Resolution No.: AC/II (21-22).2.RPS11

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for: PG

Program: M.Sc.

Program Code: Zoology (RPSZOO)

(Credit Based Semester and Grading System
for the academic year 2021–2022)

PROGRAM OUTCOMES

In the post graduate courses, S.P.Mandali's Ramnarain Ruia Autonomous College is committed to impart conceptual and procedural knowledge in specific subject areas that would build diverse creative abilities in the learner. The College also thrives to make its science post graduates research/ job ready as well as adaptable to revolutionary changes happening in this era of Industry 4.0.

PO	PO Description **A student completing Master's in Science program will be able to:**
PO 1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and to evaluate its relevance.
PO 2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
PO 3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
PO 4	Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
PO 5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
PO 6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
PO 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
PO 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM SPECIFIC OUTCOMES

PSO	Description A student completing Master's in Science program in the subject of Zoology will be able to:
PSO 1	Identify, explore, understand the classification of invertebrates and vertebrates and compare between the anatomy and physiology of different phylum.
PSO 2	Gain comprehensive knowledge about different animal species and appreciate the differences and similarities, thereby achieving proficiency in handling them experimentally or for research purposes.
PSO 3	Understand and learn various behavioural patterns displayed by animals and interrelate to evolutionary pattern.
PSO 4	Evaluate and analyse basics of chemical thermodynamics and various biochemical pathways with respect to metabolism.
PSO 5	Analyse the various communication pathways taking place inside the cell and interrelate it with genetics.
PSO 6	Compare and contrast between Mendelian inheritance, Extension of Mendelian genetics and non-Mendelian genetics
PSO 7	Interpret and analyse how morphological change due to change in environment helps drive evolution over a period of time.
PSO 8	Compare the different developmental stages of all the animals and connect it to the evolutionary link.
PSO 9	Apply the fundamentals and techniques of molecular biology in various fields.
PSO 10	Develop an ability to analyse present and interpret various concepts of Immune and Cancer Biology.
PSO 11	Understand the broad concepts of Life processes, Endocrinology, Assisted reproductive techniques, Animal biotechnology and develop employable skills.
PSO 12	Explore some of the unique migratory patterns of animals and understand their biological rhythms.
PSO 13	Apply their knowledge in problem solving and future course of their career development in higher education and research.
PSO 14	Develop critical thinking, planning and executing research projects and develop employable skills in the field of Animal Physiology.

Important Note:

In the context of UGC circular of 2006 and the need to understand animal systems better at specialization stages in Zoology, limited anatomical studies of the animals has been introduced at the level of specialization in M.Sc. Zoology. These anatomical studies have been introduced keeping in focus that all aspects of ethics of animal experimentation is informed to the students and that it will be ensured that students are made to understand the ethical use of animals in Biology. In this context, anatomical studies in a limited manner will be used for training with the following conditions:

