

John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai 400007

RE-ACCREDITED 'A' grade by NAAC



Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for T.Y.B.Sc.

Program: B.Sc.

Program Code: WUSZOO

**Choice Based Credit System (CBCS) with effect from
Academic year 2024–2025**

PROGRAM OUTLINE 2023-2024

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
T.Y	V	USZOO501	Taxonomy - Invertebrates and Type Study	4
		USZOO502	Hematology and Immunology	4
		USZOO503	Histology, Toxicology, Pathology and Biostatistics	4
		USZOO504	Anatomy and Developmental Biology	4
		USZOO5P1	Zoology Practical 1 based on Taxonomy - Invertebrates and Type Study	2 + 2
			Zoology Practical 2 based on Hematology and Immunology	
		USZOO5P2	Zoology Practical 3 based on Histology, Toxicology, Pathology and Biostatistics	2 + 2
			Zoology Practical 4 based on Anatomy and Developmental Biology	
	VI	USZOO601	Taxonomy - Chordates and Type Study	4
		USZOO602	Physiology and Tissue Culture	4
		USZOO603	Genetics and Bioinformatics	4
		USZOO604	Environmental Biology and Zoopharmacognosy	4
		USZOO6P1	Zoology Practical 1 based on Taxonomy - Chordates and Type Study	2 + 2
			Zoology Practical 2 based on Physiology and Tissue Culture	
USZOO6P2		Zoology Practical 3 based on Genetics and Bioinformatics	2 + 2	
		Zoology Practical 4 based on Environmental Biology and Zoopharmacognosy		

PROGRAMME SPECIFIC OUTCOME (PSOs)

PSO1: Learners will apprehend the basis of classification and modern classification up to class of the lower invertebrate animals and will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects.

PSO2: Learner shall comprehend basic haematology. The learner will be able to identify various components of haemostatic systems. The learner will be familiar with the terminology used and diagnostic tests performed in a pathological laboratory. The learner will realize the significant role of immune system in giving resistance against diseases and will understand immunopathology and the principles and applications of vaccines. The learner will develop basic understanding of immunology of organ transplantation.

PSO3: Learner to develop broad understanding of the different areas of toxicology. They will also be able to set up a hypothesis and verify the same using limits of significance. The course will prepare learner to develop broad understanding of the different areas of toxicology. The learner will be able to collect, organize and analyse data using parametric and nonparametric tests.

PSO4: Learner will be able to understand the importance of various types of epidermal and dermal derivatives along with their functions. Learner will be able to understand the structure, types and functions of human skeleton. Learner will be able to understand the processes involved in embryonic development and practical applications of studying the chick embryology

PSO5: Learners will get an idea of origin of Chordates, its taxonomy up to class with reference to phylogeny and their special features and will get an idea of one representative animal shark.

PSO6: The learner shall understand fundamentals of enzyme structure, action and kinetics. The learner shall appreciate the enzyme assay procedures and the therapeutic applications of enzymes. The learner will appreciate its applications in various industries. The learner shall understand the types and secretions of endocrine glands and their functions. The learner shall understand the significance of tissue culture as a tool in specialized areas of research.

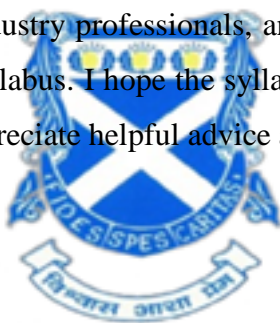
PSO7: Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material. Learner shall also understand related areas in relatively new fields of genetic engineering and biotechnology and get an idea of environmental change occurring at gene level on human health.

PSO8: Learner will understand the different factors affecting environment, its impact and environment management laws. The learners will become acquainted with how and why different animal species are distributed around the globe. Learner will be able to understand various methods for wildlife conservation. Learner will understand the paradigms of discovery and commercialization of biological resources and knowledge gained from self-medication observed in animals



PREAMBLE:

We have great pleasure in presenting the Wilson College (autonomous) T.Y.B.Sc., Zoology syllabus. We have taken into account, when creating the curricula, the need for the student to gain comprehensive knowledge and understanding in the areas of taxonomy, hematology, immunology, animal tissue culture, biostatistics and bioinformatics, histology, and osteology using the most recent and cutting-edge methodologies. Teachers held roundtable discussions to decide which units should be included in the syllabi as they were designing the curricula. In order to include more worthwhile and engaging themes that will improve their proficiency in the field, industry professionals' advice has also been sought. The T.Y.B.Sc. Zoology syllabus perfectly combines fundamental and advanced subject knowledge. The practicals are evenly divided between identification to enhance students' knowledge and performance to give students a hands-on experience in the fields of hematology and immunology, tissue culture method, etc. After reviewing the planned curriculum, I have no belief that the students will find the material provided to them for their fifth and sixth semesters to be enjoyable. I want to express my gratitude to the members of our Board of Directors, industry professionals, and the Zoology Department staff for their invaluable assistance in creating this syllabus. I hope the syllabus is enjoyable for everyone. I hope you have a great time studying. I always appreciate helpful advice and tips.



Thank you all.

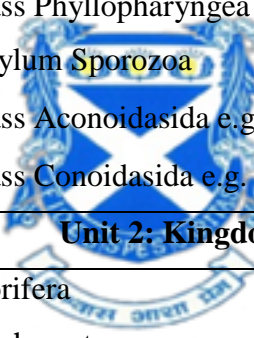
Dr. Sushant Mane,

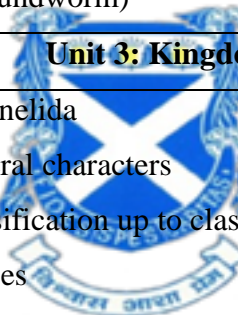
Head of Zoology Deapartemnt.

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 5				
Course: 1		Course Code: USZOO501				
Teaching Scheme		Evaluation Scheme				
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester Examination	End
4	4	0	4 + 2	(Marks- 40)	(Marks- 60)	
<p>Learning Objectives:</p> <ol style="list-style-type: none"> 1. To introduce the principles of taxonomy and modern system of classification in animal kingdom with evolution point of view. 2. To comprehend the general characters and classification of Kingdom Animalia from Porifera to Nematoda and specific characters of organisms belonging to these phyla. 3. To introduce basic concepts of classification up to class in animal kingdom from phylum Annelida to Hemichordata and to familiarize with their characters. 4. To acquaint learners with the details of Sepia as a representative of invertebrate animals 						
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • Learners will apprehend the basis of classification and modern classification up to class of the lower invertebrate animals. • The learners will be familiarized with classification up to phylum Nematoda along with their examples. • Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects. • Learners will get an idea of general characteristics and details of invertebrate animal systems. 						

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Taxonomy - Invertebrates and Type Study	Credits
		Unit 1: Principles of Taxonomy	
	1.1	Levels of Organization: 1.1.1: Unicellularity, colonization of cells, multicellularity 1.1.2: Levels of Organization: Acellular, Cellular, Tissue level, Organ level and 'Organ-system' level	
	1.2	Symmetry 1.2.1: Basic concept and definition 1.2.2: Types: a. Asymmetry: e.g. <i>Amoeba</i> b. Radial symmetry: e.g. Starfish c. Bi-lateral symmetry: e.g. Invertebrate - <i>Planaria</i> Vertebrate - Man 1.2.3: Evolutionary significance of symmetry	
	1.3	Coelom Basic concept and definition 1.3.2: Formation of coelom 1.3.3: Types: a. Acoelomate: Platyhelminthes e.g. Liverfluke b. Pseudocoelomate: Nematoda e.g. Roundworm c. Coelomate: e.g. Frog 1.3.4: Evolutionary significance of coelom	
	1.4	Metamerism 1.4.1: Basic concept and definition 1.4.2: Types: a. Pseudometamerism: e.g. Tapeworm 10 b. True metamerism: i. Homonomous - Annelida e.g. Nereis ii. Heteronomous - Cephalization - Insecta e.g. Dragonfly Cephalothorax - Crustacean e.g. Lobster 1.4.3: Evolutionary significance of metamerism	
	1.5	Taxonomy 1.5.1: Basic concept, definition and objectives 1.5.2: Linnaean Hierarchy, Binomial Nomenclature 1.5.3: Six Kingdom classification: General characters of each Kingdom with examples:	

	<ul style="list-style-type: none"> a) Kingdom Archaeobacteria b) Kingdom Eubacteria c) Kingdom Protista d) Kingdom Fungi e) Kingdom Plantae f) Kingdom Animalia 	
1.6	<p>Kingdom Protista: Animal like Protists: Protozoa</p> <p>1.6.1: General characters of Protozoa</p> <p>1.6.2: Classification of Protozoa with distinguishing features and suitable examples:</p> <ul style="list-style-type: none"> a) Phylum Sarcomastigophora <ul style="list-style-type: none"> • Class Sarcodina e.g. <i>Amoeba</i> • Class Mastigophora e.g. <i>Trypanosoma</i> b) Phylum Ciliophora <ul style="list-style-type: none"> • Class Ciliata e.g. <i>Opalina</i> • Class Phyllopharyngea e.g. <i>Dysteria</i> c) Phylum Sporozoa <ul style="list-style-type: none"> • Class Aconoidasida e.g. <i>Plasmodium</i> • Class Conoidasida e.g. <i>Toxoplasma</i> 	
	 <p>Unit 2: Kingdom Animalia I</p>	
2.1	<p>Phylum Porifera</p> <ul style="list-style-type: none"> a. General characters b. Classification up to class with distinguishing features and suitable examples: <ul style="list-style-type: none"> • Class Calcarea e.g. <i>Leucosolenia</i> (Branched sponge) • Class Hexactinellida e.g. <i>Hyalonema</i> (Glass-rope sponge) • Class Demospongia e.g. <i>Euspongia</i> (Bath sponge) 	
2.2	<p>Phylum Cnidaria</p> <ul style="list-style-type: none"> a. General characters b. Classification up to class with distinguishing features and examples <ul style="list-style-type: none"> • Class Hydrozoa e.g. <i>Hydra</i> • Class Scyphozoa e.g. <i>Aurelia</i> (Jelly fish) • Class Anthozoa e.g. <i>Meandrina</i> (Maze Coral) 	
2.3	Phylum Platyhelminthes	

