



R.E. Society's

**R. P. GOGATE COLLEGE OF ARTS & SCIENCE AND R.V.
JOGALEKAR COLLEGE OF COMMERCE, RATNAGIRI
(AUTONOMOUS)**

NAAC accredited 'A' Grade (4th Cycle)

Ratnagiri-415612 (Maharashtra-India)

Bachelor of Science (B. Sc.) Programme

Program: T.Y.B. Sc.

Course: Zoology

Syllabus for Semester V & VI

Under Choice Based Credit System (CBCS)

**To be implemented from Academic Year
2023-2024**

PERAMBLES:

Welcome to the final year of your Bachelor of Science (B. Sc.) program in Zoology! This syllabus is here to help you take your knowledge of animals and the natural world to the next level. You've learned a lot in the past two years, and now it's time to dive even deeper into the fascinating world of zoology.

Zoology is all about understanding animals, from their tiny cells to their complex behaviours, and how they fit into our world. In this year, we're going to explore some advanced topics and really get into the nitty-gritty of how animals work and how they impact our planet.

You'll study things like animal genetics (how animals inherit traits), evolution (how animals change over time), animal behaviour (why animals do what they do), and ecology (how animals interact with their environments). This year, you'll also have a chance to focus on your interests and maybe even do some research.

This final year is designed to help you become a better thinker and problem solver. It's all about preparing you for whatever comes next, whether it's more school, a job, or something else entirely. The skills and knowledge you gain this year will be super valuable, no matter where your journey takes you.

Don't be afraid to ask questions, work with your teachers and classmates, and take on new challenges. Zoology is a field where there's always more to discover, and we hope this year will inspire you to keep exploring and caring for the incredible animals that share our planet. Best of luck in your final year of Bachelor of Science in Zoology!

**Chairperson,
BOS in Zoology,
Gogate Jogalekar College,
Ratnagiri.**

Syllabus for T. Y. B. Sc. Course: ZOOLOGY
Credit Based Semester and Grading System
(To be implemented from the Academic Year 2023-2024)

SEMESTER – V

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO501	I	Principles of Taxonomy	2.5	1
	II	Kingdom Animalia I		1
	III	Kingdom Animalia II		1
	IV	Type study: Sepia		1
USZO502	I	Basic Haematology	2.5	1
	II	Applied Hematology		1
	III	Basic Immunology		1
	IV	Applied Immunology		1
USZO503	I	Mammalian Histology	2.5	1
	II	Toxicology		1
	III	General Pathology		1
	IV	Biostatistics		1
USZO504	I	Integumentary system and derivatives	2.5	1
	II	Human Osteology		1
	III	Muscles of long bones of Human limbs		1
	IV	Developmental biology of Chick		1
			10	16
USZOP05		Practicals based on all four courses	06	16
Total Number of Credits and Workload			16	32

Syllabus for T. Y. B. Sc. Course: ZOOLOGY
Credit Based Semester and Grading System
(To be implemented from the Academic Year 2023-2024)

SEMESTER – VI

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO601	I	Phylum Chordata: Group Protochordata and Group Euchordata I	2.5	1
	II	Group Euchordata II		1
	III	Group Euchordata III		1
	IV	Type study: Shark		1
USZO602	I	Enzymology	2.5	1
	II	Homeostasis		1
	III	Endocrinology		1
	IV	Animal Tissue Culture		1
USZO603	I	Molecular Biology	2.5	1
	II	Genetic Engineering		1
	III	Human Genetics		1
	IV	Bioinformatics		1
USZO604	I	Environment management	2.5	1
	II	Wildlife Management		1
	III	Bioprospecting and Zoo pharmacognosy		1
	IV	Zoogeography		1
			10	16
USZOP06		Practicals based on all four courses	06	16
Total Number of Credits and Workload			16	32

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Taxonomy - Invertebrates and Type Study
Course Code (refer to student handbook)	USZO501(Course-XI)
Class	T.Y.B. Sc.
Semester	V
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Taxonomy - Invertebrates and Type Study

CO1- Learners will apprehend the basis of classification and modern classification up to class of the lower invertebrate animals.

CO2 - The learners will be familiarized with classification up to phylum Nematoda along with their examples.

CO3 – Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects.

CO4 – Learners will get an idea of general characteristics and details of invertebrate animal systems.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	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. Amoeba b. Radial symmetry: e.g. Starfish c. Bi-lateral symmetry: e.g. Invertebrate - Planaria Vertebrate - Man 1.2.3: Evolutionary significance of symmetry 1.3 : Coelom 1.3.1 : Basic concept and definition 1.3.2: Formation of coelom 1.3.3 : Types: a. Acoelomate: Platyhelminthes e.g. Liver fluke 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. Pseudo metamerism: e.g. Tapeworm b. True metamerism: i. Homonymous - 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: Kingdom Archaeobacteria, Kingdom Eubacteria,	15

		<p>Kingdom Protista, Kingdom Fungi, Kingdom Plantae, Kingdom Animalia.</p> <p>1.6 : 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: Phylum Sarcomastigophora, Class Sarcodina e.g. Amoeba Class Mastigophora e.g. Trypanosoma Phylum Ciliophora, Class Ciliata e.g. Opalina Class Phyllopharyngea e.g. Dysteria Phylum Sporozoa, Class Aconoidasida e.g. Plasmodium, Class Conoidasida e.g. Toxoplasma</p>	
II	Kingdom Animalia I	<p>Phylum Porifera</p> <p>a. General characters</p> <p>b. Classification up to class with distinguishing features and suitable examples: Class Calcarea e.g. Leucosolenia (Branched sponge) Class Hexactinellida e.g. Hyalonema (Glass-rope sponge) Class Demospongia e.g. Euspongia (Bath sponge)</p> <p>2.2 : Phylum Cnidaria</p> <p>a. General characters</p> <p>b. Classification up to class with distinguishing features and examples Class Hydrozoa e.g. Hydra Class Scyphozoa e.g. Aurelia (Jelly fish) Class Anthozoa e.g. Meandrina (Maze Coral)</p> <p>2.3 : Phylum Platyhelminthes</p> <p>a. General characters</p> <p>b. Classification up to class with distinguishing features and examples Class Turbellaria e.g. Dugesia (Planaria) Class Trematoda e.g. Schistosoma (Blood-fluke) Class Cestoda e.g. Taenia (Tapeworm)</p> <p>c. Morphology, life cycle and pathogenicity of <i>Fasciola hepatica</i></p> <p>2.4 : Phylum Nematoda</p> <p>a. General characters</p> <p>b. Classification up to class with distinguishing features and examples Class: Aphasmida (Adenophorea) e.g. Trichinella (Trichina worm) Class: Phasmida (Secernentea) e.g. Ascaris (Roundworm)</p>	15
III	Kingdom Animalia II	<p>Phylum Annelida</p> <p>3.1.1 : General characters</p> <p>3.1.2 : Classification up to class with distinguishing features and examples Class Polychaeta e.g. Neries (Clamworm), Class Oligochaeta e.g. Pheretima (Earthworm) Class Hirudinea e.g. Hirudinaria (Leech)</p> <p>3.2: Phylum Arthropoda</p>	15

		<p>3.2.1 : General characters</p> <p>3.2.2 : Classification up to class with distinguishing features and examples Subphylum Chelicerata Class Arachnida e.g. Hottentotta (Scorpion) Class Merostomata e.g. Limulus (Horse-shoe crab) Class Pycnogonida e.g. Nymphon (Sea spider) Subphylum Crustacea Class Malacostraca e.g. Scylla (Crab) Class Maxillipoda e.g. Balanus (Barnacle) Subphylum Uniramia, Class Chilopoda e.g. Scolopendra (Centipede) Class Diplopoda e.g. Xenobolus (Millipede), Class Insecta e.g. Attacus (Moth)</p> <p>3.3 : 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 Class Aplacophora e.g. Chaetoderma (Glisten worm solenogaster) Class Polyplacophora e.g. Chiton (Coat-of-mail shell) Class Monoplacophora e.g. Neopilina Class Gastropoda e.g. Nerita (Nerit) Class Pelecypoda e.g. Solen (Razor clam) Class Scaphopoda e.g. Dentalium (Tusk shell) Class Cephalopoda e.g. Nautilus (Pearly nautilus)</p> <p>3.4 : Phylum Echinodermata</p> <p>3.4.1 General characters</p> <p>3.4.2 Classification up to class with distinguishing features and examples Class Asterozoa e.g. Protoreaster (Starfish), Class Ophiurozoa e.g. Ophiothrix (Brittle star) Class Echinozoa e.g. Clypeaster (Sand dollar), Class Holothurozoa e.g. Cucumaria (Sea cucumber) Class Crinozoa e.g. Antedon (Sea lily)</p> <p>3.5 Minor phyla</p> <p>3.5.1 : General characters along with examples of Phylum Acanthocephala e.g. Moniliformis Phylum Onychophora e.g. Peripatus (Velvet worm) Phylum Chaetognatha e.g. Sagitta (Arrow worm)</p> <p>3.5.2 : Peripatus, a connecting link - Affinities with Phylum Annelida, Arthropoda and Mollusca.</p> <p>3.6 Phylum Hemichordata</p> <p>3.6.1 : General characters, classification with distinguishing features and examples Class Enteropneusta e.g. Balanoglossus (Acorn worm) Class Pterobranchia e.g. Rhabdopleura Class Planctosphaerozoa e.g. Planctosphaera</p> <p>3.7 Basic concepts of phylogeny: Phylogenetic tree of invertebrates</p>	
	Type study: Sepia	4.1: General characters and classification, Habit and habitat, External characters, mantle cavity, locomotion, economic	15