- The college is agreed to the inclusion of anatomical studies provided, that the students are not asked to kill and cut open live animals.
- The animal specimen if used for anatomical studies will be procured dead from local food market and are items of regular consumption by people.
- The sessions of anatomical studies are arranged in a planned manner to minimize the number of animal specimens used and to reuse the same animal specimen for multiple sessions.
- Further, College will constitute an Anatomical Study monitoring board which will be informed about the use of animals and that the usage will comply to the guidelines of ethical use and handling of animals.
- Students opting for specialization in Zoology M.Sc. will be informed in advance about the inclusion of anatomical studies in the course work.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
M.Sc.-I	I	RPSZOO101	Animal Systematics, Ethology and Ecology-I	4
		RPSZOO102	Biochemistry and Metabolism – I	4
		RPSZOO103	Genetics-I and Developmental Biology	4
		RPSZOO104	Applied Zoology- I	4
			Practical	
		RPSZOOP101	Animal Systematics, Ethology and Ecology-I	2
		RPSZOOP102	Biochemistry and Metabolism – I	2
		RPSZOOP103	Genetics and Developmental Biology	2
		RPSZOOP104	Applied Zoology- I	2
	II	RPSZOO201	Animal Systematics and Ethology – II	4
		RPSZOO202	Biochemistry and Metabolism- II	4
		RPSZOO203	Molecular Biology, Syndromes and Evolution	4
		RPSZOO204	Applied Zoology-II	4
			Practical	
		RPSZOOP201	Animal Systematics and Ethology – II	2
		RPSZOOP202	Biochemistry and Metabolism- II	2
		RPSZOOP203	Molecular Biology, Syndromes and Evolution	2
		RPSZOOP204	Applied Zoology-II	2
M.Sc.-II	III	RPSZOP301	Life Processes-I	4
		RPSZOP302	Immunology and Cancer Biology	4
		RPSZOP303	Reproduction Biology	4
		RPSZOP304	Internship/Project	4
			Practical	
		RPSZOPP301	Life Processes-I	2
		RPSZOPP302	Immunology and Cancer Biology	2
		RPSZOPP303	Internship/Project	2
		RPSZOPP304	Internship/Project	2
	IV	RPSZOP401	Animal Biotechnology	4
		RPSZOP402	Life Processes-II	4
		RPSZOP403	Endocrinology	4
		RPSZOP404	Biological rhythm and Ecophysiology	4
			Practical	
		RPSZOPP401	Animal Biotechnology	2
		RPSZOPP402	Life Processes-II	2
		RPSZOPP403	Endocrinology	2
		RPSZOPP404	Biological rhythm and Ecophysiology	2

Resolution No.: AC/II (21-22).2.RPS11

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for: Semester- I& II

Program: M.Sc.

Program Code: Zoology (RPSZOO)

(Credit Based Semester and Grading System
for the academic year 2021–2022)

Semester-I
Academic year 2021-2022

Paper Code	Unit	Topic	Credits
Paper I RPSZOO101	**Animal Systematics, Ethology and Ecology-I**		
	I	Animal Taxonomy and Systematics	4
	II	Phylogeny, Systematics of non-chordates, Hemichordate and assorted topics	
	III	Ecological Principles	
	IV	Study of Animal Behavior	
Paper II RPSZOO102	**Biochemistry and Metabolism – I**		
	I	Biomolecules- a structural and functional approach-I	4
	II	Biochemical Thermodynamics	
	III	Metabolic pathways and Integration of metabolism-I	
	IV	Regulation of metabolism & Cell Communication	
Paper III RPSZOO103	**Genetics and Developmental Biology**		
	I	Genetics Chromosome theory of inheritance and Mendelism -I	4
	II	Genetics- Extension of Mendelian genetics and non-Mendelian inheritance –I	
	III	Evolution –I	
	IV	Developmental Biology	
Paper IV RPSZOO104	**Applied Zoology- I**		
	I	Instrumentation- Microtomy, microscopy, centrifugation-I	4
	II	Biostatistics	
	III	Research Methodology-I	
	IV	IPR	
Practical			
RPSZOOP101		Animal Systematics, Ethology and Ecology-I	2
RPSZOOP102		Biochemistry and Metabolism – I	2
RPSZOOP103		Genetics and Developmental Biology	2
RPSZOOP104		Applied Zoology-I.	2
Grand Total			**24**

Course Code: RPSZOO101

Course Title: Animal Systematics, Ethology and Ecology-I

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enumerate& classify the characteristics of different phyla.
CO 2	Compare and contrast between taxonomic procedures of animal classification.
CO 3	Interrelate the working and different systems of non-chordates and link it with their evolutionary process
CO 4	Understand and comprehend the broad concepts of animal behaviour and its applications in various fields of research.
CO 5	Analyze the different concepts in the field of population ecology, identify different population growth curves and correlate it with life strategies of different animals.