	<p>a. General characters</p> <p>b. Classification up to class with distinguishing features and examples</p> <ul style="list-style-type: none"> • Class Turbellaria e.g. <i>Dugesia</i> (Planaria) • Class Trematoda e.g. <i>Schistosoma</i> (Blood-fluke) • Class Cestoda e.g. <i>Taenia</i> (Tapeworm) <p>c. Morphology, life cycle and pathogenicity of <i>Fasciola hepatica</i></p>	
2.4	<p>Phylum Nematoda</p> <p>a. General characters</p> <p>b. Classification up to class with distinguishing features and examples</p> <ul style="list-style-type: none"> • Class: Aphasmda (Adenophorea) e.g. <i>Trichinella</i> (Trichina worm) • Class: Phasmida (Secernentea) e.g. <i>Ascaris</i> (Roundworm) 	
 <p>Unit 3: Kingdom Animalia II</p>		
3.1	<p>Phylum Annelida</p> <p>3.1.1: General characters</p> <p>3.1.2: Classification up to class with distinguishing features and examples</p> <ul style="list-style-type: none"> • Class Polychaeta e.g. <i>Neries</i> (Clamworm) • Class Oligochaeta e.g. <i>Pheretima</i> (Earthworm) • Class Hirudinea e.g. <i>Hirudinaria</i> (Leech) 	
3.2	<p>Phylum Arthropoda</p> <p>3.2.1: General characters</p> <p>3.2.2: Classification up to class with distinguishing features and examples</p> <p>a) Subphylum Chelicerata</p> <ul style="list-style-type: none"> • Class Arachnida e.g. <i>Hottentotta</i> (Scorpion) • Class Merostomata e.g. <i>Limulus</i> (Horse-shoe crab) • Class Pycnogonida e.g. <i>Nymphon</i> (Sea spider) <p>b) Subphylum Crustacea</p> <ul style="list-style-type: none"> • Class Malacostraca e.g. <i>Scylla</i> (Crab) • Class Maxillipoda e.g. <i>Balanus</i> (Barnacle) <p>c) Subphylum Uniramia</p>	

	<ul style="list-style-type: none"> • Class Chilopoda e.g. <i>Scolopendra</i> (Centipede) • Class Diplopoda e.g. <i>Xenobolus</i> (Millipede) • Class Insecta e.g. <i>Attacus</i> (Moth)
3.3	<p>Phylum Mollusca</p> <p>3.3.1: General characters of the Phylum</p> <p>3.3.2: Classification up to class with distinguishing features and examples</p> <ul style="list-style-type: none"> • Class Aplacophora e.g. <i>Chaetoderma</i> (Glisten worm solenogaster) • Class Polyplycophora e.g. <i>Chiton</i> (Coat-of-mail shell) • Class Monoplacophora e.g. <i>Neopilina</i> • Class Gastropoda e.g. <i>Nerita</i> (Nerit) • Class Pelecypoda e.g. <i>Solen</i> (Razor clam) • Class Scaphopoda e.g. <i>Dentalium</i> (Tusk shell) • Class Cephalopoda e.g. <i>Nautilus</i> (Pearly nautilus)
3.4	<p>Phylum Echinodermata</p> <p>3.4.1 General characters</p> <p>3.4.2 Classification up to class with distinguishing features and examples</p> <ul style="list-style-type: none"> • Class Asteroidea e.g. <i>Protoreaster</i> (Starfish) • Class Ophiuroidea e.g. <i>Ophiothrix</i> (Brittle star) • Class Echinoidea e.g. <i>Clypeaster</i> (Sand dollar) • Class Holothuroidea e.g. <i>Cucumaria</i> (Sea cucumber) • Class Crinoidea e.g. <i>Antedon</i> (Sea lily)
3.5	<p>Minor phyla</p> <p>3.5.1: General characters along with examples of</p> <ol style="list-style-type: none"> a) Phylum Acanthocephala e.g. <i>Moniliformis</i> b) Phylum Onychophora e.g. <i>Peripatus</i> (Velvet worm) c) Phylum Chaetognatha e.g. <i>Sagitta</i> (Arrow worm) <p>3.5.2: Peripatus, a connecting link - Affinities with Phylum Annelida, Arthropoda and Mollusca.</p>
3.6	<p>Phylum Hemichordata</p> <p>3.6.1: General characters, classification with distinguishing features and examples</p> <ul style="list-style-type: none"> • Class Enteropneusta e.g. <i>Balanoglossus</i> (Acorn

		worm) <ul style="list-style-type: none"> • Class Pterobranchia e.g. <i>Rhabdopleura</i> • Class Planctosphaeroidea e.g. <i>Planctosphaera</i> 	
	3.7	Basic concepts of phylogeny: Phylogenetic tree of invertebrates	
		Unit 4: Type study: Sepia	
	4.1	General characters and classification Habit and habitat, External characters, mantle cavity, locomotion, economic importance.	
	4.2	Systems: Digestive system, Respiratory system, Circulatory system, Excretory system, Nervous system and Sense organs, Reproductive system	



PROGRAM(s): T.Y.B.Sc.		SEMESTER: 5			
Course: 2		Course Code: USZOO502			
Teaching Scheme		Evaluation Scheme			
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination(Marks- 60)
4	4	0	4 +2	(Marks- 40)	(Marks- 60)
<p>Learning Objectives:</p> <ol style="list-style-type: none"> 1. To introduce to the learner the composition of blood, haemorrhage and haematopoiesis. 2. To acquaint the learner with the physiology of blood clotting and clinical aspects of haematology. 3. To introduce to the learner the basics of applied haematology and to impart knowledge of diagnostic techniques used in pathology. 4. To introduce the topic of immunology by emphasizing the basic concepts to build a strong foundation and to give an overview of the immune system that plays an important role in disease resistance. 5. To introduce immunopathology to the learners 6. To introduce the concept of vaccines and vaccination. 7. To familiarise the learner to immunological perspectives of organ transplantation. 					
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • The learner shall comprehend basic haematology. The learner will be able to identify various components of haemostatic systems. • The learner will be familiar with the terminology used and diagnostic tests performed in a pathological laboratory. • The learner shall be acquainted with diagnostic approaches in haematological disorders. • The learner will be better equipped for further pathological course or working in a diagnostic laboratory. • The learner shall comprehend the types of immunity and the components of immune system. • The learner will realize the significant role of immune system in giving resistance against diseases. • The learner shall understand immunopathology and the principles and applications of vaccines. • The learner will develop basic understanding of immunology of organ transplantation. 					

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Haematology and Immunology	Credits
		Unit 1: Basic Haematology	
	1.1	Composition of plasma: Water, respiratory gases, dissolved salts, plasma proteins, nutrients, enzymes, hormones, nitrogenous waste products	
	1.2	Haematopoiesis: Erythropoiesis, leucopoiesis and thrombopoiesis	
	1.3	Erythrocytes: Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia.	
	1.4	Haemoglobin: Structure, formation and degradation; variants of haemoglobin (foetal, adult), abnormalities in haemoglobin (sickle cell and thalassemia)	
	1.5	Leucocytes: Types and functions, total count and variation in number; leukaemia and its types	
	1.6	Thrombocytes: Structure, factors and mechanism of clotting, failure of clotting mechanism.	
	1.7	Blood volume: Total quantity and regulation; haemorrhage	
		Unit 2: Applied Haematology	
	2.1	Introduction and scope of Applied Haematology: Clinical, microbiological, oncological and forensic haematology	
	2.1	Clinical significance of Diagnostic Techniques 2.2.1: Microscopic examination of blood: Blood cancer (lymphoma, myeloma), Infectious diseases (malaria, leishmaniasis), Haemoglobinopathies (sickle cell anaemia, thalassemia) 2.2.2: Coagulopathies: Haemophilia and purpura	
	2.3	Biochemical examination of blood: a) Liver function tests: AST, ALT, LDH, Alkaline phosphatase , Total and direct bilirubin b) Kidney function test: Serum creatinine, Blood Urea Nitrogen (BUN)	

	<p>c) Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated haemoglobin test</p> <p>d) Other biochemical tests: Blood hormones - TSH, FSH, LH.</p>	
	Unit 3: Basic Immunology	
3.1	<p>Overview of Immunology</p> <p>3.1.1: Concept of immunity</p> <p>3.1.2: Innate immunity –</p> <ul style="list-style-type: none"> • Definition, factors affecting innate immunity • Mechanisms of innate immunity - First line of defence - physical and chemical barriers; Second line of defence - phagocytosis, inflammatory responses and fever <p>3.1.3: Adaptive or Acquired immunity, Antibody mediated and cell mediated immunity; Active Acquired immunity - Natural and Artificial; Passive Acquired immunity - Natural and Artificial</p>	
3.2	<p>Cells and Organs of immune system</p> <p>3.2.1: Cells of immune system - B cells, T cells and null cells, macrophages, dendritic cells and mast cells</p> <p>3.2.2: Organs of immune system Primary: Thymus and bone marrow Secondary: Lymph nodes and spleen</p>	
3.3	Antigens: Definition and properties; haptens	
3.4	Antibodies: Definition, basic structure, classes of antibodies - IgG, IgA, IgM, IgD and IgE	
3.5	<p>Antigen processing and presentation</p> <p>3.5.1: Endogenous antigens - cytosolic pathways</p> <p>3.5.2: Exogenous antigens - endocytic pathways</p>	
	Unit 4: Applied Immunology	
4.1	<p>Antigen-Antibody interaction</p> <p>4.1.1: General features of antigen-antibody interaction</p> <p>4.1.2: Precipitation reaction - Definition, characteristics and mechanism.</p> <ul style="list-style-type: none"> • Precipitation in gels (slide test) • Radial immunodiffusion (Mancini method) 	

		<ul style="list-style-type: none"> • Double immunodiffusion (Ouchterlony method) <p>4.1.3: Immuno-electrophoresis - Counter-current and Laurel's Rocket electrophoresis</p> <p>4.1.4: Agglutination reaction definition, characteristics and mechanism.</p> <ul style="list-style-type: none"> • Haemagglutination (slide and micro-tray agglutination) • Passive agglutination • Coomb's test <p>4.1.5: Immunoassay - ELISA</p>	
4.2		<p>Vaccines and Vaccination</p> <p>4.2.1: Principles of vaccines - active and passive immunization, Routes of vaccine administration</p> <p>4.2.2: Classification of vaccines:</p> <ul style="list-style-type: none"> • Live attenuated • Whole-Killed or inactivated • Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines <p>4.2.3: Adjuvants used for human vaccines:</p> <ul style="list-style-type: none"> • Virosomes and Liposomes • Saponins • Water-in-oil emulsions <p>4.2.4: Vaccines against human pathogens:</p> <ul style="list-style-type: none"> • Polio • Hepatitis A and B • Tuberculosis (BCG) 	
4.3		<p>Transplantation Immunology:</p> <ol style="list-style-type: none"> a) Introduction to transplantation b) Types of grafts c) Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte and Antibody mediated graft rejection d) Precautionary measures against graft rejection 	

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 5			
Course: 3		Course Code: USZOO503			
Teaching Scheme		Evaluation Scheme			
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination(Marks- 60)
4	4	0	4 +2	(Marks- 40)	(Marks- 60)
<p>Learning Objectives:</p> <p>To familiarize the learner with the cellular architecture of the various organs in the body.</p> <p>To make the learner understand the need and importance of different types of tissues in the vital organs and their functions.</p> <p>To introduce the learner to the principles of toxicology with particular emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing.</p> <p>It also intends to develop amongst students an introductory understanding of regulatory affairs in toxicology.</p> <p>To introduce the learner to basics of general pathology.</p> <p>To impart knowledge of retrogressive, necrotic, pathological conditions in the body. To explain repair mechanism of the body.</p> <p>To make learner familiar with biostatistics as an important tool of analysis and its applications.</p>					
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • Learner would appreciate the well planned organization of tissues and cells in the organ systems. • The course will prepare learner to develop broad understanding of the different areas of toxicology. • It will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas. • Learner will be familiar with various medical terminology pertaining to pathological condition of the body caused due to diseases. • The learner will be able to collect, organize and analyse data using parametric and nonparametric tests. • They will also be able to set up a hypothesis and verify the same using limits of significance. 					