	importance 4.2: Digestive system, Respiratory system, Circulatory system, Excretory system, Nervous system and Sense organs, Reproductive system	
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	PRACTICALS	1.5 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 Class Sarcodina e.g. Amoeba Class Mastigophora e.g. Euglena	
	B. Phylum: Ciliophora Class Ciliata e.g. Paramecium Class Phyllopharyngea e.g. Dysteria	
	C. Phylum: Sporozoa, Class Aconoidasida e.g. Eimeria Class Conoidasida e.g. Sarcocystis Kingdom Animalia	
	D. Phylum: Porifera Class Calcarea e.g. Scypha (Little vase sponge) Class Hexactinellida e.g. Hyalonemna (Glass-ropes sponge) Class Demospongia e.g. Spongilla (Freshwater sponge)	
	E. Phylum Cnidaria Class Hydrozoa e.g. Vellela (By-the-wind sailor) Class Scyphozoa e.g. Rhizostoma (Barrel jellyfish) Class Anthozoa e.g. Corallium (Coral)	
	F. Phylum Platyhelminthes Class Turbellaria e.g. Dugesia (Planaria) Class Trematoda e.g. Fasciola (Liverfluke) Class Cestoda e.g. Taenia (Tapeworm)	
	G. Phylum Nematoda Class Aphasmida (Adenophorea) e.g. Trichinella (Trichina worm) Class Phasmida (Secernentea) e.g. Ascaris (Roundworm)	
	H. Phylum Annelida Class Polychaeta e.g. Arenicola (Lugworm) Class Oligochaeta e.g. Tubifex (Sludge worm) Class Hirudinea e.g. Pontobdella (Marine leech)	
	I. Phylum Arthropoda Subphylum Chelicerata Class Arachnida e.g. Hotentotta (Scorpion) Class Merostomata e.g. Limulus (Horseshoe crab) Class Pycnogonida e.g. Nymphon (Sea spider) Subphylum Crustacea Class Malacostraca e.g. Panulirus (Lobster) Class Maxillipoda e.g. Cyclops (Copepods)	

	<p>Subphylum Uniramia Class Chilopoda e.g. Scolopendra (Centipedes) Class Diplopoda e.g. Xenobolus (Millipedes) Class Insecta e.g. Attacus (Moth)</p>	
	<p>J. Phylum Mollusca Class Aplacophora e.g. Chaetoderma (Glisten worm solenogaster) Class Polyplacophora e.g. Tonicella (Lined Chiton) Class Monoplacophora e.g. Neopilina Class Gastropoda e.g. Turbo (Turban shell) Class Pelycypoda e.g. Donax (Wedge shell) Class Scaphopoda e.g. Dentalium (Tusk shell) Class Cephalopoda e.g. Octopus</p>	
	<p>K. Phylum Echinodermata Class Asterozoa e.g. Asterias (Starfish) Class Ophiurozoa e.g. Ophiothrix (Brittle star) Class Echinozoa e.g. Echinus (Sea urchin) Class Holothurozoa e.g. Cucumaria (Sea cucumber) Class Crinozoa e.g. Crinoid (Sea lily)</p>	
	<p>L. Phylum Hemichordata Class Enteropneusta e.g. Saccoglossus Class Pterobranchia e.g. Rhabdopleura Class Planctosphaerozoa e.g. Planctosphaera</p>	
2.	<p>Minor Phyla Acoelomate M. Phylum Acanthocephala e.g. Echinorhynchus Coelomate N. Phylum Chaetognatha e.g. Sagitta O. Phylum Onychophora e.g. Peripatus (Velvet worm)</p>	
3.	<p>Study of Sepia with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.</p> <ol style="list-style-type: none"> Digestive system, Reproductive system Nervous system Jaws Radula Chromatophores Spermatophores Statocyst 	
4.	<p>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.</p>	

Learning Resources recommended:

1. A manual of Zoology - Part I, Invertebrates; Ayyar, M. Ekambar Anath Invertebrate Zoology - Volumes of different Phyla; Hyman L.H. Instant Notes in Animal Biology by Richard D. Jurd.
2. Introduction to Zoology - Vol I: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book Agency.
3. Modern text book of Zoology - Invertebrates; Eleventh; Edition Professor R.L. Kotpal; Rastogi publication.
4. Invertebrate Zoology by E. L. Jordan & P. S. Verma Rev. edition, 2009, Chand publications Invertebrate Zoology by P. S. Verma, edition, 2009, Chand publications.
5. Zoology for degree students, non-chordates by V.K. Agarwal 2011, S. Chand Publication Zoology for Degree Students, B.Sc. First Year, by V. K. Agarwal, Pub. S. Chand Coy.
6. B. Sc. Zoology, Invertebrate Zoology by V.K. Aggarwal 2017, S. Chand publications Invertebrate Zoology by Fatik Baran 2012, PHI Learning.
7. A Textbook of Invertebrates by N.C. Nair et al. 2010 Saras publications Practical Zoology: Invertebrate, by S. S. Lal, 2016.
8. Invertebrate Zoology by Ruppert, Fox, Barnes, 7th edition, 2003 publications Cengage Learning.
9. Invertebrate Zoology by D.T. Anderson 2nd edition 2002, publications Oxford Invertebrates by Richard C. Brusca *et. al*, 3rd edition 2016, publications Oxford.
10. Biology of the invertebrates by Jan A. Pechenik, 7th edition, 2014 publications McGraw Hill.
11. An introduction to the invertebrates by Janet Moore, 2nd edition 2006, publications Cambridge.
12. Protozoology, by S. V. Nikam & S. T. Tanveer ed. 2011, Pub. Oxford Book Company (N.B.: This book includes Phylum Sarcomastigophora).

Evaluation Pattern:**A. Internal Evaluation- 40 %****40 Marks**

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%**Semester End Evaluation (Paper Pattern)- 60 Marks**

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Hematology and Immunology
Course Code (refer to student handbook)	USZO502 (Course-XII)
Class	T.Y.B. Sc.
Semester	V
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Haematology and Immunology

CO1-The learner shall comprehend basic hematology.

CO2-The learner will be able to identify various components of haemostatic systems.

CO3-The learner will be familiar with the terminology used and diagnostic tests performed in a pathological laboratory.

CO4-The learner shall be acquainted with diagnostic approaches in haematological disorders.

CO5-The learner will be better equipped for further pathological course or working in a diagnostic laboratory.

CO6-The learner shall comprehend the types of immunity and the components of immune system.

CO7- The learner shall understand immune pathology and the principles and applications of vaccines.

CO8- The learner will develop basic understanding of immunology of organ transplantation.

CO9-The learner will realize the significant role of immune system in giving resistance against diseases

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Basic Haematology	1.1: Composition of plasma: Water, respiratory gases, dissolved salts, plasma proteins, nutrients, enzymes, hormones, nitrogenous waste products 1.2: Hematopoiesis: Erythropoiesis, leucopoiesis and thrombopoiesis 1.3: Erythrocytes: Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia 1.4: Hemoglobin: Structure, formation and degradation; variants of hemoglobin (foetal, adult), abnormalities in hemoglobin (sickle cell and thalassemia) 1.5: Leucocytes: Types and functions, total count and variation in number; leukemia and its types 1.6: Thrombocytes: Structure, factors and mechanism of clotting, failure of clotting mechanism 1.7: Blood volume: Total quantity and regulation; hemorrhage	15
II	Applied Hematology	2.1: Introduction and scope of Applied Haematology : Clinical, microbiological, oncological and forensic hematology 2.2: 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 2.2.3: Biochemical examination of blood: Liver function tests: AST, ALT, LDH, Alkaline	15

		phosphatase, Total and direct bilirubin Kidney function test: Serum creatinine, Blood Urea Nitrogen (BUN) Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated hemoglobin test Other biochemical tests: Blood hormones - TSH, FSH, LH.	
III	Basic Immunology	<p>3.1 Overview of Immunology</p> <p>3.1.1 : Concept of immunity</p> <p>3.1.2 : Innate immunity - Definition, factors affecting innate immunity, Mechanisms of innate immunity - First line of defense - physical and chemical barriers; Second line of defense - phagocytosis, inflammatory responses and fever</p> <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> <p>3.2 : 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> <p>3.3 : Antigens: Definition and properties; haptens</p> <p>3.4 : Antibodies: Definition, basic structure, classes of antibodies - IgG, IgA, IgM, IgD and IgE</p> <p>3.5 : Antigen processing and presentation</p> <p>3.5.1: Endogenous antigens - cytosolic pathways</p> <p>3.5.2: Exogenous antigens - endocytic pathways</p>	15
IV	Applied Immunology	<p>4.1: 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. Precipitation in gels (slide test) Radial immunodiffusion (Mancini method) Double immunodiffusion (Ouchterlony method)</p> <p>4.1.3 : Immuno-electrophoresis - Counter-current and Laurel's Rocket electrophoresis</p> <p>4.1.4: Agglutination reaction definition, characteristics and mechanism. Haemagglutination (slide and micro-tray agglutination) Passive agglutination Coomb's test</p> <p>4.1.5: Immunoassay - ELISA</p> <p>4.2: 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: Live attenuated Whole-Killed or inactivated</p>	15

	<p>Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines</p> <p>4.2.3 : Adjuvants used for human vaccines: Virosomes and Liposomes Saponins Water-in-oil emulsions</p> <p>4.2.4 : Vaccines against human pathogens: Polio Hepatitis A and B Tuberculosis (BCG)</p> <p>4.3: Transplantation Immunology: Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte and Antibody mediated graft rejection; Precautionary measures against graft rejection.</p>	
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PRACTICALS		
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 hemoglobin 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.	