RPSZOO101	Title: Animal Systematics, Ethology and Ecology-I	Credits 4
UNIT–I	***Animal Taxonomy and Systematic*** • *Introduction to taxonomy – Principles, stages, importance and rise of taxonomy. • *Taxonomic Procedures – Traditional or evolutionary method, Phonetic and Cladistic Methods. • *ICZN regulations and Zoological Nomenclature including use of suffixes 'i', 'orum', 'ae', 'arum', 'ensis' and 'iensis'. oidea, idea, inae; Tautonyms, synonyms and Homonyms. • Concept of species- Different Species concepts, sub-species and other intra-specific categories. • New trends in taxonomy: Ecological, Ethological, Cytological and Biochemical approaches and Numerical taxonomy • Molecular basis of animal taxonomy- DNA hybridization, Restriction analysis and sequencing of nucleotides. • Systematics of Porifera up to classes. • Systematics of Coelenterate up to classes. • Systematics of Ctenophora up to classes	**15 Lectures**
UNIT–II	***Phylogeny, Systematics of non-chordates, Hemichordata & assorted topics*** • Phylogeny, salient features, classification (wherever applicable) up to classes of the following phyla- Mollusca, Bryozoa, Brachiopoda, Echinodermata, Chaetognatha • Systematic position and affinities of Hemichordata. • *Economic importance of Protozoa. • Mesenteries in Coelenterata. • Sense organs in Arthropoda. • Spines and Pedicellariae in Echinodermata. Invertebrate larvae- larval forms of free-living invertebrates, larval forms of parasites, Strategies and evolutionary significance of larval forms	**15 Lectures**

UNIT–III	***Study of Animal Behavior*** • Reflexes and complex behaviour-Latency, after discharge, summation, warm up, fatigue inhibition and feedback control. • Instinctive Behaviour - Fixed action pattern, Types of sign stimuli and releasers as triggers, Genetic basis of instinctive behavior. • Learning- Classical conditioning experiment, latent and insight learning. Social learning; Altruism. • *Anti predator behaviour- Avoiding detection through colour and Markings (Mullerian mimicry), Warning coloration, Batesian mimicry. • Biological communication- *Forms of signals, vision, audition and chemicals; Role of pheromone-Insects social organization; pheromone effects in mammals- Lee Boot, Whitten, Bruce, Collidge and Castro-Vandenberg effects.	**15 Lectures**
UNIT –IV	***Ecological Principles*** • *The Environment: Physical environment; biotic environment; biotic and abiotic interactions • Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. • Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *k* selection); concept of meta population – demes and dispersal, interdemic extinctions, age structured populations • Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis • Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. • Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax stage, Succession after Fire. • *Ecosystem Ecology: Ecosystem structure; primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). • *Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.	**15 Lectures**

RPSZOOP101	**Practical Title** **Animal Systematics, Ethology and Ecology-I**	**Credits** **2**
	1. Study of anatomy: Sepia: Morphology, digestive system, nervous system, reproductive system. Mounting of jaws, radula, statocyst and spermatophore 2. Study of systematic and major features of: i. Protozoa -Amoeba, Paramoecium, ii. Porifera - Grantia, Euplectella iii. Coelenterata- Porpita, Sea-anemone iv. Mollusca- Chiton, Mytilus v. Echinodermata- Starfish, Sea urchin, Sea cucumber vi. Hemichordata (Balanoglossus) vii. Cephalochordata (Amphioxus) viii. Agnatha- Petromyzon. ix. Pisces- Hippocampus, Eel x. Amphibia- Caecilian, Toad xi. Reptilia -Viper, Rattle snake, Crocodile/Alligator/Gharial 3. Study of invertebrate (earthworm /crab) heart. 4. Grooming behaviour in cockroaches/house flies 5. Social organization in insects: Termite nest and caste system. 6. Nest construction behaviour and altruism in red ants. 7. Culture of Daphnia/ Rotifers as fish food animals. 8. Behavioural interaction between individuals of Siamese Fighter fishes (*Betta splendens*) 9. Planting and maintaining of larval host plants of different butterfly species. 10. Field activities: field visits- zoos/sanctuaries/national parks.	