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Histology, Toxicology, Pathology and Biostatistics	Credits
		Unit 1: Mammalian Histology	
	1.1	Vertical section (V.S.) of skin: Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors	
	1.2	Digestive System 1.2.1: Vertical section (V.S.) of tooth; hard tissue - dentine and enamel; soft tissue - dentinal pulp and periodontal ligaments 1.2.2: Transverse section (T.S.) of tongue - mucosal papillae and taste buds 1.2.3: Alimentary canal - Transverse section (T.S.) of stomach, small intestine, large intestine of mammal. 1.2.4: Glands associated with digestive system - Transverse section (T.S.) of salivary glands, liver.	
		Unit 2: Toxicology	
	2.1	2.1.1: Introduction to toxicology - brief 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, Sub-acute toxicity, Sub-chronic toxicity and Chronic 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) 2.1.8: Target organ toxicity: Hepatotoxicity: susceptibility of the liver, types of liver injury, examples of	

	hepatotoxicants; Neurotoxicity: vulnerability of nervous system, examples of neurotoxicants; Nephrotoxicity: susceptibility of kidney, examples of nephrotoxicants	
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: General Pathology	
3.1	General Pathology: Introduction and scope	
3.2	Cell injury: Mechanisms of cell injury: ischemic, hypoxic, free radical mediated and chemical	
3.3	Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)	
3.4	Disorders of pigmentation: Endogenous: Brief ideas about normal process of pigmentation, melanosis, jaundice (causes and effects)	
3.5	Necrosis: Definition and causes; nuclear and cytoplasmic changes; types: coagulative, liquefactive, caseous, fat and fibroid.	
3.6	Gangrene: Definition and types - dry, moist and gas gangrene	
	Unit 4: Biostatistics	
4.1	Probability Distributions: Normal, Binomial, Poisson distribution, Z-transformation, pvalue, Probability - Addition and multiplication rules a	
4.2	Measures of Variation: Variance, standard deviation, standard error	
4.3	Testing of Hypothesis: Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis, Levels of significance and testing of hypothesis	
4.4	Parametric and non-parametric test: Parametric tests: two-tailed Z-test and t-test Non-parametric test: Chi-square test and its applications	
4.5	Correlation: Correlation coefficient and its significance	

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 5			
Course: 4		Course Code: USZOO504			
Teaching Scheme		Evaluation Scheme			
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination(Marks- 60)
4	4	0	4 +2	(Marks- 40)	(Marks- 60)
<p>Learning Objectives:</p> <p>To introduce the learner to understand different integumentary structures and derivatives in the vertebrates and to acquaint learners with special derivatives of integument.</p> <p>To introduce the learner to different bones of human skeleton and their functional importance.</p> <p>To study long limb muscles involved in body movements.</p> <p>To identify various arrangements of the long limb muscles and to relate the arrangement with contraction and motion.</p> <p>To study muscle injuries and syndromes.</p> <p>To introduce the learner to the basics of developmental biology with reference to chick as a model and also familiarize with experiments related to it.</p>					
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • Learner will be able to understand the importance of various types of epidermal and dermal derivatives along with their functions. • Learner will be able to understand the structure, types and functions of human skeleton. • Learner will be able to understand the types of long limb muscles, its arrangement and their role in body movements. • Learner will be able to understand the processes involved in embryonic development and practical applications of studying the chick embryology. 					


DETAILED SYLLABUS

Course Code	Sub unit	Course/Title	Credits
		Anatomy and Developmental Biology	
		Unit 1: Integumentary system and derivatives	
	1.1	Basic structure of integument: Epidermis and dermis	
	1.2	Epidermal derivatives of Vertebrates 1.2.1: Hair, hoof, horn, claw, teeth, beak and epidermal scales (small scales, large scales, modified scales - spine) 1.2.2: Glands - types (mucous, serous, ceruminous, poison, uropygial and salt gland) and functions 1.2.3: Type of feathers	
	1.3	Dermal derivatives of Vertebrates: Scales in fish; scutes in reptiles and birds; dermal scales in mammals - Armadillo, Antler - Caribou	
	1.4	Special derivatives of integument: Wart in toad, rattle in snake, whale bone in baleen whale, kneepads in camel.	
		Unit 2: Human Osteology	
	2.1	Introduction: Bone structure (Histology), physical properties, chemical composition and general functions of bones. Cartilage: General structure, functions.	
	2.2	Axial skeleton 2.2.1: Skull: General characteristics of skull bones - Cranial and facial bones 2.2.2: Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum and coccyx) 2.2.3: Ribs and sternum: General skeleton of ribs and sternum 2.2.4: Hyoid bone: Structure and function.	
	2.3	Appendicular skeleton 2.3.1: Pectoral girdle and bones of forelimbs 2.3.2: Pelvic girdle and bones of hind limbs	
		Unit 3: Muscles of long bones of Human limbs	
	3.1	Introduction and types of long limb muscles 3.1.1: Flexors, Extensor, Rotator, Abductors, Adductors	
	3.2	Muscles of forelimbs	

	<p>3.2.1: Muscles that move the arm (Humerus) - Triceps brachii, Biceps brachii, brachialis and brachioradialis</p> <p>3.2.2: Muscles that move the forearm (Radius-ulna) - Flexor carpi radialis, Flexor carpi ulnaris and Extensor carpi ulnaris</p> <p>3.2.3: Muscles that move the wrist, hand and fingers - Flexor digitorum superficialis, Extensor carpi radialis and Extensor digitorum</p>	
3.3	<p>Muscles of hindlimbs</p> <p>3.3.1: Muscles that move the thigh (Femur) - Sartorius, Adductor group, Quadriceps group (Rectus femoris, Vastus lateralis, Vastus medialis), Hamstring group (Biceps femoris, Semimembranosus, Semitendinosus)</p> <p>3.3.2: Muscles that move the lower leg (tibia-fibula) - Fibularis longus, Gastrocnemius, Tibialis anterior, Soleus, Extensor digitorum longus and Fibularis tertius</p> <p>3.3.3: Muscles that move the ankle, foot and toes - Tibialis anterior, Extensor digitorum, Longus and Fibularis muscles</p>	
	<p>Unit 4: Developmental biology of Chick</p>	
4.1	<p>Introduction to Developmental Biology: Basic concept and principles of developmental biology - morphogenesis, organogenesis, fate maps, cell adhesion, cell affinity and cell differentiation.</p>	
4.2	<p>Development of Chick embryo</p> <p>4.2.1: Structure of Hen's egg, physico-chemical nature and forms of yolk - granular, platelets and spheres; fertilization, cleavage, blastulation, gastrulation</p> <p>4.2.2: Structure of chick embryo - 18hours, 24 hours, 33 hours, 48 hours and 72 hours</p> <p>4.2.3: Extra embryonic membranes</p> <p>4.2.4: Organizer: Introduction, Spemann Mangold experiment, Hensen's node as an organizer</p>	

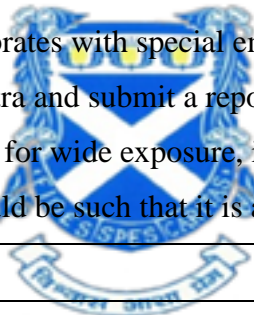
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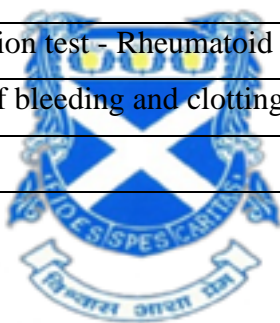
Practical Course Code	Sr no.	Zoology Practical 1 based on Taxonomy - Invertebrates and Type Study	Credits
	1	Classification of phyla up to class and study of the general characters up to class. Kingdom Protista - Animal-like Protists: Protozoa A. Phylum: Sarcomastigophora <ul style="list-style-type: none"> • Class Sarcodina e.g. <i>Amoeba</i> • Class Mastigophora e.g. <i>Euglena</i> B. Phylum: Ciliophora <ul style="list-style-type: none"> • Class Ciliata e.g. <i>Paramecium</i> • Class Phyllopharyngea e.g. <i>Dysteria</i> C. Phylum: Sporozoa, <ul style="list-style-type: none"> • Class Aconoidasida e.g. <i>Eimeria</i> • Class Conoidasida e.g. <i>Sarcocystis</i> 	
	D. E.	Phylum: Porifera <ul style="list-style-type: none"> • Class Calcarea e.g. <i>Scypha</i> (Little vase sponge) • Class Hexactinellida e.g. <i>Hyalonemma</i> (Glass-rope sponge) • Class Demospongia e.g. <i>Spongilla</i> (Freshwater sponge)  Phylum Cnidaria <ul style="list-style-type: none"> • Class Hydrozoa e.g. <i>Vellela</i> (By-the-wind sailor) • Class Scyphozoa e.g. <i>Rhizostoma</i> (Barrel jellyfish) • Class Anthozoa e.g. <i>Corallium</i> (Coral) 	
	F. G.	Phylum Platyhelminthes <ul style="list-style-type: none"> • Class Turbellaria e.g. <i>Dugesia</i> (Planaria) • Class Trematoda e.g. <i>Fasciola</i> (Liverfluke) • Class Cestoda e.g. <i>Taenia</i> (Tapeworm) Phylum Nematoda <ul style="list-style-type: none"> • Class Aphasmdida (Adenophorea) e.g. <i>Trichinella</i> (Trichina worm) • Class Phasmida (Secernentea) e.g. <i>Ascaris</i> (Roundworm) 	
	H.	Phylum Annelida <ul style="list-style-type: none"> • Class Polychaeta e.g. <i>Arenicola</i> (Lugworm) 	