Learning Resources recommended:

1. Human Physiology -Volume1; C.C. Chatterjee.
2. Essentials of Haematology; Shirish M. Kawthalkar; Jaypee Brothers.
3. Williams Hematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas J. Kipps, Josef Prchal, Uri Seligsohn.
4. Essential Haematology; Victor Hoffbrand, Paul Moss, John Pettit. Rapid Review of Hematology; Ramadas Nayak; Jaypee Brothers.
5. Precise Haematology; Usha Rusia, Meera Sikka, Renu Saxena; Wiley India. Short Textbook of Haematology; Shah B.S.; C.B.S. Publisher and Distributor.
6. Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd. New Delhi;1978.
7. A Text book of Practical Physiology; First Edition; V.G. Ranade; A.V.G. Prakashan, Pune;1968.
8. Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.;2012.
9. Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013.
10. Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier);2014.
11. Harrison's Hematology and Oncology; 3rd Edition (Harrison's Specialty); Dan Longo; McGraw-Hill.

12. Essentials of Haematology; Second Edition; Kawthalkar Shirish M.; Jaypee; 2013. Medical Biochemistry by C. Jaypee; 2012.
13. Essentials in Hematology and Clinical Pathology; Nayak, Ramadas. Clinical Pathology and Hematology; Maheshwari, Nanda; Jaypee.
14. Practical Hematology; Dacie J V; Churchill Livingstone; 2006.
15. Lecture Notes: Haematology; Hatton, Chris S. R. Hughes-Jones, Nevin C. Hay, Deborah; Wiley-Blackwell. ABC series: ABC of Clinical Haematology; Provan; Drew Publisher: BMJ Books.
16. Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.
17. Immunology- Introductory Textbook; Shetty N.; New Age International; 2005.
18. Immunology-Essential and Fundamental; Pathak S., & Palan U.; Science Publishers; 2005.
19. Immunology: A textbook; Rao C.V.; Alpha Science Int'l Ltd.; 2005.
20. Anantha Narayan and Paniker's textbook of Microbiology; C. J. Paniker (Ed.); Anantha Narayan R.; Orient Blackswan; 2005.
21. Textbook of Immunology; Haleem Khan, Rajendra Sagar, Sadguna.
22. Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher
23. Immunology; Third Edition; Janis Kuby; W.H. Freeman; 1997.
24. Kuby Immunology; Sixth Edition; Thomas J. Kindt, Richard A. Goldsby, Barbara Osborne & Janis Kuby; W.H. Freeman; 2007.
25. Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Histology, Toxicology, Pathology and Biostatistics
Course Code (refer to student handbook)	USZO503 (Course-XIII)
Class	T.Y.B. Sc.
Semester	V
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Histology, Toxicology, Pathology and Biostatistics

CO1 - Learner would appreciate the well-planned organization of tissues and cells in the organ systems.

CO2 – The course will prepare learner to develop broad understanding of the different areas of toxicology.

CO3 - It will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas.

CO4 - Learner will be familiar with various medical terminologies pertaining to pathological condition of the body caused due to diseases.

CO5 - The learner will be able to collect, organize and analyze data using parametric and non-parametric tests.

CO6 - will also be able to setup a hypothesis and verify the same using limits of significance.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	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.	15
II	Toxicology	2.1 Basic toxicology 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	15

		<p>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)</p> <p>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</p> <p>2.2 Regulatory toxicology</p> <p>2.2.1 : OECD guidelines for testing of chemicals (an overview)</p> <p>2.2.2 : CPCSEA guidelines for animal testing center, ethical issues in animal studies</p> <p>2.2.3: Animal models used in regulatory toxicology studies</p> <p>2.2.4: Alternative methods in toxicology (in vitro tests)</p>	
III	General Pathology	<p>3.1 General Pathology: Introduction and scope</p> <p>3.2: Cell injury: Mechanisms of cell injury: ischemic, hypoxic, free radical mediated and chemical</p> <p>3.3: Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)</p> <p>3.4: Disorders of pigmentation: Endogenous: Brief ideas about normal process of pigmentation, melanosis, jaundice (causes and effects)</p> <p>3.5: Necrosis: Definition and causes; nuclear and cytoplasmic changes; types: coagulative, liquefactive, caseous, fat and fibroid</p> <p>3.6: Gangrene: Definition and types - dry, moist and gas gangrene</p>	15
IV	Biostatistics	<p>4.1: Probability Distributions: Normal, Binomial, Poisson distribution, Z-transformation, p- value, Probability - Addition and multiplication rules and their applications</p> <p>4.2: Measures of Variation: Variance, standard deviation, standard error</p> <p>4.3: Testing of Hypothesis: Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis, Levels of significance and testing of hypothesis</p> <p>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</p> <p>4.5: Correlation: Correlation coefficient and its significance</p>	15

	PRACTICALS	1.5 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.	Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) and manually:	
	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.	

Learning Resources recommended:

1. A Textbook of Histology; Deshmukh Shivaji; Dominant Pub. Colour Textbook of Histology; Gartner, Leslie P.; Saunders. A Textbook of Histology; Mathur Ramesh; Anmol Pub.
2. A Textbook of Histology and A Practical Guide; Gunasegaran J. P.; Elsevier A Textbook of Histology; Khanna D. R.; Sonali Pub.
3. Practical Zoology; Second Edition; Dr. K. C. Ghose & Dr. B. Manna; New Central Book
4. Agency Pvt. Ltd., Kolkata; 1999.
5. Casarett and Doulls Toxicology-The basic science of poisons; Edited by Curtis Klaassen; McGraw-Hill; 2001.
6. Toxicological testing handbook Principles, applications and data interpretation; David Jacobson – Kram and Kit Keller; CRC Press; 2006.
7. Principles and methods of toxicology; A. Wallace Hayes; CRC Press; 2007. Toxicology-principles and methods; M.A. Subramanian; MJP Publishers, Chennai; 2004.
8. Fundamentals of Toxicology; Kamleshwar Pandey and JP Shukla; New Central book Agency Ltd., Kolkata; 2011.
9. Elements of Toxicology; Kamleshwar Pandey and JP Shukla; Wisdom Press, New Delhi; 2010.
10. Principles and Applications of Toxicology; Lahir Y.K.; Seekay Publications; 2013.
11. Essentials of Clinical Toxicology; Lall S.; Narosa Publishing House; 1998.
12. A Textbook of Veterinary and General Pathology; Second edition; J. L. Vagad; IBDC Publishers.
13. Clinical Pathology; Guru G.; NCERT; 1988.
14. Clinical Pathology; Batra Neelam; Vikas Publishing House Pvt. Ltd.; Nov. 1982.
15. Essentials of General Pathology; Dr. Sudha Shivraj, Dr. Satish Kumar Amarnath, Dr. Sheela Devi; Exclusively distributed by CBS Publishers & Distributors.
16. Textbook of Pathology; Harsh Mohan; Jaypee Publishers.
17. Biostatistics-The Bare Essentials; Third Edition; Geoffrey R. Norman, David L. Streiner; B.C. Decker, Inc., Hamilton; 2008.
18. Fundamentals of Biostatistics; Second Edition; Veer Bala Rastogi; Ane Books Pvt. Ltd., New

Delhi;2009(Reprint2010).

19. Fundamentals of Biostatistics; Second Revised Edition; Irfan Ali Khan and Atiya Khanum; Ukaaz Publications, Hyderabad;2004.
20. Instant Medical Biostatistics; Dr. Ranjan Das and Dr. Papri N. Das; Ane Books Pvt. Ltd., New Delhi;2009.
21. Primer of Biostatistics; Fifth Edition; Stanton A. Glantz; McGraw-Hill Companies, Inc.;2002.
22. Basic Biostatistics-Statistics for Public Health Practice; Second Edition; B. Burt Gerstman; Jones and Bartlett Learning Burlington;2015.
23. Biostatistics-A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Frothier, Eun Sul Lee and Mike Hernandez; Elsevier, Inc., (Academic Press), USA; 2007.
24. Statistics in Biology and Psychology; Sixth Edition; Debajyoti Das and Arati Das; Academic Publishers, Kolkata.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Anatomy and Developmental Biology
Course Code (refer to student handbook)	USZO504(COURSE-XIV)
Class	T.Y.B. Sc.
Semester	V
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Anatomy and Developmental Biology

CO1- Learner will be able to understand the importance of various types of epidermal and dermal derivatives along with their functions.