References:

1. K.V. Kardong, Vertebrate comparative anatomy, Function, Evolution, 3rd Ed. Tata McGraw Hill Publication.
2. F.H.Pough, C.M.Janis, J.B.Heiser: Vertebrate Life: 6th Ed. Pearson Education.
3. K.F.Liem, W.E.Bemis, W, F.Walker, L. Grande: Functional Anatomy of Vertebrates. An evolutionary perspective. 3rd Ed. Harcourt College Publishers.
4. J.Z.Young : The Life of Vertebrates, ELBS-Oxford Univ. Press.
5. T.J.Parkar and W.A.Haswell, McMillan: A Text Book of Zoology.
6. E.L.Jordan and P.S.Verma, S. Chand & Company: Chordate Zoology.
7. J.A.Pechenik: Biology of Invertebrates; 4th Ed, Tata McGraw Hill Publication.
8. Milton Hildebrand Wiley: International Analysis of Vertebrate Structure.
9. Russell, W.D. Hunter, McMillan: Life of Invertebrates.
10. Bares, R.D: Invertebrate Zoology, Saunders Publication.
11. Barrington, E J W, (1976): Structure and Functions of Invertebrates.
12. Hyman, L.H: The invertebrates (all volumes), McGraw Hill, Philadelphia, USA
13. Huston, AM: Biological Diversity, Cambridge University Press, Cambridge

14. Kapoor V.C: Theory and Practice of Animal Taxonomy, Oxford and IBH Publ., Delhi
15. McNeely, JA: Economics and Biological Diversity, IUCN, Gland, Switzerland
16. Miller,S.A. and Harley,J.P. (2005) : Zoology. 6th Ed. McGraw Hill Higher Education, Boston, Toronto,Sydney
17. Prasad S.N: Life of Invertebrates, Vikas Publ. New Delhi
18. Sinha, A.K, Adhikari S and Ganguly BB: Biology of Animals (vol. I & II), Central Book Agency, Kolkata
19. Young, J.Z: Life of Vertebrates, Clarendon Press, Oxford.
20. Alcock, J. (2001): Animal Behaviour, an Evolutionary Approach. Sinauer associates, INC. Sunderland, Massachusetts. USA
21. Bernard, C. (2004): Animal Behaviour, Mechanism, Development function and evolution. Pearson and Prentice Hall Publication. New York
22. Dunlap, J. C., Loros J. J. and Decoursey P. J. (2004): Chronobiology Biological Timekeeping. Sinuaer Associates, Inc. publishers, Sunderland, Massachusetts, USA
23. Goodenough, J.E., Mc Guire, B. and Wallace, R. A. (1993): Perspectives on Animal Behaviour. John Wiley and Sons, New York.
24. Mandal, F. B. (2010): Textbook of Animal Behaviour. PHI Learning Private Limited, Estern Economy Edition. New Delhi -110001
25. Manning, A. and Dawkins M.S. (1997): Introduction to Animal Behaviour, 5th edition, Cambridge University Press. UK.
26. Scott, G. (2005): Essential Animal Behaviour. Black Well Publishing, University of Hull, UK.
27. Stumpter, T. J. D. (2010): Collective Animal Behaviour; Princeton University Press. Oxford.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOO102

Course Title: Biochemistry and Metabolism – I

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and analyse the classification, structures, and functions of Carbohydrates, Lipids and Nucleic acids.
CO 2	Enumerate the law of Biochemical thermodynamics, ETS chain reaction and oxidative phosphorylation concepts.
CO 3	Apply the knowledge of antioxidants and free radicals quenching to cancer research and anticancer activity.
CO 4	Compare and contrast between different metabolic pathways and understand its significance.
CO 5	Analyse and understand the different cell signalling pathways and apply it in the field of cancer genetics.
CO 6	Calculate Normality, Molarity and prepare solutions of different strengths.