		<ul style="list-style-type: none"> • Class Oligochaeta e.g. <i>Tubifex</i> (Sludge worm) • Class Hirudinea e.g. <i>Pontobdella</i> (Marine leech) 	
	I.	<p>Phylum Arthropoda</p> <p>Subphylum Chelicerata</p> <ul style="list-style-type: none"> ▪ Class Arachnida e.g. <i>Hotentotta</i> (Scorpion) ▪ Class Merostomata e.g. <i>Limulus</i> (Horseshoe crab) ▪ Class Pycnogonida e.g. <i>Nymphon</i> (Sea spider) <p>Subphylum Crustacea</p> <ul style="list-style-type: none"> ▪ Class Malacostraca e.g. <i>Panulirus</i> (Lobster) ▪ Class Maxillipoda e.g. <i>Cyclops</i> (Copepods) <p>Subphylum Uniramia</p> <ul style="list-style-type: none"> ▪ Class Chilopoda e.g. <i>Scolopendra</i> (Centipedes) ▪ Class Diplopoda e.g. <i>Xenobolus</i> (Millipedes) ▪ Class Insecta e.g. <i>Attacus</i> (Moth) 	
	J.	<p>Phylum Mollusca</p> <ul style="list-style-type: none"> • Class Aplacophora e.g. <i>Chaetoderma</i> (Glisten worm solenogaster) • Class Polyplacophora e.g. <i>Tonicella</i> (Lined Chiton) • Class Monoplacophora e.g. <i>Neopilina</i> • Class Gastropoda e.g. <i>Turbo</i> (Turban shell) • Class Pelycypoda e.g. <i>Donax</i> (Wedge shell) • Class Scaphopoda e.g. <i>Dentalium</i> (Tusk shell) • Class Cephalopoda e.g. <i>Octopus</i> 	
	K.	<p>Phylum Echinodermata</p> <ul style="list-style-type: none"> • Class Asterozoa e.g. <i>Asterias</i> (Starfish) • Class Ophiurozoa e.g. <i>Ophiothrix</i> (Brittle star) • Class Echinozoa e.g. <i>Echinus</i> (Sea urchin) • Class Holothurozoa e.g. <i>Cucumaria</i> (Sea cucumber) • Class Crinozoa e.g. <i>Crinoid</i> (Sea lily) 	
	L.	<p>Phylum Hemichordata</p> <ul style="list-style-type: none"> • Class Enteropneusta e.g. <i>Saccoglossus</i> • Class Pterobranchia e.g. <i>Rhabdopleura</i> • Class Planctosphaerozoa e.g. <i>Planctosphaera</i> 	
	2.	<p>Minor Phyla</p> <p>Acoelomate</p>	
	M.	<p>Phylum Acanthocephala e.g. <i>Echinorhynchus</i></p>	

	N. O.	Coelomate Phylum Chaetognatha e.g. <i>Sagitta</i> Phylum Onychophora e.g. <i>Peripatus</i> (Velvet worm)	
	3.	Study of <i>Sepia</i> with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected. <ul style="list-style-type: none"> a) Digestive system, b) Reproductive system c) Nervous system d) Jaws e) Radula e) Chromatophores f) Spermatophores g) Statocyst 	
	4.	Study tour - Visit to fish market / Aquarium / Local Gardens / Local available niche / National Parks / Sanctuaries / and such other places to observe invertebrates with special emphasis on Western Ghats and coast of Maharashtra and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.	



Practical Course Code	Sr no.	Zoology Practical 2 based on Hematology and Immunology	Credits
	1.	Enumeration of Erythrocytes - Total Count.	
	2.	Enumeration of Leucocytes - Total Count	
	3.	Differential count of Leucocytes.	
	4.	Erythrocyte Sedimentation Rate by suitable method - Westergren or Wintrobe method.	
	5.	Estimation of haemoglobin by Sahli's acid haematin method	
	6.	Determination of serum LDH by using colorimeter / spectrophotometer	
	7.	Estimation of total serum/ plasma proteins by Folin's method.	
	8.	Estimation of serum/ plasma total triglycerides by Phosphovanillin method.	
	9.	Latex agglutination test - Rheumatoid Arthritis.	
	10.	Determination of bleeding and clotting time.	



Practical Course Code	Sr no.	Zoology Practical 3 based on Histology, Toxicology, Pathology and Biostatistics	Credits
	1.	Study of mammalian tissues: V.S. of Tooth, T.S. of Stomach, T.S. of small intestine, T.S. of Liver.	
	2.	Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.	
	3.	Identification of diseases or conditions (from slides or pictures): Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema	
	4.	To study the effect of CCl ₄ on the level of enzyme activity in liver on aspartate and alanine amino transferase, alkaline phosphatase (in vitro approach).	
	5.	Study and interpretation of abnormal pathological reports: Blood (CBC), Urine (Routine) and Stool (Routine).	
	6.	<p>Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) and manually:</p> <ul style="list-style-type: none"> a. Problems based on Z-test b. Problems based on t-test c. Problems based on Chi-square test d. Correlation, regression analysis - demonstration only. e. Problems based on ANOVA - demonstration only. <p>(Learner is expected to identify appropriate test for the given problem)</p>	

Practical Course Code	Sr no.	Zoology Practical 4 based on Anatomy and Developmental Biology.	Credits
	1.	Study of integumentary systems - V. S. of Skin of Shark, Frog, Calotes, Pigeon and Human.	
	2.	Study of Human Axial Skeleton - Skull (whole) and Vertebral column (axis, atlas, typical cervical, typical thoracic, typical lumbar, sacrum, coccyx)	
	3.	Study of Human Appendicular Skeleton - Pectoral and pelvic girdle with limb bones	
	4.	Study of muscles of forelimbs - Biceps brachii, Brachialis, Brachio radialis, Triceps brachii, Flexor carpi radialis, Flexor carpi ulnaris and Extensor carpi ulnaris	
	5.	Study of muscles of hind limbs - Sartorius, Adductor group, Quadriceps group Rectus femoris, Vastus lateralis, Vastus medialis, Hamstring group (Biceps femoris, Semimembranosus, Semitendinosus), Fibularis longus, Gastrocnemius Tibialis anterior, Soleus, Extensor digitorum longus, Fibularis tertius.	
	6.	Study of ontogeny of chick embryo using permanent slides - 18 hours, 24 hours, 33 hours, 48 hours and 72 hours.	
	7.	Preparation of temporary mounting of chick embryo up to 48 hours of incubation.	

MODALITY OF ASSESSMENT.**A. Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Case study/ field visit report/ presentation/ project	20
	Total	40

B. External Examination- 60%- 60 Marks per paper**Semester End Theory Examination:**

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
 - a. There shall be 3 questions each of 20 marks one on each unit.
 - b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
1a	100 %	10	Unit I
1b	100 %	05	
2a	100 %	10	Unit II
2b	100 %	05	
3a	100 %	10	Unit III
3b	100 %	05	
4a	100 %	10	Unit IV
4b	100 %	05	
	TOTAL	60	

Practical Examination Pattern:**A. Internal Examination: 40%- 40 Marks**

Particulars	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	05
Experimental tasks	10	10	10	10

Participation	05	05	05	05
Total	20	20	20	20

B. External Examination: 60%- 60 Marks

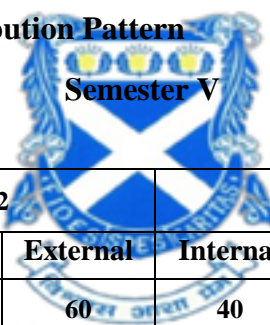
Semester End Practical Examination:

Particulars	Paper I	Paper II	Paper III	Paper IV
Laboratory work	10	10	10	10
Viva + Spots + Report	20	20	20	20
Total	30	30	30	30

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified.
The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern



COURSE	1		2		3		4		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
THEORY	40	60	40	60	40	60	40	60	400
PRACTICALS	20	30	20	30	20	30	20	30	200

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 6				
Course: 5		Course Code: USZOO601				
Teaching Scheme		Evaluation Scheme				
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester Examination.	End
4	4	0	4 + 2	(Marks- 40)	(Marks- 60)	
<p>Learning Objectives:</p> <ol style="list-style-type: none"> 1. To introduce basic concepts of modern Chordate classification with evolution point of view and to understand the concept of taxonomy in higher animal kingdom. 2. To introduce the learners to the distinguishing characters of classes Reptilia, Aves and Mammalia and their adaptive features with reference to their habitat. 3. To study in depth one vertebrate animal type i. e. general characteristics and salient features of animal type - shark. 						
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • Learners will get an idea of origin of Chordates, its taxonomy up to class with reference to phylogeny and their special features. • Learners will understand the characteristic features and examples of class of Reptilia, Aves and Mammalia. • Learners will get an idea of vertebrate animal life after studying one representative animal - shark. 						

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Taxonomy - Chordates and Type Study	Credits
		Unit 1: Phylum Chordata: Group Protochordata and Group Euchordata I	
	1.1	General characters, Difference between non-chordates and chordates Origin of chordates: Annelids as ancestors, Arachnids as ancestors and affinities with Echinodermata	
	1.2	Protochordata 1.2.1: General characters of Group Protochordata 1.2.2: Distinguishing characters of Subphylum Urochordata and Cephalochordata 1.2.3: Subphylum Urochordata <ul style="list-style-type: none"> • Class Ascidiacea e.g. <i>Herdmania</i> • Class Thaliacea e.g. <i>Salpa</i> • Class Larvacea e.g. <i>Oikopleura</i> 1.2.4: Subphylum Cephalochordata <ul style="list-style-type: none"> • Class Leptocardii e.g. <i>Branchiostoma</i> (Amphioxus) 	
	1.3	Group Euchordata I Group Euchordata: General characters Subphylum Vertebrata: General characters Division Agnatha and Gnathostomata: Distinguishing characters. General characters with examples of: <ul style="list-style-type: none"> • Class Ostracodermii e.g. <i>Cephalaspis</i> • Class Cyclostomata e.g. <i>Petromyzon</i> (Lamprey) 	
		Unit 2: Group Euchordata II	
	2.1	Division: Gnathostomata Superclass: Pisces and Tetrapoda Superclass - Pisces: Distinguishing characters <ul style="list-style-type: none"> • Class Placodermi e.g. <i>Climatius</i> • Class Chondrichthyes e.g. <i>Rhinobatos</i> (Guitar fish) • Class Osteichthyes e.g. <i>Exocetus</i> (Flying fish) 	
	2.2	Dipnoi (Lung fish): Distribution, habit and habitat, external and internal characters, affinities with super class Pisces,	