CO2- Learner will be able to understand the structure, types and functions of human skeleton

CO3- Learners will identify various arrangement soft hind limb muscle sand will relate the arrangement with contraction and motion.

CO4 -Learner will be able to understand the processes involved in embryonic development and practical applications of studying the chick embryology.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	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.	15
II	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	
III	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 3.2.1: Muscles that move the arm (Humerus) - Triceps brachii, Biceps brachii, brachialis and	15

		<p>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> <p>3.3: 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>	
IV	Developmental biology of Chick	<p>4.1: Introduction to Developmental Biology: Basic concept and principles of developmental biology - morphogenesis, organogenesis, fate maps, cell adhesion, cell affinity and cell differentiation.</p> <p>4.2: 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>	15

	PRACTICALS	1.5 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, Brachio radialis, Triceps brachii, flexor carpi, flexor ulnaris and Extersor 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.	

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

- 1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
- 2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

Composition of DMC shall be as follows:

- i) Head of the Concerned Department (Convener / Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
- iv) One or two members of related department from neighbouring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT /DISSECTION /MOUNTING IS BANNED. SIMULATIONS, AUTHORIZED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OT OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Learning Resources recommended:

1. Comparative Anatomy of the Vertebrates; Ninth Edition; Kent, G.C. and Carr R.K.; The McGraw-Hill Companies; 2000.
2. Textbook of Chordates; Saras publication. Modern textbook of Zoology; Prof. R. L. Kotpal.
3. Integumentary system and its derivatives; Samuel D. Hodge.
4. Atlas of Human Anatomy – Vol. I; R.D. Sinelnikov; Mr. Publishers Moscow. A Guide of Osteology (for medical students); Prakash Kendra, Lucknow.
5. Human Osteology-Tim D White.
6. Text Book of Human Osteology- Singh Inderbir.
7. Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
8. Human Anatomy-John W. Hole, Jr., Karen A. Koos, Publisher: W.C. Brown Publisher, USA.
9. Principles of Anatomy and Physiology-Gerard T. Tortora and Sandra Reynolds Grabowski. Publisher: Harpers Collins College Publishers (7th Edition).
10. Developmental biology-Gilbert. Development of Chick-Patten. Developmental Biology-Wolpert.
11. Textbook of Embryology-N. Arumugam.
12. Chicken Development-Embryology; W.H. Freeman & B. Bracegirdle.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Taxonomy - Chordates and Type Study
Course Code (refer to student handbook)	USZO601 (Course-XV)
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Taxonomy - Chordates and Type Study

CO1- Learners will get an idea of origin of Chordates, its taxonomy upto class with reference to phylogeny and their special features.

CO2- Learners will understand the characteristic features and examples of class of Reptilia, Aves and Mammalia.

CO3- Learners will get an idea of vertebrate animal life after studying one representative animal-shark.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Phylum Chordata: Group Protochordata and Group Euchordata I	<p>1.1 General characters, Difference between non-chordates and chordates Origin of chordates: Annelids as ancestors, Arachnids as ancestors and affinities with Echinodermata</p> <p>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</p> <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> <p>1.2.4: Subphylum Cephalochordata Class Leptocardii e.g. <i>Branchiostoma (Amphioxus)</i></p> <p>1.3: Group Euchordata I Group Euchordata: General characters</p> <ul style="list-style-type: none"> • Subphylum Vertebrata: General characters • Division Agnatha and Gnathostomata: Distinguishing characters. <p>General characters with examples of:</p> <ul style="list-style-type: none"> • Class Ostracodermii e.g. <i>Cephalaspis</i> • Class Cyclostomata e.g. <i>Petromyzon (Lamprey)</i> 	15
II	Group Euchordata II	<p>2.2.1: Division: Gnathostomata Superclass: Pisces and Tetrapoda Superclass - Pisces: Distinguishing characters</p> <ul style="list-style-type: none"> • Class Placodermi e.g. <i>Climatius</i> • Class Chondrichthyes e.g. <i>Rhinobatos (Guitar fish)</i> • Class Osteichthyes e.g. <i>Exocetus (Flying fish)</i> <p>2.2.2: Dipnoi (Lungfish): Distribution, habit and habitat, external and internal characters, affinities with superclass Pisces, affinities and differences</p>	15

		with class Amphibia	
III	Group Euchordata III	<p>3.1 Class Reptilia: General characters Examples a. Extinct reptile e.g. Ichthyosaurus b. Living fossil e.g. Sphenodon (Tuatara) c. Aquatic reptile e.g. Chelonia (Sea turtle) d. Arboreal reptile e.g. Chamaeleon(Chamaeleon)</p> <p>3.2: Class Aves: General Characters Examples a. Arboreal bird e.g. Melanerpes (Wood pecker) b. Terrestrial bird e.g. Gallus (Fowl) c. Swimming bird e.g. Phalacrocorax (Cormorant) d. Wading bird e.gs. Ardeola (Heron) e. Birds of prey e.g. Tyto (Owl) f. Flightless birds e.g. Dromaius (Emu)</p> <p>3.3 Class Mammalia: General characters Examples a. Egg-laying mammals e.g. Ornithorhyncus (Duck-billed platypus) b. Pouched mammals e.g. Macropus (Kangaroo) c. Insect eating mammals e.g. Sorex (Common shrew) d. Toothless mammals e.g. Bradypus (Sloth) e. Gnawing mammals e.g. Funambulus (Squirrel) f. Primates e.g. Macaca (Monkey)</p>	15
IV	Type study: Shark	<p>4.1: Habit & habitat, distribution, external characters, classification and economic importance.</p> <p>4.2: Skin, exoskeleton, endoskeleton and systems a) Digestive system b) Respiratory system c) Blood vascular system d) Nervous system and receptor organs e) Urinogenital system, copulation, fertilization and development</p>	15

PRACTICALS		1.5 Credits
1.	<p>Group Protochordata Subphylum Urochordata</p> <ul style="list-style-type: none"> • Class Larvacea e.g. Oikopleura (Sea squirt) • Class Ascidiacea e.g. Ciona (Transparent Sea squirt) • Class Thaliacea e.g. Salpa (Common salp) <p>Subphylum Cephalochordata</p> <ul style="list-style-type: none"> • Class Leptocardii e.g. Branchiostoma (Amphioxus) <p>Subphylum Vertebrata: Division Agnatha</p> <ul style="list-style-type: none"> • Class Ostracodermi e.g. Pharyngolepis • Class Cyclostomata e.g. Petromyzon (Lamprey) 	
2.	<p>Division Gnathostomata Superclass Pisces:</p> <ul style="list-style-type: none"> • Class Placodermi e.g. Bothriolepis 	

	<ul style="list-style-type: none"> • Class Chondrichthyes e.g. Rhinobatos (Guitar fish), Chimaera (Rabbitfish) • Class Osteichthyes e.g. Protopterus, Clarius (Catfish) <p>Superclass Tetrapoda:</p> <ul style="list-style-type: none"> • Class Amphibia e.g. Alytes (Midwife toad) and Triton (Salamander) • Class Reptilia e.g. Varanus (Monitor lizard) and Crocodylus (Crocodile) 	
3.	Class Aves: Examples: Eudyptes (Penguin), Phoenicopterus (Flamingo) and Gyps (Vulture)	
4.	Class Mammalia: Examples: Dasyurus (Quoll), Petaurista (Flying squirrel) and Macaca (Monkey).	
5.	<p>Study of Shark with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected.</p> <ol style="list-style-type: none"> a. Digestive system b. Heart and Aortic arches c. Urinogenital System d. Endoskeleton of shark: <ol style="list-style-type: none"> i. Axial - Skull and vertebral column ii. Appendicular - Pelvic and pectoral fins, pelvic and pectoral girdle 	
6.	Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens / Local available niche/ Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare 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.	

Learning Resources recommended:

1. Modern text book of Zoology - Vertebrates; Professor R.L. Kotpal; Rastogi publication; Third Edition 2012.
2. Vertebrate Zoology for Degree students; V. K. Agarwal; S. Chand Publication; 2012. Fundamentals of Zoology, Dr. K. C. Ghosh and Dr. B. Manna, New Central book Agency
3. (P) Ltd.
4. Chordate Zoology Volume II, Prof. N. Arumogam. Saras Publication. Chordate Anatomy Mohan P. Arora, Himalaya Publishing House, First edition.
5. The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press; Third edition, 2006 Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar; Campus Book International, First edition, 2005.
6. Introduction to Zoology - Vol II: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book Agency.
7. URL for search on net: <https://www.amazon.com/Protozoology-Susheel-Vilas-Nikam/dp/9350300044>.
8. Chordate Zoology by E. L. Jordan and P. S. Verma, edition,2009, Chand publications. Chordate Zoology by P. S. Verma, edition,2009, Chand publications.