RPSZOO102	Biochemistry and Metabolism – I	Credits 4
UNIT-I	***Biomolecules- a structural and functional approach-I*** • Concepts: Biological Macromolecules, Polymerization and macromolecules, Central role of carbon, Common functional groups, Common ring structure and isomerization in biological molecules. • Carbohydrates: Classification: mono-, oligo- and polysaccharides. Monosaccharides- structure, classification, D- and L- isomers, Anomers and mutarotation, open chain and ring forms, pyranose and furanose forms, reactions of monosaccharides, glycocydic bonds and nomenclature. Oligosaccharides, Polysaccharides- homo- and hetero-polysaccharides. *Biological functions of carbohydrates. • Lipids: Classification: simple and complex lipids, Fatty acids- Even and odd carbon fatty acids, numbering the carbon atoms, saturated and unsaturated fatty acids, cis- and trans-configuration, nomenclature and shorthand representation of fatty acids. Acylglycerols- Mono-, di- and triglycerides, stereospecific numbering of glycerols in glycerides, properties of triacylglycerol. Complex lipids- Phospholipids, Sphingolipids, Sterols and waxes, Amphipathic lipids Membrane lipid bilayers. *Biological functions of lipids. • Nucleic acids: Types- RNA and DNA- Components: Pentose, Nitrogenous bases, Nucleosides, tautomeric forms of purines and pyrimidines. *Structure of DNA: Watson and Crick model; *different forms of DNA double helix. Structure, *types and functions of RNA. • Complex biomolecules • Glycoproteins: Blood group substances • Glycolipids: Gangliosides • Lipoproteins: Classification and functions- chilomicrons, VLDL, LDL, HDL, and free fatty acid-albumin complex.	15 Lectures

Unit-II	***Biochemical Thermodynamics*** • Biochemical Thermodynamics: *Laws of thermodynamics, free energy, entropy, enthalpy, exergonic and endergonic reactions • High energy compounds: ATP, ADP, ATP-ADP cycle, ATP-AMP ratio. • Biological oxidation: Electron transport chain and mitochondria; Oxidative phosphorylation- mechanism, uncoupling of oxidative phosphorylation and its significance. • Free radicals, antioxidants and antioxidant system.	**15 Lectures**
Unit-III	***Metabolic pathways and Integration of metabolism-I*** • *Metabolism: Concept; Definitions; Catabolism; Anabolism. • Carbohydrate Metabolism- Glycolysis: Reaction sequence, flow of carbon, conversion of pyruvate to lactate and Acetyl coenzyme-A, significance of pyruvate-lactate interconversion, aerobic and anaerobic glycolysis and energetic of glycolysis. Regulation of glycolysis. Gluconeogenesis: Reaction sequence from pyruvate, gluconeogenesis from amino acids, glycerol, propionate, lactate. Regulation of gluconeogenesis. Glycogen metabolism: Glycogenesis, Glycogenolysis. Regulation of the two pathways. *Significance of following pathways: Hexose monophosphate shunt as a multifunctional pathway, Uronic Acid Pathway; Glyoxalate cycle. • Lipid Metabolism- Dynamics of body lipids, mobilization of fats, regulation of hormone sensitive TG- lipase, fate of glycerol and free fatty acids. Fatty acid metabolism: Oxidation of even-carbon and odd-carbon atom fatty acid, oxidation of unsaturated fatty acids, biosynthesis of fatty acids including desaturation, metabolism of phospholipids, cholesterol and alcohol.	**15 Lectures**
Unit-IV	***Regulation of metabolism & Cell Communication*** • Regulation of metabolism- *Concept of homeostasis Regulation of metabolic flux by genetic mechanisms: Control of enzyme synthesis, constitutive and inducible enzymes; induction and repression of enzymes (lac operon and trp operon); regulatory proteins- Helix turn Helix, Zinc Fingers, Leucine Zippers. • *Regulation of metabolism by extracellular signals: nutrient	**15 Lectures**

	supply, nutrient transport, endocrine control, neural control. • Cell signaling- Hormones and their receptors, Cell surface receptor, Signaling through G-protein coupled receptors, Signal transduction pathways, Second messengers, Regulation of signaling pathways, Bacterial and plant two-component systems, Light signaling in plants, Bacterial chemotaxis and quorum sensing, G Proteins in cell signaling.	
RPSZOOP102	**Practical Title** **Biochemistry and Metabolism – I**	**Credits 2**
	1. Determination of reducing sugars by 3,5-dinitrosalicylic acid (colorimetric) method. 2. Determination of glycogen in the given tissue (liver/ skeletal muscle/ kidney/ brain). 3. Acid and enzyme hydrolysis of glycogen and colorimetric estimation of the products by 3,5-DNSA method. 4. Determination of acid value of fats/ oils. 5. Determination of saponification value of fats/ oils. 6. Agarose gel electrophoresis of DNA separated from suitable samples. 7. Solutions and Buffers: Mode of expressing concentration of solutions- Molarity (M), Molality (M), normality (N), Mass concentration, mass fraction, mass percentage or %(w/w), % by volume (v/v), parts per million (ppm) with practical exercises. 8. Types of solutions- Stock solutions practical exercises. 9. Preparation of buffers of different pH using Henderson-Hasselbalch equation and its verification using pH meter.	