		affinities and differences with class Amphibia	
2.3	Superclass Tetrapoda	<ul style="list-style-type: none"> • Class Amphibia: General characters Examples: <ol style="list-style-type: none"> a. Limbless amphibian e.g. <i>Ichthyophis</i> (Caecilian) b. Tailed amphibian e.g. <i>Amphiuma</i> c. Tailless amphibian e.g. <i>Hyla</i> (Tree frog) 	
		Unit 3: Group Euchordata III	
3.1	Class Reptilia:	General characters Examples <ol style="list-style-type: none"> a. Extinct reptile e.g. <i>Ichthyosaurus</i> b. Living fossil e.g. <i>Sphenodon</i> (Tuatara) c. Aquatic reptile e.g. <i>Chelonia</i> (Sea turtle) a. d. Arboreal reptile e.g. <i>Chamaeleo</i> (Chamaeleon) 	
3.2	Class Aves:	General Characters Examples <ol style="list-style-type: none"> a. Arboreal bird e.g. <i>Melanerpes</i> (Wood pecker) b. Terrestrial bird e.g. <i>Gallus</i> (Fowl) c. Swimming bird e.g. <i>Phalacrocorax</i> (Cormorant) d. Wading bird e.g. <i>Ardeola</i> (Heron) e. Birds of prey e.g. <i>Tyto</i> (Owl) f. Flightless birds e.g. <i>Dromaius</i> (Emu) 	
3.3	Class Mammalia:	General characters Examples <ol style="list-style-type: none"> a. Egg-laying mammals e.g. <i>Ornithorhyncus</i> (Duck-billed platypus) b. Pouched mammals e.g. <i>Macropus</i> (Kangaroo) c. Insect eating mammals e.g. <i>Sorex</i> (Common shrew) d. Toothless mammals e.g. <i>Bradypus</i> (Sloth) e. Gnawing mammals e.g. <i>Funambulus</i> (Squirrel) f. Primates e.g. <i>Macaca</i> (Monkey) 	
		Unit 4: Type study: Shark	
4.1		Habit & habitat, distribution, external characters, classification and economic importance.	
4.2		Skin, exoskeleton, endoskeleton and systems <ol style="list-style-type: none"> a) Digestive system b) Respiratory system 	

		c) Blood vascular system d) Nervous system and receptor organs e) Urinogenital system, copulation, fertilization and development	
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PROGRAM(s): T.Y.B.Sc.		SEMESTER: 6				
Course: 6		Course Code: USZOO602				
Teaching Scheme		Evaluation Scheme				
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester Examination	End
4	4	0	4 + 2	(Marks- 40)	(Marks- 60)	
<p>Learning Objectives:</p> <ol style="list-style-type: none"> 1. To introduce to the learner the fundamental concepts of enzyme biochemistry and to enable the learner realize applications of enzymes in basic and applied sciences. 2. To introduce to the learner the concept of homeostasis-thermoregulation and osmoregulation 3. To introduce to the learner the details of endocrine glands and its disorders. 4. To introduce to the learner the fundamental concepts of tissue culture and guide them progressively to certain areas of animal tissue culture. 						
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • The learner shall understand fundamentals of enzyme structure, action and kinetics. The learner shall appreciate the enzyme assay procedures and the therapeutic applications of enzymes. • The learner shall comprehend the adaptive responses of animals to environmental changes for their survival. • The learner shall understand the types and secretions of endocrine glands and their functions. • The learner shall understand the significance of tissue culture as a tool in specialized areas of research. • The learner will appreciate its applications in various industries. 						

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Physiology and Tissue Culture	Credits
		Unit 1: Enzymology	
	1.1	Introduction and Nomenclature: Definition; concept of activation energy; nomenclature and classification (based on IUB - Enzyme Commission) of enzymes; chemical nature of enzyme, co-factors and co-enzymes	
	1.2	Enzyme Action and Kinetics: Mechanism; Factors affecting enzyme activity - substrate, pH and temperature. Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of Km, Vmax and Kcat	
	1.3	Enzyme Inhibition: Competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors	
	1.4	Regulation of Enzyme Activity: Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)	
	1.5	Industrial applications of enzymes: Food and detergents	
		Unit 2: Homeostasis	
	2.1	Homeostasis 2.1.1: External and internal environment; Acclimation and acclimatization 2.1.2: Body clock - Circadian & Diurnal rhythm	
	2.2	Thermoregulation 2.2.1: Endothermy and ectothermy 2.2.2: Temperature balance: Heat production - shivering and non-shivering thermogenesis; brown fat, mechanisms of heat loss 2.2.3: Adaptive response to temperature - daily torpor, hibernation, aestivation	
	2.3	Osmotic and Ionic Regulation 2.3.1: Living in hypo-osmotic, hyper-osmotic and terrestrial environment - Water absorption, salt water ingestion and salt	

	excretion, salt glands, metabolic water 2.3.2: Role of kidney in ionic regulation	
	Unit 3:Endocrinology	
3.1	General organization of mammalian endocrine system	
3.2	Hormones: Classification, properties, mechanism of hormone action.	
3.3	Histology, functions and disorders of the following endocrine glands: a) Pituitary b) Thyroid c) Parathyroid d) Pancreas e) Adrenal	
	Unit 4: Animal Tissue Culture	
4.1	Aseptic techniques 4.1.1: Sterilization - basic principles of sterilization, importance of sterility in cell culture 4.1.2: Sterile handling - swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring	
4.2	Culture media 4.2.1: Types of media - Natural and Artificial media 4.2.2: Balanced Salt Solutions 4.2.3: Complete Media - amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics 4.2.4: Factors influencing cell culture - surface tension and foaming, viscosity, temperature, osmolality, pH, CO ₂ , bicarbonate and O ₂	
4.3	Advantages of tissue culture - control of the environment, in vitro modelling of in vivo conditions	
4.4	Limitations of tissue culture	
4.5	Culture techniques 4.5.1: Preparation of cells / organs for culture 4.5.2: Cover slip, Flask and Tube culture 4.5.3: Primary and established cell lines 4.5.4: Hybridoma technology	

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 6				
Course: 7		Course Code: USZOO603				
Teaching Scheme		Evaluation Scheme				
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester Examination.	End
4	4	0	4 + 2	(Marks- 40)	(Marks- 60)	
<p>Learning Objectives:</p> <ol style="list-style-type: none"> 1. To introduce learner to chemical and molecular processes that affect genetic material. 2. To make learner understand the concept of DNA damage and repair, and how gene control is necessary for cell survival. 3. To introduce learner to a set of techniques to modify an organism's genome to produce improved or novel genes and organisms. 4. To introduce learner with genetic alterations in human genome and their diagnosis. 5. To introduce learner to bioinformatics - a computational approach to learning the structure and organization of genomes, phylogeny and metabolism. 						
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material. • Learner will be able to recognize the significance of molecular biology as a basis for the study of other areas of biology and biochemistry. • Learner shall also understand related areas in relatively new fields of genetic engineering and biotechnology. • The learner shall get acquainted with the vast array of techniques used to manipulate genes which can be applied in numerous fields like medicine, research, etc. for human benefit. • The learner shall become aware of the impact of changes occurring at gene level on human health and its diagnosis. • Learner shall become aware of the computational point of view of studying the genomes. 						

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Genetics and Bioinformatics	Credits
		Unit 1: Molecular Biology	
	1.1	Types of mutation 1.1.1: Point mutations - substitution, deletion and insertion mutations Substitution mutations - silent, missense and nonsense mutations, transition and transversion Deletion and Insertion mutations - frameshift mutations 1.1.2: Trinucleotide repeat expansions - fragile X syndrome, Huntington disease 1.1.3: Spontaneous mutation - tautomeric shifts, spontaneous lesions	
	1.2	Induced mutations 1 .2.1: Physical agents. Ionizing radiation (X-rays, α , β and γ rays) Non-ionizing radiation (UV light) 1.2.2: Chemical agents: <ul style="list-style-type: none"> • Base analogs (5-bromouracil) • Intercalating agents (ethidium bromide) • Deaminating agents (nitrous acid) • Hydroxylating agents (hydroxylamine) • Alkylating agents (mustard gas) • Aflatoxin (aflatoxin B1) 	
	1.3	Preventative and repair mechanisms for DNA damage 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: Postreplication repair - recombination repair, mismatch repair, SOS repair	
	1.4	Eukaryotic gene expression 1.4.1: Regulatory protein domains - zinc fingers, helix-turn-helix domain and leucine zipper 1.4.2: DNA methylation	

		Unit 2: Genetic Engineering	
2.1		<p>Tools in Genetic Engineering</p> <p>2.1.1: Enzymes involved in Genetic Engineering: Introduction, nomenclature and types of restriction enzymes with examples, Ligases - E. coli DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA polymerases, reverse transcriptase, terminal transferase</p> <p>2.1.2: Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors - plasmid vectors (pBR322), phage vectors (λ Phage), cosmid vectors (c2XB)</p> <p>2.1.3: 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</p>	
2.2		<p>Techniques in Genetic Engineering</p> <p>2.2.1: PCR techniques: Principle of polymerase chain reaction (PCR), Applications of PCR</p> <p>2.2.2: Sequencing techniques: DNA sequencing: Maxam-Gilbert method, Sanger's method Protein sequencing: Sanger's method, Edman's method Applications of sequencing techniques</p> <p>2.2.3: Detection techniques: Blotting techniques - Southern blotting, Northern blotting and Western blotting Applications of blotting techniques</p>	
		Unit 3: Human Genetics	
3.1		<p>Non-disjunction during mitosis and meiosis</p> <p>3.1.1: Chromosomal Aberrations: Structural:</p> <ul style="list-style-type: none"> • Deletion: types, effects and disorders; • Translocation: types: Robertsonian and non-Robertsonian disorders; • Inversion: types, effects and significance; • Duplication and their evolutionary significance (multigene families) • Numerical: Aneuploidy and Polyploidy 	

	(Autopolyploidy and Allopolyploidy)	
3.2	<p>Genetic Disorders</p> <p>3.2.1: Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism</p> <p>3.2.2: Single gene mutation: Cystic fibrosis</p> <p>3.2.3: Multifactorial: Breast Cancer</p> <p>3.2.4: Uniparental Disomy: Angelman Syndrome and Prader-Willi Syndrome</p>	
3.3	<p>Diagnosis</p> <p>3.3.1: Prenatal Diagnosis: Amniocentesis and Chorionic villus sampling, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT)</p> <p>3.3.2: Genetic counselling</p>	
	Unit 4: Bioinformatics	
4.1	<p>Introduction</p> <p>4.1.1: Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, OMIM, PubMed)</p> <p>4.1.2: Applications of Bioinformatics</p>	
4.2	<p>Databases - Tools and their uses</p> <p>4.2.1: Biological databases; Primary sequence databases:</p> <ul style="list-style-type: none"> • Nucleic acid sequence databases (GenBank, EMBLEBI, DDBJ) Protein sequence databases (UniProtKB, PIR) • Secondary sequence databases • Derived databases - PROSITE, BLOCKS Structure databases and bibliographic databases 	
4.3	<p>Sequence alignment methods</p> <p>4.3.1: BLAST, FASTA</p> <p>4.3.2: Types of sequence alignment (Pairwise & Multiple sequence alignment)</p> <p>4.3.3: Significance of sequence alignment</p>	
4.4	<p>Predictive applications using DNA and protein sequences</p> <p>4.4.1: Evolutionary studies: Concept of phylogenetic tree, convergent and parallel evolution</p> <p>4.4.2: Pharmacogenomics: Discovering a drug: Target identification</p>	

		4.4.3: Protein Chips and Functional Proteomics: Different types of protein chip (detecting and quantifying), applications of Proteomics 4.4.4: Metabolomics: Concept and applications	
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PROGRAM(s): T.Y.B.Sc.		SEMESTER: 6				
Course: 8		Course Code: USZOO604				
Teaching Scheme		Evaluation Scheme				
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA)	Semester Examination.	End
4	4	0	4 + 2	(Marks- 40)	(Marks- 60)	
<p>Learning Objectives:</p> <ol style="list-style-type: none"> 1. Learner should understand different factors affecting the environment and various methods to improve environmental stewardship. 2. To sensitize learner regarding the various threats to the wildlife. 3. To introduce learner various ways that can help in the protection, conservation, management, and enhancement of wildlife populations and habitat. 4. To introduce the learner to the concepts of bioprospecting and zoopharmacognosy. 5. To introduce learner with various ethological aspects by which non-human animals apparently self-medicate themselves. 6. To introduce learner to the geographic distribution (present and past) of animal species. 7. To introduce learner to various ways of animal distribution. 						
<p>Course Outcomes:</p> <ul style="list-style-type: none"> • Learner will understand the different factors affecting environment, its impact and environment management laws. • Learner will be able to understand various methods for wildlife conservation. • Learner will be able to apply knowledge to overcome the issues related to wildlife conservation and management. • Learner will be made aware of the process of discovery and commercialization of new products based on biological resources. • Learner will understand the paradigms of discovery and commercialization of biological resources and knowledge gained from self-medication observed in animals • The learners will become acquainted with how and why different animal species are distributed around the globe. 						