9. Modern Textbook of Zoology Vertebrates by R.L. Kotpal, edition Jan 2015, Rastogi publications.
10. Practical Zoology: Vertebrate, by S. S. Lal, 2015.
11. A Textbook of Invertebrate Zoology & Cell Biology, by V. S. Kanwate, A. N. Kulkarni *et al.* ed. Alka Prakashan.
12. The Animal Kingdom: An Elementary Textbook in Zoology; Specially Classified and Arranged for the Use of Science Classes, Schools and Colleges (Classic Reprint), by Ellis
13. Davidson, Sept. 2015, Publisher: Forgotten Book.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Physiology and Tissue Culture
Course Code (refer to student handbook)	USZO602 (Course-XVI)
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Physiology and Tissue Culture

CO1 – The learner shall understand fundamentals of enzyme structure, action and kinetics.

CO2 – The learner shall appreciate the enzyme assay procedures and the therapeutic applications of enzymes.

CO3 – The learner shall comprehend the adaptive responses of animals to environmental changes for their survival.

CO4 – The learner shall understand the types and secretions of endocrine glands and the functions.

CO5 -The learner shall understand the significance of tissue culture as a tool in specialized areas of research.

CO6 – The learner will appreciate its applications in various industries.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Enzymology	<p>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</p> <p>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 K_m, V_{max} and K_{cat}</p> <p>1.3 Enzyme Inhibition: Competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors.</p> <p>1.4 Regulation of Enzyme Activity: Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)</p> <p>1.5 Industrial applications of enzymes: Food and detergents</p>	15
II	Homeostasis	<p>2.1 Homeostasis</p> <p>2.1.1: External and internal environment; Acclimation and acclimatization</p> <p>2.1.2: Body clock-Circadian & Diurnal rhythm</p> <p>2.2 : Thermoregulation</p> <p>2.2.1: Endothermy and ectothermy</p> <p>Temperature balance: Heat production shivering and non-shivering thermogenesis; brown fat, mechanisms of heat loss</p> <p>2.2.2: Adaptive response to temperature-daily torpor, hibernation, aestivation</p> <p>2.3: Osmotic and Ionic Regulation</p> <p>2.3.1: Living in hypo-osmotic, hyper-osmotic and terrestrial environment-Water absorption, salt water ingestion and salt excretion, salt glands, metabolic water</p>	15

		2.3.2: Role of kidney in ionic regulation	
III	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: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal	15
IV	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, <i>in vitro</i> modeling of <i>in vivo</i> 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	15

PRACTICALS		1.5 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.	

Learning Resources recommended:

1. Comparative Animal Physiology; Knut Schmidt Nielson; Cambridge Press. Comparative Animal Physiology; Prosser and Brown.
2. Comparative Animal Physiology; William S Hoar.
3. Text book of Comparative Physiology; R Nagabhushanam, M S Kodarkar, Sarojini R. India Book House Pvt. Ltd.
4. Animal Physiology; N. Arumugam, A. Mariakuttikan; Saras Publication. Text book of Endocrinology; Williams.
5. Textbook of Endocrinology Hardcover; Dharmalingam; 2010. Endocrinology; 6th Edition; Mac Hadley, Jon E. Levine.
6. Bailey's textbook of histology Hardcover; Frederick R Bailey.
7. Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978.
8. Culture of animal cells - A manual of basic technique; R. Ian Freshney; John Wiley and Sons Publications; 2005.
9. Basic cell culture - A practical approach; J. M. Davis; Oxford University Press; Indian edition; 2005.
10. Animal cell culture - Biotechnology Series: Vol.1; Bina Mishra, B. P. Mishra, Pran P. Bhat, P.N. Bhat; Studium Press (India) Pvt. Ltd; 2011.
11. Animal cell culture - Concept and Applications; Shweta Sharma; Oxford book Company; 2012.
12. Biotechnology of Animal Tissues; Dr. P. R. Yadav and Dr. Rajiv Tyagi; Discovery Publishing House, New Delhi; 2006.

Evaluation Pattern:**A. Internal Evaluation- 40 % 40 Marks**

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%**Semester End Evaluation (Paper Pattern)- 60 Marks**

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)
All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Genetics and Bioinformatics
Course Code (refer to student handbook)	USZO603 (Course-XVII)
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Genetics and Bioinformatics

CO1- Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material.

CO2- The course shall prepare learner to recognize the significance of molecular biology as a basis for the study of other areas of biology and biochemistry.

CO3- Learner shall understand related areas in relatively new fields of genetic engineering and biotechnology.

CO4- 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.

CO5- The learner shall become aware of the impact of changes occurring at gene level on human health and its diagnosis.

CO6- Learner shall become aware of the computational point of view of studying the genomes.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	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: 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, photo-reactivation, excision repair) 1.3.3: Post replication 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	15

II	Genetic Engineering	<p>2.1 Tools in Genetic Engineering</p> <p>2.1.1: Enzymes involved in Genetic Engineering: Introduction, nomenclature and types of restriction enzymes with examples, Ligases-<i>E. coli</i> 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> <p>2.2: 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>	15
III	Human Genetics	<p>3.1 Non-disjunction during mitosis and meiosis</p> <p>3.1.1: Chromosomal Aberrations: Structural: Deletion: types, effects and disorders; Translocation: types: Robertsonian and non-Robertsonian disorders; Inversion: types, effect and significance; Duplication and their evolutionary significance (multigene families)</p> <p>Numerical: Aneuploidy and Polyploidy (Auto polyploidy and Allo polyploidy)</p> <p>3.2 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> <p>3.3: 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>	15

IV	Bioinformatics	<p>4.1 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> <p>4.2 Databases - Tools and their uses</p> <p>4.2.1: Biological databases; Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBLEBI, DDBJ) Protein sequence databases (UniProtKB, PIR) Secondary sequence databases Derived databases - PROSITE, BLOCKS Structure databases and bibliographic databases</p> <p>4.3: 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> <p>4.4 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> <p>4.4.3: Protein Chips and Functional Proteomics: Different types of protein chip (detecting and quantifying), applications of Proteomics</p> <p>4.4.4: Metabolomics: Concept and applications</p>	15
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	PRACTICALS	1.5 credits
1.	Quantitative Estimation of RNA by Orcinol method.	
2.	Quantitative Estimation of DNA by Diphenyl amine 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.	Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and /or structural variations in chromosomes (no cutting of chromosomes):	
	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 query in a nucleotide or protein sequence.	
11.	Exploring bibliographic database PubMed for downloading a research paper on subject of interest with the use of operators.	

Learning Resources recommended:

1. Genetics - The continuity of life; Daniel Fairbanks and Ralph Andersen; Brooks/ Cole Publishing Company; 1999.
2. Introduction to Molecular Biology; Peter Paoella; Tata McGraw Hill; 2010. Molecular Biology; David Freifelder; Narosa Publishing House; 2008.
3. i Genetics - A Molecular Approach; Third Edition; Peter J. Russell; Pearson Education, Inc. (Benjamin Cummings), San Francisco; 2010.
4. Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978.
5. Principles of Genetics; Eighth Edition; Gardner, Simmons and Snustad; John Wiley and Sons (Asia) Pte. Ltd., Singapore; 2002.
6. The Science of Genetics - An Introduction to Heredity; Fourth Edition; George W. Burns;
7. Molecular cloning; Joseph Sambrook, David William Russell; Third Edition; CSHL Press; 2001.
8. Gene Cloning - An Introduction; Brown. T.A; Fourth Edition; Wiley-Blackwell; 2011. Recombinant DNA - Genes and Genomes- A short course; 3rd Edition; Watson, J.D., Myers, R.M., Caudy A., Witkowski, J.K.; Freeman and Co. NY; 2007.
9. Principles Of Gene Manipulation & Genomics; Primrose SB and R. Twyman; Blackwell Science Publications; 2006.
10. Microbiology; Fifth Edition; Pelczar, M.J. et al; Tata McGraw-Hill Co., New Delhi; 2001. Introduction to Protein Structure; Second Edition; Branden C. and Tooze J.; Garland
11. Publishing; 1999.
12. Genetic engineering - Principles and Practice; Sandhya Mitra; Macmillan India Ltd., New Delhi.
13. Biotechnology - Fundamentals and Applications; Third Enlarged Edition; S.S. Purohit; Student Edition, Jodhpur; 2005.
14. Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988.
15. Genetics (Bios Instant Notes); Third Edition; G.I. Hickey, H.L. Fletcher and P. Winter; Taylor and Francis Group, New York; 2007.
16. Genetics - A Conceptual Approach; Third Edition; Benjamin A. Pierce; W.H. Freeman and Company, New York; 2008.
17. Human Molecular Genetics; Fourth Edition; Tom Strachan and Andrew Read; Garland Science, USA; 2011.
18. Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978. Human Genetics - An Overview; Alice Marcus; Narosa Publishing House; 2010.

19. Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003.
20. Bioinformatics - A practical guide to analysis of Genes & Proteins; Andreas D Baxevanis & B F Francis; John Wiley; 2000.
21. Bioinformatics; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003. Bioinformatics sequence and genome analysis; David W. Mount; Cold spring Harbor Laboratory Press; 2004.
22. Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well Publishing; 1998.
23. Proteomics - From Protein Sequence to Function; 12 S. R. Pennington, M. J. Dunn; First edition; Springer publications; 2001.
24. Metabolomics - A Powerful Tool in Systems Biology; Jens Hřiriis Nielsen, Michael C. Jewett; Springer; 2007.
25. Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008.
26. Bioinformatics Computing - The complete practical guide to bioinformatics for life scientists; Bryan Bergeron; Eastern Economy Edition; Prentice-Hall of India Pvt. Ltd., New Delhi; 2003.
27. Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009.
28. Introduction to Bioinformatics; First Edition; S. Sundara Rajan and R. Balaji; Himalaya Publishing House, Mumbai; 2002.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

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Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options		Unit	Marks
1.	Answer any two out of the three (6 marks each)		1	12
2.	Answer any two out of the three (6 marks each)		2	12
3.	Answer any two out of the three (6 marks each)		3	12
4.	Answer any two out of the three (6 marks each)		4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.		1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Environmental Biology and Zoo pharmacognosy
Course Code (refer to student handbook)	USZO604 (Course-XVIII)
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: Environmental Biology and Zoo pharmacognosy

CO1- Learner will understand the different factors affecting environment, its impact and environment management laws.

CO2- Learner will be able to understand various methods for wildlife conservation.

CO3- Learner will be able to apply knowledge to overcome the issues related to wildlife conservation and management.

CO4- Learner will understand the paradigms of discovery and commercialization of biological resources and knowledge gained from self-medication observed in animals.

CO5-The learners will become acquainted with how and why different animal species are distributed around the globe.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	Environment management	<p>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, bio-drying, pyrolysis, Up-flow 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: Rain water 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 1.5.1: Environment Protection Act- 1986, Air (Prevention and Control of Pollution) Act-1981,</p>	15

		<p>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>	
II	Wildlife Management	<p>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</p> <p>2.2: 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> <p>2.3: 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: Harvesting Trees, Thinning harvest, Clear cut Harvest, Shelterwood harvest, Seed tree harvest, Group selection harvest, Single-tree selection harvest, Prescribed burning, Reforestation</p> <p>Forestpolicy1894, 1952,1988; The Indian ForestAct,1927; Forest (Conservation) Act, 1980</p>	15
III	Bioprospecting and Zoo pharmacognosy	<p>3.1: Bioprospecting</p> <p>3.1.1: Traditional and modern bioprospecting, economic value of bioprospecting</p> <p>3.1.2: Bioprospecting and conservation, advantages and disadvantages</p> <p>3.2: Zoo pharmacognosy</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> <ol style="list-style-type: none"> Ingestion-ants and mammals Geophagy-invertebrates and birds 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>	15
IV	Zoogeography	<p>4.1: Introduction: Plate tectonics and continental drift theory</p> <p>4.2: Animal Distribution and Barriers</p> <p>4.2.1: Isolating Mechanisms</p>	15

	<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, landmass, lack of salinity and special characteristic habit (homing instinct).</p> <p>4.2.4: Means of dispersal-land bridges, natural rafts and driftwood, favouring gales, migration by host, accidental transportation and by human agencies</p> <p>4.3: Zoogeographical Realms: Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic</p>	
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	PRACTICALS	1.5 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:	
	Tumour suppression compounds e.g. Sponge.	
	Skin erythema treatment from gel- <i>Aloe vera</i> , <i>Aloe ferox</i> .	
8.	Study of Zoo pharmacognosy 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. <ul style="list-style-type: none"> 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.	

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

- 1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and

2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

Composition of DMC shall be as follows:

- i) Head of the Concerned Department (Convener / Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
- iv) One or two members of related department from neighbouring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT /DISSECTION /MOUNTING IS BANNED. SIMULATIONS, AUTHORIZED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Learning Resources recommended:

1. Essentials of Environmental Science; N. Vasudevan; Narosa Publishing House Pvt. Ltd. New Delhi 110002.
2. Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd. New Delhi 110055.
3. A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation, New Delhi 110002.
4. Environmental Biotechnology - Basic Concepts and Application; Indu Shekhar Thakur; I. K. International Pvt. Ltd. New Delhi 110016.
5. Text book of environmental science; S. C.Santra. Wildlife management; Rajesh Gopal.
6. Wildlife Management and Conservation - Contemporary Principles and Practices; Paul R. Krausman and James W. Cain III.
7. Wildlife Ecology, Conservation, and Management; John M. Fryxell, Anthony R. E. Sinclair, Graeme Caughley.
8. Molecular Biotechnology - Principles and Practices; Channarayappa. Biotechnology - P. K. Gupta.
9. Biotechnology - B. D. Singh.
10. Biotechnology Fundamentals & Applications - S. S. Purohit. Pharmacognosy and Pharmaco biotechnology- Ashutosh Kar. Trease and Evans Pharmacognosy - Evans, W.C. Pharmacognosy - Kokate, C. K. A. and Purohit, A.P.
11. Practical Pharmacognosy- Gokhale, S. B. and Kokate, C. K. Text book of Pharmacognosy; T. E. Wallis.
12. Zoogeography - The Geographical Distribution of Animals; Philip J. Darlington JR;
13. Academic Publishers, Kolkata Animal Geography - Newbegin. Vertebrate Paleontology - Romer.
14. Ecological animal geography- Allee, Park and Schmidt.
15. Zoogeography of India and South East Asia - Dr. S. K. Tiwari; CBS Publishers and Distributors, Delhi; 1985.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Date:

Place: Ratnagiri



Signature
Chairperson and HoD



R.E. Society's

**R. P. GOGATE COLLEGE OF ARTS & SCIENCE AND R.V.
JOGALEKAR COLLEGE OF COMMERCE, RATNAGIRI
(AUTONOMOUS)**

NAAC accredited 'A' Grade (4th Cycle)

Ratnagiri-415612 (Maharashtra-India)

Bachelor of Science (B. Sc.) Programme

Program: T.Y.B. Sc.
Course: Fishery Biology
(Applied Component)

Syllabus for Semester III & IV

Under Choice Based Credit System (CBCS)

**To be implemented from Academic Year
2023-2024**

PREAMBLE:

Welcome to the exciting world of Fishery Biology at the T. Y. B. Sc. (Third Year Bachelor of Science) level! This syllabus has been thoughtfully crafted to cater to the unique coastal environment and rich aquatic resources surrounding Gogate College, Ratnagiri, a coastal district in Maharashtra. Our program aims to equip you with the knowledge and practical skills required to understand, manage, and sustainably utilize the diverse aquatic ecosystems of this region.

Gogate College, situated in the heart of a coastal district, is uniquely positioned to offer an applied component of Fishery Biology that draws from the local marine and freshwater environments. The study of fishery biology here takes on special significance as it directly contributes to the conservation and management of the region's aquatic resources, which play a vital role in the livelihoods of local communities and the overall health of our coastal ecosystems.

Throughout this course, you will explore various aspects of fishery biology, including the biology and ecology of fish and other aquatic organisms, fisheries management, aquaculture techniques, and the sustainable use of aquatic resources. You will gain hands-on experience in collecting data from local aquatic ecosystems, analysing it, and using the information to make informed decisions about fisheries and conservation.

As a student of Fishery Biology at Gogate College, you have a unique opportunity to connect classroom learning with real-world challenges. Your education will extend beyond the four walls of the classroom as you engage in fieldwork, interact with local stakeholders, and contribute to the sustainable management of the region's fisheries and aquatic biodiversity.

This syllabus is designed to empower you with the knowledge and skills needed to pursue careers in fisheries management, marine conservation, aquaculture, research, and more. It is our hope that you will become ambassadors for responsible and sustainable fisheries practices, contributing to the long-term health and prosperity of the coastal communities in Ratnagiri and beyond.

As you embark on this academic journey, remember that the coastal waters of Ratnagiri hold a wealth of opportunities and knowledge waiting to be discovered. Embrace this unique learning experience, immerse yourself in the rich marine environment, and let your studies in Fishery Biology be a source of inspiration and stewardship for the aquatic ecosystems of this remarkable coastal region.

Best wishes for your academic and practical endeavours in Fishery Biology at Gogate College, Ratnagiri.

**Chairperson,
BOS in Zoology,
Gogate Jogalekar College,
Ratnagiri.**

Syllabus for T. Y. B. Sc. Course: ZOOLOGY

Applied Component

Fishery Biology

Credit Based Semester and Grading System

(To be implemented from the Academic Year 2023-2024)

SEMESTER – V

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USACFBIO501	I	Oceanography	2	1
	II	Crafts and Gear		1
	III	Farming of major carps		1
	IV	Quality control and packaging		1
			2	4
USACFBIO501		Practicals based on all four courses	1	4
Total Number of Credits and Workload			3	8

SEMESTER – VI

COURSE CODE	UNIT	TOPIC	CREDITS	LECTURES /WEEK
USZO501	I	Marine Fin-fish of India	2	1
	II	Nutrition		1
	III	Diseases		1
	IV	By-products and Value-Added Products		1
			2	4
USZOP05		Practicals based on all four courses	1	4
Total Number of Credits and Workload			3	8

Syllabus for (T.Y.B. Sc.) Autonomous from the year 2023-24

Name of the Course	Oceanography, Aquaculture Practices, Marketing and Finance
Course Code (refer to student handbook)	USACFBIO501
Class	T.Y.B.Sc.
Semester	05
No of Credits	02
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Applied Component
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Oceanography, Aquaculture Practices, Marketing and Finance

Course Outcomes:

CO1-Learner shall understand and learn about the use of sea safety, navigational equipments and oceanographic instruments