References

1. U. Satyanarayan: Biochemistry- 2nd Ed. 2002, Books and Allied Publ.
2. S.C. Rastogi: Biochemistry- 2nd Ed., Tata McGraw Hill.
3. J.I.Jain, S. Chand and Co. Publ : Fundamentals of Biochemistry- 3rd Ed. 1988.
4. Lehninger, A. L., Nelson, D. L. and Cox, M. M., 2nd Edn.: Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
5. Conn, E. E., Stumpt, P. K., Bruencing, G. and Dol, R. G. (1995): Outlines of Biochemistry. John Wiley, Singapore.
6. Murray, RK., Garner, D.K., Mayes P.A. and Rodwell, V.W. (2003): Harper's Illustrated Biochemistry, 26th Edn. Lange Medical Books, McGraw Hill, New York.
7. www.enzymesIndia.com

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOO103

Course Title: Genetics and Developmental Biology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand in detail the principles of Mendelian and Non-Mendelian genetics.
CO 2	Correlate the concept of non-disjunction as a genetic anomaly with different genetic disorders and maternal age.
CO 3	Identify different cell cycle checkpoints and correlate them with cancer.
CO 4	Solve genetic problems based on three-point cross over, epistasis, complementation and multipleallelism.
CO 5	Understand and analyse different concepts in developmental biology and correlate it with evolution.

RPSZOO103	Genetics and Developmental Biology	Credits 4
UNIT-I	***Genetics Chromosome theory of inheritance and Mendelism –I*** • Mitosis- Interphase and cell cycle, genetic control of cell cycle, stages of mitosis. • Meiosis: An overview of meiosis, the first meiotic division, the second meiotic division, comparison of spermatogenesis and oogenesis in animal cells. • Non-disjunction and its implications • *Organization of genetic material- Structure of chromosomes, Chromosome number, shape and types, Structural features of eukaryotic chromosomes (chromatids, centromeres and telomeres; significance of telomeres; telomeres and cancer) • Heterochromatin and euchromatin • *In situ* hybridization • Giant chromosomes: lamp brush and polytene chromosomes and salivary gland chromosomes • *Human chromosomes • *Chromosome banding • Variations in chromosome structure and chromosome number. • *Principles of Mendelian Genetics: i. Mendel's first law- segregation of allele ii. Mendel's second law- independent assortment iii. Monohybrid and dihybrid crosses • Molecular basis of dominance (genotype, phenotype, dominance, alleles) • The cellular basis of segregation and independent assortment • Genetics of cancer- Relationship of cell cycle to cancer, Oncogenes, Tumour suppressor genes, Mutator genes, Chemicals and radiations as carcinogens.	15 Lectures
UNIT-II	***Genetics- Extension of Mendelian genetics and non-Mendelian inheritance –I*** • Alleles and phenotypes: i. Incomplete or partial dominance and co-dominance ii. Epistasis – Dominant and Recessive iii. Complementation analysis iv. Multiple alleles v. Lethal alleles (recessive and dominant lethal alleles)	15 Lectures