DETAILED SYLLABUS

Course Code	Sub unit	Course/Title Environmental Biology and Zoopharmacognosy	Credits
		Unit 1: Environment management	
	1.1	Natural resources and their Classification 1.1.1: Forest resources, water resources (surface and ground) and mineral resources 1.1.2: Energy resources: renewable (solar, tidal, wind, biofuel) and non-renewable resources (coal, petroleum oil, natural gas)	
	1.2	Exploitation and Modification of Natural Resources: Impact on climate, flora and fauna)	
	1.3	Waste Management 1.3.1: Technologies in solid waste management: a) Traditional methods for solid waste management: Composting, Incineration, Landfill Recycling, Windrow composting b) Modern methods for solid waste management: Anaerobic digestion, ethanol production, biodrying, pyrolysis, Upflow anaerobic sludge blanket (UASB) technology, waste autoclave 1.3.2: e-waste and hazardous waste (biological, chemical, medical and nuclear) management	
	1.4	Water management 1.4.1: Rainwater harvesting: Definition ways of harvesting, components, model of rain water harvesting: Rural and Urban, Advantages and disadvantages 1.4.2: Watershed management: Definition, need and objectives, classification (mini, micro, mili, sub-watershed, macro-watershed), Watershed management practices: Contour, gully control, stone bunds. Growing greenery and integrated watershed approach (IWA). 1.4.3: Case study: Ice-stupa artificial glaciers by Sonam Wangchuk 1.4.4: Effluent treatment, recycling plants, control and treatment of sewage water.	
	1.5	Acts and Rules of Environment Management	

	<p>1.5.1: Environment Protection Act - 1986, Air (Prevention and Control of Pollution) Act - 1981, Water (Prevention and Control of Pollution) Act - 1974</p> <p>1.5.2: Hazardous Wastes (Management and Handling) Rules - 1989</p> <p>1.5.3: EIA (Environmental Impact Assessment)</p> <p>1.5.4: Role of Central and State Government (Pollution Control Board) and NGOs</p>	
	Unit 2: Wildlife Management	
2.1	Habit, Habitat, Territory and Niche of Wild Animals: Herbivores, carnivores, solitary, social (flock, pod, community), pack and herd, types of habitats and territories, niche concept	
2.2	<p>Threats to Wildlife</p> <p>2.2.1: Poaching and hunting, deforestation, encroachment, competition (intra-specific and inter-specific), overgrazing and climate change, diseases (zoonosis and reverse zoonosis)</p> <p>2.2.2: Tourism and human animal conflict</p>	
2.3	<p>Wildlife Conservation</p> <p>2.3.1: Techniques and methods used for wildlife census: Aerial counts, camera trap, line transect census and track surveys, capture mark recapture method, wildlife radio telemetry</p> <p>2.3.2: Forest management, policies and Acts:</p> <ul style="list-style-type: none"> • Harvesting Trees, Thinning harvest, Clearcut Harvest, Shelterwood harvest, Seed tree harvest, Group selection harvest, Single-tree selection harvest, Prescribed burning, • Reforestation Forest policy 1894, 1952, 1988; The Indian Forest Act, 1927; Forest (Conservation) Act, 1980. 	
	Unit 3: Bioprospecting and Zoopharmacognosy	
3.1	<p>Bioprospecting</p> <p>3.1.1: Traditional and modern bioprospecting, economic value of bioprospecting</p> <p>3.1.2: Bioprospecting and conservation, advantages and</p>	

		disadvantages	
3.2		<p>Zoopharmacognosy</p> <p>3.2.1: Definition and types</p> <p>3.2.2: Self-medication and its mechanism</p> <p>3.2.3: Methods of self-medication through:</p> <ul style="list-style-type: none"> a) Ingestion - ants and mammals b) Geophagy - invertebrates and birds c) Absorption and adsorption <p>3.2.4: Applications - Social and trans-generational aspects of insects, birds and mammals</p> <p>3.2.5: Contribution to human medicines</p>	
		Unit 4: Zoogeography	
4.1		Introduction: Plate tectonics and continental drift theory	
4.2		<p>Animal Distribution and Barriers</p> <p>4.2.1: Isolating Mechanisms</p> <p>4.2.2: Patterns of animal distribution - continuous, discontinuous and bipolar</p> <p>4.2.3: Barriers of distribution - Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habit (homing instinct).</p> <p>4.2.4: Means of dispersal - land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies</p>	
4.3		Zoogeographical Realms: Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic	

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Practical Course Code	Sr no.	Zoology Practical 1 based on Taxonomy – Chordates and Type Study	Credits
	1.	<p>Group Protochordata</p> <p>Subphylum Urochordata</p> <ul style="list-style-type: none"> • Class Larvacea e.g. <i>Oikopleura</i> (Sea squirt) • Class Ascidiacea e.g. <i>Ciona</i> (Transparent Sea squirt) • Class Thaliacea e.g. <i>Salpa</i> (Common salp) <p>Subphylum Cephalochordata</p> <ul style="list-style-type: none"> • Class Leptocardii e.g. <i>Branchiostoma</i> (Amphioxus) <p>Subphylum Vertebrata: Division Agnatha</p> <ul style="list-style-type: none"> • Class Ostracodermi e.g. <i>Pharyngolepis</i> • Class Cyclostomata e.g. <i>Petromyzon</i> (Lamprey) 	
	2.	<p>Division Gnathostomata</p> <p>Superclass Pisces:</p> <ul style="list-style-type: none"> • Class Placodermi e.g. <i>Bothriolepis</i> • Class Chondrichthyes e.g. <i>Rhinobatos</i> (Guitar fish), <i>Chimaera</i> (Rabbitfish) • Class Osteichthyes e.g. <i>Protopterus</i>, <i>Clarius</i> (Catfish) <p>Superclass Tetrapoda:</p> <ul style="list-style-type: none"> • Class Amphibia e.g. <i>Alytes</i> (Midwife toad) and Triton (Salamander) • Class Reptilia e.g. <i>Varanus</i> (Monitor lizard) and <i>Crocodylus</i> (Crocodile) 	
	3.	Class Aves: Examples: <i>Eudyptes</i> (Penguin), <i>Phoenicopterus</i> (Flamingo) and <i>Gyps</i> (Vulture)	
	4.	Class Mammalia: Examples: <i>Dasyurus</i> (Quoll), <i>Petaurista</i> (Flying squirrel) and <i>Macaca</i> (Monkey).	
	5.	<p>Study of Shark</p> <p>a) Digestive system</p> <p>b) Heart and Aortic arches</p> <p>c) Urinogenital System</p> <p>d) Brain of shark.</p> <p>e) Endoskeleton of shark:</p> <p>i. Axial - Skull and vertebral column</p> <p>ii. Appendicular - Pelvic and pectoral fins, pelvic and pectoral girdle</p>	
	6.	Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens /	

		<p>Local available niche / Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare a report.</p> <p>College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.</p>	
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Practical Course Code	Sr no.	Zoology Practical 2 based on Physiology and Tissue culture	Credits
	1.	Effect of varying 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 on the activity of enzyme Acid Phosphatase.	
	5.	Separation of LDH isozymes by agarose / polyacrylamide gel electrophoresis.	
	6.	Histology of endocrine glands: T.S. of pituitary, thyroid, parathyroid, pancreas, adrenal.	
	7.	Instruments for tissue culture - Autoclave Millipore filter, CO ₂ incubator, Laminar air-flow. (Principle and use).	
	8.	Packaging of glassware for tissue culture.	
	9.	Aseptic transfer techniques.	
	10.	Trypsinization and vital staining using Trypan blue stain.	



Practical Course Code	Sr no.	Zoology Practical 3 based on Genetics and Bioinformatics.	Credits
	1.	Quantitative Estimation of RNA by Orcinol method.	
	2.	Quantitative Estimation of DNA by Diphenylamine method.	
	3.	Separation of Genomic DNA by Agarose gel electrophoresis.	
	4.	Colorimetric estimation of proteins from given sample by Folin-Lowry's method.	
	5.	Problems based on Restriction endonucleases	
	6.	<p>Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes (no cutting of chromosomes):</p> <ul style="list-style-type: none"> a. Turner's syndrome b. Klinefelter's syndrome c. Down's syndrome d. Cri-du-chat syndrome e. D-G translocation f. Edward's syndrome g. Patau's syndrome 	
	7.	Interpretation of genetic formulae: Deletion, duplication, inversion and translocation.	
	8.	Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.	
	9.	Explore BLAST for nucleotide sequence comparison.	
	10.	Explore the databases (Nucleotide, Protein) at NCBI for querying a nucleotide or protein sequence.	
	11.	Exploring bibliographic database PubMed for downloading a research paper on subject of interest with the use of operators.	

Practical Course Code	Sr no.	Zoology Practical 4 based on Environmental Biology and Zoopharmacognosy.	Credits
	1.	Estimation of phosphates from sample water.	
	2.	Estimation of BOD from sample water.	
	3.	Estimation of COD from sample water.	
	4.	Estimation of Nitrates from sample water.	
	5.	Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.	
	6.	Comparative study of sound intensity in different places by Decibel meter.	
	7.	Study of bioprospecting: a. Tumour suppression compounds e.g. Sponge. b. Skin erythema treatment from gel - Aloe vera, Aloe ferox.	
	8.	Study of Zoopharmacognosy in ants, cats, elephants and dogs.	
	9.	Indicate the distribution of fauna in the world map with respect to its realm and comment on the pattern of distribution. a. Palearctic: Giant Panda and Japanese Macaque b. Ethiopian: Common ostrich and African bush elephant c. Oriental: Indian one-horned Rhinoceros and Gharial d. Australian: Platypus and Red Kangaroo e. Neotropical: Guanaco and South American Tapir f. Nearctic: Virginia opossum and Sea otter g. Antarctic: Emperor Penguin and Antarctic Minke Whale	
	10.	Excursion (Study tour / Visit) to Zoo / Sanctuary /National Park / Research institute, etc. and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.	