CO2- Learner shall understand basic physical, chemical and biological oceanography

CO3-Learner shall comprehend boat building techniques and design of engines used in mechanized boats

CO4-Learner will gain knowledge about the postmortem changes, spoilage mechanisms and methods involved in evaluating the freshness and quality of fishes and prawns / shrimps

CO5-Learner shall comprehend the value of maintaining and taking sanitary precautions during the processing and packaging operations

CO6- Learner shall understand the operations of various types of nets and fishing method learner shall understand breeding techniques, hatchery and management of fin- fish and shell fishes

Curriculum:

Unit	Title	Learning Points	No of Lectures
1.	Oceanography	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	15
2.	Crafts and Gear	2.1 Basic boat building (parts, design, material used), methods of protection from fouler 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	15
3.	Farming of major carps	3.1 Breeding techniques of major carps and common carp 3.2 Hatchery and nursery management of:	15

		<ul style="list-style-type: none"> • Major carps: <ul style="list-style-type: none"> i) IMCs: <i>Labeo rohita</i> (Rohu), <i>Catla catla</i> (Catla), <i>Cirrhinus mrigala</i> (Mrigal) ii) Exotic carps: <i>Hypophthalmichthys molitrix</i> (Silver carp), <i>Ctenopharyngodon idella</i> (Grass carp) iii) <i>Cyprinus carpio</i> (Common carp) 3.3 Mono-culture and polyculture practices: <ul style="list-style-type: none"> i) Extensive ii) Semi-intensive iii) Intensive 	
4.	Quality control and packaging	<p>6.1 Post mortem changes and mechanism of spoilage:</p> <ul style="list-style-type: none"> i) Hyperaemia ii) Rigor mortis iii) Autolysis iv) Rancidity <p>6.2 Brief methods for evaluating freshness and quality of fish and prawns / shrimps</p> <ul style="list-style-type: none"> i) Organoleptic ii) Microbial iii) Chemical <p>6.3 Sanitary operations</p> <ul style="list-style-type: none"> i) Maintenance of hygiene of food contact surfaces, storage and equipment ii) Water quality, ice, sewage and waste water disposal and effluent treatment plant <p>6.4 Various packaging materials used in freezing and canning industry</p> <ul style="list-style-type: none"> i) Polyolefin ii) Wax duplex carton iii) Master carton iv) Can v) Lacquered can vi) Retort vii) Freezing procedures including hygienic washing, dressing <p>6.5 Quality Policy and Quality Analysis: ISO 22000/HACCP/ BRC/IFS</p>	15

	PRACTICALS USACFBIO501	1 Credits
1.	Identification and functioning of oceanographic instruments: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • <i>Labeo rohita</i> (Rohu) • <i>Catla catla</i> (Catla) • <i>Cirrhinus mrigala</i> (Mrigal) Exotic carps: <ul style="list-style-type: none"> • <i>Cyprinus carpio</i> (Common Carp) • <i>Hypophthalmichthys molitrix</i> (Silver Carp) • <i>Ctenopharyngodon idella</i> (Grass Carp) 	
4.	Identification of fishes: <ul style="list-style-type: none"> • <i>Anabas testudineus</i> (Climbing perch) • <i>Clarius batrachus</i> (Walking catfish) • <i>Boleophthalmus spp.</i> (Mudskipper) • <i>Pangasianodon hypophthalmus</i> (Iridescent shark) • <i>Pangasius bocourti</i> (Basa catfish) • Tilapia(GIFT) 	
5.	Study of models and functioning of D 81 hatchery, Shirgur's hatcheries and Chinese hatchery.	
6.	Microbial studies: i. Dilution of sample ii. Gram staining technique iii. Identification of Bacilli, Cocci, Vibrio bacteria	
7.	Organoleptic tests for fish and prawn / shrimp	
8.	Total Plate Count (TPC) of bacteria from fish.	
9.	Identification of packaging materials: <ul style="list-style-type: none"> • Waxed duplex carton • Master carton • Simple cans • Coated [Lacquered] cans • Polyolefin • Retort 	
10.	Estimation of toxins and moulting retardant <ul style="list-style-type: none"> • H₂S (qualitative) • Ammonia (qualitative) • Ca (quantitative) • Mg (quantitative) 	
11.	Assignment (may be submitted in a group not exceeding three students)	

Please refer the Annexure I for the suggested topics for assignment for Course code USACFBIO5P1.

*Note – The practicals may be conducted by using specimens authorized by the wild life and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/ models etc. as recommended by the UGC and as envisaged in the regulation of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

- 1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
- 2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

Composition of DMC shall be as follows:

- i) Head of the Concerned Department (Convener / Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
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Evaluation pattern:

A. Internal Evaluation- 40 %

40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)-

60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. On each unit there will be one question and the fourth question will be based on entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.

4. Question may be subdivided into sub-questions A and B and the allocation of marks depend on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12
2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Field work	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

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Syllabus for (T.Y. B. Sc.) Autonomous from the year 2023-24

Name of the Course	Marine resources, Post-harvest and Farm Engineering
Course Code (refer to student handbook)	USACFBIO601
Class	T.Y.B.Sc.
Semester	06
No of Credits	02
Nature	Theory/ Practical/ Field visit
Type (applicable to NEP only)	Applied Component
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-

Nomenclature: Marine resources, Post-harvest and Farm Engineering Course

Outcomes:

CO1- Learner shall understand deep sea and coastal fishes.

CO2- Learner shall understand commercial potential and know about the major landing centers of the fishes.

CO3-Learner will get acquainted with basics of nutritional requirements at various developmental stages of fish and crustaceans.

CO4-Learner will be oriented towards understanding causes, pathogenicity, prophylaxis and preventive measures of various fish diseases and physiological disorders

CO5-Learner will gain sound knowledge about the fish by-products and value-added products

CO6- Learner will explore good manufacturing practices while manufacturing these products

Curriculum:

Unit	Title	Learning Points	No of Lectures
1	Marine Fin-fish of India	1.1 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 1.2 Deep sea fisheries (more than 45 fathoms) of Indian exclusive economic zone • <i>Thunnus alalunga</i> (Longfin tuna) • <i>Sarda orientalis</i> (Striped bonito) 1.3 Commercial potential and major landing centers of the above fishes	15
2	Nutrition	3.1 Nutritional requirements at various stages of development of fish and crustaceans 3.2 Culture of natural feed: i) Chaetoceros ii) Infusoria iii) Artemia iv) Brachionus v) Daphnia / Moina spp. 3.3 Algology – Identification and culture of commercially important nutritious algae and its products 3.4 Formulated / Pelleted feed – Understanding the composition and use of formulated feed for fish and prawns / shrimps at various stages	15
3	Diseases	4.1 Viral diseases, prophylaxis and preventive measures 4.2 Bacterial, fungal, protozoan infections and treatment	15

		4.3 Crustacean infections and treatment 4.4 Physiological disorders (Dropsy) / diseases and treatment	
4	By-products and Value-Added Products	6.1 Proximate composition of fish meat and products 6.2 Introduction to by-products i) Fish protein concentrate ii) Fish maws / Isinglass iii) Fish hydrolysates iv) Chitin, Chitosan v) Glucosamine hydrochloride vi) Gelatin vii) Fish silage viii) Surimi and imitation products ix) Pearl essence 6.3 Different types of value added products from fish and shell fish i) Fish / Prawn / Shrimp pickle ii) Fish wafers iii) <i>Acetes indicus</i> (Prawn) chutney iv) Fish soup powder v) Fish / Crab steaks vi) RTE (Ready To Eat) vii) Battered and breaded products viii) Marinated tandoori prawns ix) Prawn curry 6.4 Good manufacturing practices: Health and training of personnel, hygiene	15

PRACTICALS USACFBIO501		1 Credit
1.	Identification of marine fishes. <ul style="list-style-type: none"> • <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) 	
2.	Preparation of formulated feed for fish and prawn.	
3.	Identification of parasitic infections in aquatic organisms. <ul style="list-style-type: none"> • Fungal – Dermatomycois • Bacterial – Fin/Tail rot and Dropsy • Protozoan – Costiasis and White Spot • Crustacean – Argulosis 	
4.	Fish dressing, filleting, prawn peeling – PUD, DV and grading.	

