiong; Cambridge University Press; 2006
- Proteomics - From Protein Sequence to Function; First Edition; S.R. Pennington, M.J. Dunn; Springer publications; 2001
- Proteomics; Timothy Palzkill; Springer; 2002
- Metabolomics - A Powerful Tool in Systems Biology; Jens, Nielsen, Michael C., Jewett; Springer; 2007
- Systems Metabolic Engineering; Dr. Christoph Wittmann & Sang Yup Lee; Springer; 2012
- Bioinformatics (Bios Instant Notes); Second Edition (Special Indian Edition); T. Charlie Hodgman, Andrew French & David R. Westhead; Garland Science (Taylor and Francis Group); 2010
- Understanding Bioinformatics; Marketa Zvelebil & Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008
- Bioinformatics Computing – The complete practical guide to bioinformatics for Life scientists; Bryan Bergeron; Eastern Economy Edition; Prentice-Hall of India Pvt. Ltd., New Delhi; 2003
- Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009
- Introduction to Bioinformatics; First Edition; S. Sundara Rajan & R. Balaji; Himalaya Publishing House, Mumbai; 2002
- Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013
- DNA & Biotechnology; Third Edition; Molly Fitzgerald-Hayes & Frieda Reichsman; Academic Press; 2009
- Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014

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*
- *Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007*
- *Biology: Eleventh Revised Edition; Sylvia S. Mader & Michael Windelspecht; McGraw- Hill Education; 2012*
- *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

Environment Management

- Essentials of Environmental Science; N. Vasudevan; Narosa Publishing House Pvt . Ltd. New Delhi 110002
- Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd., New Delhi 110055
- A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation, New Delhi 110002
- Environmental Biotechnology - Basic Concepts and Application; Indu Shekhar Thakur; I.K. International Pvt. Ltd., New Delhi 110016
- Text book of environmental science; S.C. Santra

Wildlife Management

- Wild life management; Rajesh Gopal
- Wildlife Management & Conservation - Contemporary Principles & Practices**;** Paul R. Krausman & James W. Cain III
- Wildlife Ecology, Conservation & Management; John M. Fryxell, Anthony R. E. Sinclair, Graeme Caughley

Note: The department will constitute Dissection Monitoring Committee or Animal Ethics Committee to oversee the compliance of ethical treatment to animals, during the use of laboratory animals for practical's or experiments included in the curriculum/syllabus, and for research projects as per the requirements of the syllabus. The recommended composition of this Committee will be as follows:

i) Head of the concerned Department (Convener/ Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of related department from the same college
iv) One or two members of related department from neighboring colleges

Practical Course: 50 Marks (External)

Note: Field excursions (with at least one beyond the limits of Mumbai) for habitat studies are compulsory. Field work of not less than eight hours duration is equivalent to one period per week for a batch of fifteen students. A candidate will be allowed to appear for the practical examinations only if he/ she submits a certified journal and the Field Report or a certificate from the Head of the Department/ Institute to the effect that the candidate has completed the practical course as per the minimum requirements. In case of loss of journal, a candidate must produce a letter signed by the Head of the Department/ Institute that the practical's for the academic year were attended and performed by the student. Although, such a candidate will be allowed to appear for the practical examination, however, the marks allotted for the journal may not be given to the student.

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