MODALITY OF ASSESSMENT.**C. Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Case study/ field visit report/ presentation/ project	20
	Total	40

D. External Examination- 60%- 60 Marks per paper**Semester End Theory Examination:**

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
 - a. There shall be 3 questions each of 20 marks one on each unit.
 - b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
1a	100 %	10	Unit I
1b	100 %	05	
2a	100 %	10	Unit II
2b	100 %	05	
3a	100 %	10	Unit III
3b	100 %	05	
4a	100 %	10	Unit IV
4b	100 %	05	
	TOTAL	60	

Practical Examination Pattern:**C. Internal Examination: 40%- 40 Marks**

Particulars	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	05
Experimental tasks	10	10	10	10

Participation	05	05	05	05
Total	20	20	20	20

D. External Examination: 60%- 60 Marks

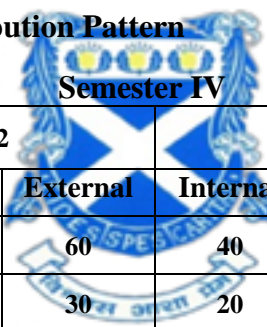
Semester End Practical Examination:

Particulars	Paper I	Paper II	Paper III	Paper IV
Laboratory work	10	10	10	10
Viva + Spots + Report	20	20	20	20
Total	30	30	30	30

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified.
The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern



COURSE	1		2		3		4		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
THEORY	40	60	40	60	40	60	40	60	400
PRACTICALS	20	30	20	30	20	30	20	30	200

John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai 400007

RE-ACCREDITED 'A' grade by NAAC



Affiliated to the

UNIVERSITY OF MUMBAI

**Syllabus for T.Y.B.Sc., Zoology,
Applied Component Fishery Biology**

Program: B.Sc.

Program Code: WUSA

**Choice Based Credit System (CBCS) with effect from
Academic year 2024–2025**

PROGRAM OUTLINE 2023-2024

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
T.Y	V	WUSAFB501	Oceanography, Aquaculture, Preservation and Processing	4
		WUSAFB5P1	Applied Component Fishery Biology Practical 1	2
	VI	WUSAFB601	Marine fin and shell fishes, Nutrition, Preservation and Processing, Farm engineering	4
		WUSAFB6P1	Applied Component Fishery Biology Practical 2	2

PROGRAMME SPECIFIC OUTCOME (PSOs)

PSO1: Learner shall understand and learn about the use of sea safety, navigational equipments, oceanographic instruments also basic physical, chemical and biological oceanography.

PSO2: Learner shall comprehend boat building techniques and design of engines used in mechanized boats, they will also understand the operations of various types of nets and fishing method.

PSO3: Learner will be equipped to carry out entrepreneurial operations or gain confidence to work in freshwater prawn unit and gain knowledge about how to breed and rear ornamental fishes and commercially viable fish species.

PSO4: Learner will be oriented towards understanding the various stages of quality control and will be informed about the postmortem changes, spoilage mechanisms and methods involved in evaluating the freshness and quality of fishes and prawns / shrimps.

PSO5: Learner through practical will be able to identify Oceanographic instruments, types of engines, stages of development in fishes, types of aquaculture fishes and ornamental fishes, different aquatic plants and aquarium accessories and different hatchery models.

PSO6: Learner through practical will also be introduced to various packaging material and Quality assessment methods in fishery Biology.

PSO7: Learner shall understand deep sea fishes, coastal fishes, commercial potential and major landing centres of the fishes.

PSO8: Learner shall understand crustacean and molluscan fisheries also understand the performance of landing centres of above fisheries.

PSO9: Learner will get acquainted with basics of nutritional requirements at various developmental stages of fish and crustaceans and they will acquire the knowledge and would put into practice the preservation and processing techniques for commercial ventures.

PSO10: Learner will understand the selection process of hatchery sites and various types of designs and construction of aquaculture farm practices, they will also comprehend the uses of equipment and accessories involved in aquaculture farms.

PSO11: The learner will be able to identify marine fishes, crustaceans, molluscs, diseases causing pathogens, farm equipments, models of raft, pen, cage culture.

PSO12: The learner will be able to prepare formulated fish feed, surimi, fish protein concentrate, prawn pickle, feasibility report, they will also get knowledge about fish morphometry and fish dressing.

PREAMBLE:

With immense pleasure, we present herewith the T.Y.B.Sc., Zoology, Applied Component, Fishery Biology syllabus of Wilson College (autonomous). While designing the syllabi, we have taken into consideration that the learner must get thorough information and knowledge about the field of fishery biology with the advanced techniques used today. During the course of syllabi design, rounds of meetings were conducted among the teachers to deliberate upon the units to be kept for the syllabi. Also, guidance from industry experts has been taken to put in more interesting and fruitful topics that will enhance their skills in the field.

The fishery biology syllabus designed is a perfect blend of traditional and advanced knowledge of the field. The practicals are perfectly distributed into identification to improve the knowledge of the learners and also performing practicals to provide a hands-on experience to the learners in the preparation of various by-products from fish, the preservation and processing of fish, fish feed preparation, etc.

Looking into the prepared syllabus, I am sure that the learners will enjoy the syllabus of fishery biology presented to them for their 5 and 6 semesters. I am sincerely thankful to the staff of the Zoology Department, industry experts, and our BoS members for their valuable contribution in the construction of this syllabus.

I hope you all enjoy the syllabus. Happy learning, and valuable suggestions and recommendations are most welcome.

Thank you all.

Dr. Sushant Mane

Head of the Zoology Department.

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 5			
Course: 1		Course Code: WUSAFB501			
Teaching Scheme		Evaluation Scheme			
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
4	4	-	6	40 Marks	60 Marks

Learning Objectives:

- To study different instruments and equipments in navigation and oceanography
 - To introduce physical, chemical and biological oceanography.
 - To study the process of boat building, materials used and various types of diesel engines
 - To study various types of nets used in fishery.
 - To develop skills and understanding of breeding and rearing of sewage-fed fishery, Basa cat fish and Tilapia by novel ways
 - To comprehend various aspects of quality control and packaging involved in fish processing and marketing
- Desired outcome

Course Outcomes:

- Learner shall understand and learn about the use of sea safety, navigational equipments and oceanographic instruments
- Learner shall understand basic physical, chemical and biological oceanography
- Learner shall comprehend boat building techniques and design of engines used in mechanized boats
- Learner shall understand the operations of various types of nets and fishing method
- Learner will be equipped to carry out entrepreneurial operations or gain confidence to work in freshwater prawn unit
- Learner will gain knowledge about how to breed and rear ornamental fishes and commercially viable fish species
- Learner will be oriented towards understanding the various stages of quality control
- Learner will gain knowledge about the postmortem changes, spoilage mechanisms and methods involved in evaluating the freshness and quality of fishes and prawns / shrimps

• Learner shall comprehend the value of maintaining and taking sanitary precautions during the processing and packaging operations

DETAILED SYLLABUS

Course Code WUSAFB501	Sub unit	Course/Title	Credits
		Unit 1 Oceanography	1 credit 15 Lectures
	1.1	Navigational and sea safety equipments i) Life saving devices ii) Global Positioning System (GPS) iii) Rudder iv) Signaling devices	
	1.2	Oceanographic Instruments i) Niskin water sampler ii) Peterson's grab iii) Dredges iv) Fish finding instruments / Methods v) Remote sensing	
	1.3	Introduction to basic physical, chemical and biological oceanography	
		Unit 2 Crafts and Gears	1 credit 15 Lectures
	2.1	Basic boat building (parts, design, material used), methods of protection from foulers and borers	
	2.2.	Basic studies of marine engines: i) Outboard and Inboard Engines ii) Sectional View of 2-stroke and 4-stroke Diesel engines iii) Winch and Deck Side Equipment	
	2.3	Operations: i) Gill, Trawl, Purse seine Nets ii) Hooks and Lines iii) Non-conventional Fishing Methods such as • Light Fishing • Hose Pipe Fishing • Electric Fishing	

		Unit 3 Introduction to other commercial aquaculture practices in fresh water	1 credit 15 Lectures
3.1	Macrobrachium rosenbergii (Freshwater prawn) i) Breeding, life cycle, hatchery management ii) Monoculture of <i>Macrobrachium rosenbergii</i> iii) Composite culture of major carps and <i>Macrobrachium rosenbergii</i>		
3.2	Ornamental fishes – breeding and rearing: i) Egg layers: • <i>Danio spp. (Danio)</i> • <i>Pterophyllum spp. (Angel)</i> • <i>Symphysodon spp. (Discus)</i> • <i>Paracheiroduon innesi (Neon tetra)</i> • <i>Flower horn (Hybrid variety)</i> • <i>Betta splendens (Siamese fighter)</i> ii) Live bearers: • <i>Poecilia reticulata (Guppy)</i> • <i>Xiphophorus hellerii (Swordtail)</i> • <i>Poecilia velifera (Tangerine)</i> • <i>Poecilia sphenops (Molly)</i> • <i>Xiphophorus maculatus (Platy)</i>		
3.3	Breeding and rearing of: • Sewage-fed fishery of air breathing fish: <i>Pangasianodon hypophthalmus (Striped catfish)</i> , <i>Clarius spp.</i> , <i>Heteropneustes spp. and Anabas spp.</i> • <i>Pangasius bocourti (Basa Catfish)</i> • All meal (Less bones) Tilapia – GIFT (Genetically Improved Farmed Tilapia)		
		Unit 4 Quality Control and Packaging	1 credit 15 Lectures
4.1	Post mortem changes and mechanism of spoilage: i) Hyperaemia ii) Rigor mortis iii) Autolysis iv) Rancidity		
4.2	Brief methods for evaluating freshness and quality of fish and prawns / shrimps i) Organoleptic ii) Microbial iii) Chemical		
4.3	Sanitary operations i) Maintenance of hygiene of food contact surfaces, storage and equipment ii) Water quality, ice, sewage and waste water disposal and effluent treatment plant		

	4.4	Various packaging materials used in freezing and canning industry i) Polyolefin ii) Wax duplex carton iii) Master carton iv) Can v) Lacquered can vi) Retort vii) Freezing procedures including hygienic washing, dressing	
	4.5	Quality Policy and Quality Analysis: ISO 22000/HACCP/BRC/IFS	