5.	Fish morphometry – Length weight relationship of a suitable fish.	
6.	Preparation of Surimi, Fish protein concentrate.	
7.	Preparations of fish burger, fish fingers, fish/prawn pickle, fish chutney, fish curry.	
8.	Preparation of Chitin – Chitosan, Pearl essence.	
9.	Identification of various farm equipment such as: <ul style="list-style-type: none"> • Feeding cups / Trays • Paddle wheel aerator • Fountains • Sluice gate models • Elbow pipe outlets 	
10.	Study of models of raft, pen, cage culture and materials used in rope culture.	
11.	Project – Feasibility / Scientific.	
12.	Field Visit Report. (Refer Annexure-I)	

Learning Resources recommended:

- 1) A Text Book of Marine Ecology by Nair M.B. and Thumpty D.H. – Tata MacGraw Hill Pub. – New Delhi.
- 2) An Introduction to Fishes by Khanna S.S. – Central Book Depot, Allahabad (1993).
- 3) Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing News Books (1988).
- 4) Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai.
- 5) Crafts and Gear of India by Y. Shrikrishnan and Latha Shenoy – ICAR Pub.
- 6) Ecological Methods for Field and Laboratory Investigations by P. Michael. The Oceans By Svedrup H.V. – et.al. - Asian Pub. House.
- 7) Financial management by Prasanna Chandra- Seventh Edition.
- 8) Financial management by Khan and Jain.
- 9) Financial management by I. M. Pandey.
- 10) Fish Biology by C.B.C. Srivastava – Narendra Pub. House.
- 11) Fish and Fisheries by Chandy – National Book Trust.
- 12) Fish and Fisheries in India – by Jhingran V.G. – Hindustan Pub. Corporation – New Delhi.
- 13) Fisheries Biology, Assessment and Management by Michael King – Fishing News Publishers (1995).
- 14) Fishery Science by Santhanam R. – Daya Pub. House – 1990.
- 15) Fisheries Bioeconomic – Theory, Modelling and Management – FAO Fisheries Technical Paper 368 – FAO, 2001.
- 16) General and Applied Ichthyology by Gupta and Gupta, S Chand Publishers.
- 17) Handbook of Fish Biology and Fisheries Edited By J.B. Hart and John Reynold.
- 18) Hand Book of Fresh Water Fishes of India by Beaven C.R. – Narendra Pub. House.
- 19) Introductory Oceanography by Harold Thurman – Printis Hall Pub. London – 8th Edition.
- 20) Marine Ecology by Tait R.B. – Oxford Press.
- 21) Marine Fish and Fisheries by Dr. D. V. Bal and K.V. Rao - Tata MacGraw Hill Pub. – New Delhi.
- 22) Marketing Management by Philip Kotler.
- 23) Modern Fishing Gear Technology by N. Shahul Hameed, Boopendranath – Daya Pub. House – 2000.
- 24) Prawn and Prawn Fisheries by Kurian and Sebastian.
- 25) Project Management by Prasanna Chandra.

For Additional and Latest Information on the topics, various Web Sites can be visited.

Please refer the **Annexure II** for the suggested field visits and **Annexure – III** for suggested topics for projects for Course code USACFBIO6P1.

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N.B:

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Composition of DMC shall be as follows:

- i) Head of the Concerned Department (Convener / Chairperson)
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- iii) One Faculty of related department from the same College
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**Annexures
Annexure -I**

Suggested Topics for Assignment USACFBIO5P1 (Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students)

- 1) Market survey for various preserved and processed fish / prawns.
- 2) Observation on handling of fish on board, at landing center, in secondary market and at consumer level.
- 3) Survey of the local market for the availability of various by-products / value added products and its price.
- 4) Comparative study of the shelf life of various fishes / fish by-products / value added products in relation to their cost.
- 5) Study of economics of brackish water pond culture.
- 6) Study of working of fisheries co-operative societies in your area.
- 7) Study of cost of construction of fishing vessel and subsidies available for the same.
- 8) Study of cost of gear manufacturing with different materials and subsidies available for the same.

- 9) Study of cost and profit analysis of any one of the following methods – Trawler / Gill netter / Purse seiner / hooks and lines and non-mechanized fishing units.
 - 10) Survey of various packaging materials used in fish processing industries.
 - 11) Survey of various feeds used in local aqua farms.
 - 12) Study of economics of pond culture from nearby area.
 - 13) Comparative cost analysis of fingerlings of major carps from your area.
 - 14) Setting up of marine / fresh water aquarium with various accessories and its costing.
 - 15) Survey of costing of aquaria of different sizes and shape.
 - 16) Study of various courses run by Institutes in your area in relation to fisheries.
 - 17) Survey of aquarium shops to compare the costs of various aquarium fishes.
 - 18) Study of economics involved in breeding / rearing of aquarium fishes.
 - 19) Review of different marketing strategy (w.r.t. attracting target clients) used by manufacturers of fish products / byproducts / value added products.
 - 20) Survey of target clients of manufacturers of fish products / byproducts / value added products.
 - 21) Study of working of financial institutions involved in funding fishing industry.
 - 22) Review of export import procedures followed by the fishing industry in your area.
- All the topics mentioned above are suggestive in nature and more creative and innovative topics are expected from the students under the able guidance of concerned teachers, to suit the expertise, human resources, infrastructure and local needs as also the interest of the students. The assignment may be submitted in a group not exceeding three students.

Annexure - II

Suggested Field Visits USACFBIO6P1

- There shall be various short and long excursions / study tours / field visits / industrial visits in every semester, at least one of which shall be financially affordable to every student in the class; and that assessment and marks of field trips shall be solely based upon such where no student was restrained for financial limitations.
 - Field visits are to be organized to facilitate students to have firsthand experience and exposure to technology / production / functioning of an organization / unit or witness a relevant activity.
 - Each student must make at least 01 (one) such visits to the units/markets/sea shores out of 2 to 3 such visits organized by the college.
 - **The list is suggestive and not exhaustive**
- I) Visit to one of the units with one or multiple activities such as:
 - Ornamental / Brackish water / Fresh water fish farm / hatchery
 - II) Visit to witness one of the activities such as
 - Fish angling / trawling / purse seining / gill netting
 - Fish finding operations, etc. (Echo Sounder / Sonar / Fish Magnifier)
 - III) Visit any production units such as
 - Food / Fish processing and preservation
 - Ornamental articles

IV) Hi-tech and multinational total export-oriented units such as

- IQF plant
- Surimi plant
- Fishery plant
- Microbiological units
- Hi-tech fish / prawn / chick hatcheries
- Fish consumer product industries

V) Others –

- Self-Sale Groups
- Co-operative Societies

VI) Govt. Offices such as

- Fishery Department
- MPEDA
- Wild-life Authority

- CITES
- JDEI (Jt. Director-Export and Import)
- Sales Tax
- Income Tax
- Excise Department
- Customs Authority of India
- Local Self Govt. (BMC)
- Clearing Agencies / Agents
- FDA
 - ISI
 - Agmark, etc.

VII) Visit any ancillary unit such as

- Ice plant
- Can reforming
- Packaging
- Cold storage

VIII) Visit to National Laboratories, National Research Labs and Training Institutes such as NIO, CIFE, CMFRI, CIFT, FSI, IFP, CIFI, CIFNET, NBFGR, etc.

IX) Following places may be considered for short/long excursions:

- Ganpatipule beach
- Dapoli (Harnai / Harne Port Fish Auctioning)/ Dabhol / Burondi
- Mirkarwada Harbour (Major fish landing and assembling centre, Ratnagiri)
- Rajiwada (Satellite landing centre, Ratnagiri town)
- Guhagar beach (Use of Solunar Clock for fishing)
- Karla (Ratnagiri) – First Fisherman co-operative society of India (Estd. 1913)
- Marine Biological Research Station, Zadgaon, Ratnagiri (Aquarium Management Training Programme)

Annexure III

Suggested Topics for Project USACFBIO6P1 (Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students)

- 1) Feasibility report of the maintenance of aquarium fishes in high profile residences.
- 2) Feasibility report of fresh water / brackish water fish / prawn culture for extensive, semi-intensive and intensive.
- 3) Probability report of maintenance of a culture of Chaetopteros and Artemia by the fish farmers.
- 4) Project report for the establishment of small / medium / large scale ice factory, freezing and canning industry.
- 5) Feasibility report of various packaging materials in freezing / canning industry.
- 6) Feasibility report for establishing an aquarium shop.
- 7) Feasibility report for establishing a fish feed industry.
- 8) Monitoring various physico-chemical parameters of an aquarium / pond / lake / river / sea.
- 9) Feasibility report for establishing value added products of fish / shell fish.
- 10) Project report for culture of commercially important nutritious algae and its products.
- 11) Project report on survey of fish markets for fluctuation in the availability and price of fishes.

The project may be submitted in a group not exceeding three students.

Evaluation Pattern:

A. Internal Evaluation- 40 % 40 Marks

Method	Marks
Class test	20
Assignment	10
Class participation & overall conduct	10
Total	40

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 60 Marks

1. The examination shall be of 2 Hours duration. Maximum marks 60.
2. There shall be four questions each of 12 marks. In each unit, there will be one question and the fourth question will be based on the entire syllabus or as per the directive of BOS.
3. All questions shall be compulsory with internal choice within the questions.
4. Questions may be subdivided into sub-questions A and B and the allocation of marks depends on the weightage of the topic.

Distribution of marks for descriptive external examination (60 marks)

All the Questions are compulsory

Time: 2 hours

Total marks: 60

Question No.	Options	Unit	Marks
1.	Answer any two out of the three (6 marks each)	1	12

2.	Answer any two out of the three (6 marks each)	2	12
3.	Answer any two out of the three (6 marks each)	3	12
4.	Answer any two out of the three (6 marks each)	4	12
5.	Multiple Choice Questions/True or false/One sentence answer/Define/Give appropriate answer etc.	1,2,3,4	12

Practical Examination Pattern:

(A) Internal Examination

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	20

(B) External (Semester end practical examination)

Particulars	Practical
Lab work	30
Total	30

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

Date:

Place: Ratnagiri



**Signature
Chairperson and HoD**