Practical Course Code	Sr. no.	Applied Component Fishery Biology Practical 1	Credits: - 2
WUSAFB5P1	1	Identification and functioning of oceanographic instruments: • Niskin water sampler • Peterson's Grab • Dredge	
	2	Layout of fishing vessels and sectional view of 2 stroke and 4 stroke diesel engines, lifesaving equipment, winch and deck side equipment.	
	3	Identification of various stages of development of carps and study of sexual dimorphism in adults. Indian major carps: • <i>Labeo rohita</i> (Rohu) • <i>Catla catla</i> (Catla) • <i>Cirrhinus mrigala</i> (Mrigala)	
	4	a) Identification of <i>Litopenaeus vannamei</i> (Pacific white shrimp) and <i>Macrobrachium rosenbergii</i> (Freshwater prawn) b) Study of sexual dimorphism in adults.	
	5	Identification of fishes: • <i>Anabas testudineus</i> (Climbing perch) • <i>Clarius batrachus</i> (Walking catfish) • <i>Boleophthalmus</i> spp. (Mudskipper) • <i>Pangasianodon hypophthalmus</i> (Iridescent shark) • <i>Pangasius bocourti</i> (Basa catfish) • <i>Tilapia</i> (GIFT)	
	6	Identification of Ornamental fishes: • <i>Pterophyllum</i> spp. (Angel) • <i>Xiphophorus hellerii</i> (Swordtail) • <i>Paracheirodon innesi</i> (Neon tetra) • <i>Betta splendens</i> (Siamese fighter) • <i>Danio</i> spp. (Danio) • <i>Symphysodon</i> spp. (Discus) • Flower Horn (Hybrid variety)	
	7	Identification of Aquatic plants: • Ludwigia • Cabomba • Corkscrew Vallisneria • Aquarose • Amazon Sword plant	
	8	Identification of Aquarium accessories: • Aerator • Under Gravel Filter • Internal Filter • External / Canister Filter • Food dispensers	
	9	Study of models and functioning of D 81 hatchery, Shirgur's hatcheries and Chinese hatchery	
	10	Gram staining technique	
	11	Organoleptic tests for fish and prawn / shrimp	

	12	Identification of packaging materials: • Waxed duplex carton • Master carton • Simple cans • Coated [Lacquered] cans • Polyolefin • Retort
	13	Qualitative estimation of Ammonia from water sample
	14	Quantitative estimation of Mg and Ca from water sample
	15	Project Work

MODALITY OF ASSESSMENT.

A. Internal Assessment- 40%- 40 Marks per paper

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Case study/ field visit report/ presentation/ project	20
	Total	40

B. External Examination- 60%- 60 Marks per paper

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
 - a. There shall be 3 questions each of 20 marks one on each unit.
 - b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
1a	100 %	10	Unit I
1b	100 %	05	
2a	100 %	10	Unit II
2b	100 %	05	
3a	100 %	10	Unit III
3b	100 %	05	
4a	100 %	10	Unit IV
4b	100 %	05	

	TOTAL	60	
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Practical Examination Pattern:

A. Internal Examination: 40%- 40 Marks

Particulars	Paper I
Journal	05
Experimental tasks	10
Participation	05
Total	20

B. External Examination: 60%- 60 Marks

Semester End Practical Examination:

Particulars	Paper I
Laboratory work	10
Viva + Spots + Report	20
Total	30

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

PROGRAM(s): T.Y.B.Sc.		SEMESTER: 6			
Course: 2		Course Code: WUSAFB601			
Teaching Scheme		Evaluation Scheme			
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CIA) (Marks- 40)	Semester End Examination (Marks- 60)
4	4	-	6	40 Marks	60 Marks

Learning Objectives:

1. To study coastal and deep sea fishes.
2. To study commercial potential and major landing centres Desired outcome.
3. To develop an in-depth understanding of crustacean and molluscan fisheries Desired outcome.
4. To study, acquaint and discover the growing market for fish nutrition Desired outcome:
5. To derive knowledge about various fish preservation and processing methods Desired outcome
6. To acquire knowledge about farm engineering and novel fish culture practices Desired outcome.

Course Outcomes:

- Learner shall understand deep sea and coastal fishes.
- Learner shall understand commercial potential and know about the major landing centres of the fishes.
- Learner shall understand crustacean and molluscan fisheries.
- Learner shall understand the performance of landing centres of above fisheries.
- Learner will get acquainted with basics of nutritional requirements at various developmental stages of fish and crustaceans
- Learners will acquire the knowledge and would put in to practice the preservation and processing techniques for commercial ventures
- Learner will understand the selection process of hatchery sites and various types of designs and construction of aquaculture farm practices.
- Learners will comprehend the uses of equipment and accessories involved in aquaculture farms.

DETAILED SYLLABUS

Course Code WUSAFB601	Sub unit	Course/Title	Credits
		Unit 1 Marine fin and shell fishes of India	1 credit 15 Lectures
	1.1	Study of Coastal fisheries: i) <i>Stromateus cinereus</i> (Silver pomfret) ii) <i>Stromateus niger</i> (Black pomfret) iii) <i>Polynemus tetradactylus</i> (Threadfin) iv) <i>Pseudosciaena diacanthus</i> (Two-spined Jewfish or Ghol) v) <i>Synagris japonicus</i> (Blackmouth splitfin) vi) <i>Scomber microlepidotus</i> (Mackerel) vii) <i>Cybium guttatum</i> (Seerfish or Surmai) viii) <i>Sardinella longiceps</i> Indian Oil Sardine (Explanation about Morphological Characters, Distribution, Fishery, Food and Feeding, Reproduction and spawning)	
	1.2	Deep sea fisheries (more than 45 fathoms) of Indian exclusive economic zone • <i>Thunnus alalunga</i> (Longfin tuna)	
	1.3	Crustacean fisheries i) <i>Penaeus monodon</i> (Giant tiger prawn) ii) <i>Penaeus ndicus</i> (Indian prawn) iii) <i>Metapenaeus affinis</i> (Jinga shrimp) iv) <i>Parapenaeopsis styliifera</i> (Kiddi shrimp) v) <i>Acetes indicus</i> (Jawala paste shrimp) vi) <i>Panulirus polyphagus</i> (Mud spiny lobster) vii) <i>Scylla serrata</i> (Giant mud crab)	
	1.4	Molluscan fisheries i) <i>Crassostrea</i> spp. (Oyster) ii) <i>Sepia pharaonis</i> (Pharaoh cuttlefish) iii) <i>Loligo duvaucelii</i> (Indian squid)	
	1.5	Commercial potential and major landing centres of the above fin and shell fishes	
		Unit 2 Nutrition	1 credit 15 Lectures
	2.1	Nutritional requirements at various stages of development of fish and crustaceans	
	2.2	Culture of natural feed: i) <i>Chaetoceros</i> ii) <i>Infusoria</i> iii) <i>Artemia</i> iv) <i>Brachionus</i> v) <i>Daphnia</i> / <i>Moina</i> spp	
	2.3	Algology – Identification and culture of commercially important nutritious algae and its products	

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	2.4	Formulated / Pelleted feed – Understanding the composition and use of formulated feed for fish and prawns / shrimps at various stages	
		Unit 3 Preservation and Processing	1 credit 15 Lectures
	3.1	Traditional methods and their modifications: i) Icing ii) Drying iii) Salting	
	3.2	1) Introduction to refrigeration: Types and properties of refrigerants 2) Types of freezers: a. Brine b. Air blast c. Tunnel d. Contact plate e. Cryo-quick f. IQF: Individual Quick Freezing 3) Freezing Procedures: a. PUD (Peeled and Un-deveined) b. DV (Deveined)	
	3.3	Principle and steps involved in can reform and canning of fish and shrimp in various media.	
	3.4	Equipment and utensils used in seafood processing	
		Unit 4 Farm engineering	1 credit 15 Lectures
	4.1	Site selection, designing and construction of hatchery and farms for extensive, semi intensive and intensive freshwater or brackishwater aquaculture.	
	4.2	i) Raft culture ii) Rope culture iii) Pen culture iv) Cage culture with special reference to <i>Rachycentron canadum</i> (Cobia)	
	4.3	Equipment and accessories used in various aqua farms	

Practical Course Code WUSAFB6P1	Sr no.	Applied Component Fishery Biology Practical 2	Credits 2
	1	Identification of marine fishes. • <i>Stromateus cinereus</i> (Silver pomfret) • <i>Stromateus niger</i> (Black pomfret) • <i>Polynemus tetradactylus</i> (Threadfin) • <i>Pseudosciaena diacanthus</i> (Two-spinned jewfish or Ghol) • <i>Trichiurus haumela</i> (Ribbon fish) • <i>Synagris japonicus</i> (Blackmouth splitfin) • <i>Scomber microlepidotus</i> (Mackerel) • <i>Cybium guttatum</i> (Seerfish or Surmai) • <i>Sardinella longiceps</i> (Indian Oil Sardine) • <i>Thunnus alalunga</i> (Longfin tuna) (Explanation only about Morphology to be done)	
	2	Identification of Crustaceans and Molluscs. • <i>Penaeus monodon</i> (Giant Tiger Prawn) • <i>Metapenaeus affinis</i> (Jinga shrimp) • <i>Parapenaeopsis stylifera</i> (Kiddi shrimp) • <i>Acetes indicus</i> (Jawala paste shrimp) • <i>Panulirus polyphagus</i> (Mud spiny lobster) • <i>Scylla serrata</i> (Giant mud crab) • <i>Crassostrea spp.</i> (Oyster) • <i>Sepia pharaonis</i> (Pharaoh cuttlefish) • <i>Loligo duvaucelii</i> (Indian squid) (Explanation only about Morphology to be done)	
	3	Preparation of formulated feed for fish and prawn.	
	4	Identification of parasitic infections in aquatic organisms. • Fungal – Dermatomycois • Bacterial – Fin/Tail rot and Dropsy • Protozoan – Costiasis and White Spot • Crustacean – Argulosis	
	5	Fish dressing, filleting, prawn peeling – PUD, DV and grading	
	6	Fish morphometry – Length weight relationship of a suitable fish.	
	7	Preparation of Surimi.	
	8	Preparation of fish protein concentrate	
	9	Preparation of Prawn Pickle	
	10	Identification of various farm equipment such as: • Feeding cups / Trays • Paddle wheel aerator • Fountains • Sluice gate models • Elbow pipe outlets	
	11	Study of models of raft, pen, cage culture and materials used in rope culture.	
	12	Feasibility Report	
	13	Field Visit Report	

MODALITY OF ASSESSMENT.

C. Internal Assessment- 40%- 40 Marks per paper

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Case study/ field visit report/ presentation/ project	20
	Total	40

D. External Examination- 60%- 60 Marks per paper

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
 - a. There shall be 3 questions each of 20 marks one on each unit.
 - b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
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1b	100 %	05	
2a	100 %	10	Unit II
2b	100 %	05	
3a	100 %	10	Unit III
3b	100 %	05	
4a	100 %	10	Unit IV
4b	100 %	05	
	TOTAL	60	

Practical Examination Pattern:

C. Internal Examination: 40%- 40 Marks

Particulars	Paper II
Journal	05
Experimental tasks	10
Participation	05
Total	20

D. External Examination: 60%- 60 Marks**Semester End Practical Examination:**

Particulars	Paper II
Laboratory work	10
Viva + Spots + Report	20
Total	30

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

REFERENCES:

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