	vi. Penetrance and expressivity • Quantitative inheritance: i. Traits controlled by many loci. ii. Location of polygenes iii. Heritability: measurement of heritability • Linkage, crossing over and gene mapping: Chromosomal theory of linkage, Mechanism and types of crossing over, Mapping in prokaryotes and bacterial viruses, Gene mapping in eukaryotes (three-point cross) • Genetic mapping in humans- Physical chromosome mapping: deletion mapping, somatic cell hybridization mapping, mapping by *in situ* hybridization; correspondence of genetic and physical maps. Practical application of chromosome mapping- tracking the inheritance of an allele with coupled DNA markers.	
UNIT-III	***Evolution –I*** • *Concept of evolution & theories of organic evolution (Lamarckism, Darwinism, De Vries mutation theory, Neo-Darwinism) • Evolution of horse • Human evolution • Evolution of Elephant • Human Migration and dispersal • Molecular Evolution • Molecular clock • Circadian Rhythm • Population and Evolutionary genetics: Gene pool, Calculating allelic frequencies. • The Hardy-Weinberg equilibrium and mating systems (non-random mating, assortative mating, inbreeding, dis-assortative mating's)	**15 Lectures**

UNIT -IV	***Developmental Biology*** • Basic concepts of Developmental Biology- cell fate, competence, commitment, *trans- dedifferentiation, Cell specification, Potency, induction, determination and differentiation; *morphogenetic gradients; *cell fate and cell lineages, Apoptosis**,** Stem cells, genomic equivalence and the *cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development. • Cell aggregation and differentiation in *Dictyostelium* • *Morphogenesis and cell adhesion- Differential cell affinity, cadherins and cell adhesion. • Axis formation and pattern formation: Drosophila and**Xenopus* • Organogenesis • Vulva formation in *Caenorhabditis elegans* • Regeneration as a replay of development stages (intro, brief account of epimorphogenesis, morphylaxis & compensatory regeneration) • New theories of Aging.	**15 Lectures**
RPSZOOP103	**Practical Title** **Genetics and Developmental Biology**	**Credits 2**
	1. Culturing of *Drosphila.* 2. Culturing of *Caenorhabditis elegans* 3. Temporary squash preparation of onion/garlic root tip cells to study stages of mitosis. 4. Temporary squash preparation of testis of cockroach/ Tradescantia pollen to study stages of meiosis. 5. Temporary preparation of polytene chromosomes from salivary gland cells of Chironomus larva 6. Study of chromosome structures in human karyotype. 7. Observation of morphogenetic movements in chick embryo. 8. Effect of drug Ephedra / *Mucuna Prurines* on heart rate of 72 hours of chick embryo in vitro condition.	

References:

1. Robert H. Tamarin: Prin. Of Genetics; 7th Ed. Tata McGraw Hill
2. Elaine Johansen Mange and Arthur Mange: Basic Human Genetics; Indian Reprint; 1997; Rastogi Publ.
3. A.P. Jha: Genes and Evolution; MacMillon India
4. William S. Kluge: Concepts of Genetics; M.R.Cummings, Pearson Edu
5. F Scott. Gilbert, Sinauer Associates Inc: Developmental Biology.
6. T. Subramanian: Developmental Biology; Narosa Publ.
7. Philip Grant: Biology of Developing System; Holt Saunders International Ed.
8. M. W. Strikberger: Evolution;CBS Publ.
9. Sumitra Sen and Dipak Kumar Kar: Cytology and Genetics; Narosa Publ.
10. R.M. Twyman, Bios: Instant Notes- Developmental Biology; Scientific Pub. Ltd.
11. Epstein, R. J. (2003): Human Molecular Biology. Cambridge Univ. Press, Cambridge
12. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, (2004). Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India.
13. Alberts, B, Johnson, J Lewis, M. Raff, K Roberts and P. Watter. (2014): Molecular Biology of the cell. 6th edition. Garland Science, New York.
14. Lodish, H., A. Berk, C.A Kaiser, M.P. Scott, A Bretscher, H. Ploegh, P. Matsudaira. (2016): 8th Edition, Molecular Cell Biology. W. H. Freeman and Co., N. Y.
15. Brachet, J. (1985) Molecular Cytology, Academic Press, N. Y.
16. Pollard, T. D. and W. C. Earnshaw. (2002): Cell Biology. Saunders
17. Daniel J. Fairbanks and W.R. Anderson: Genetics; Wadsworth Publ.
18. Elaine Johansen Mange and Arthur Mange: Basic Human Genetics; Indian Reprint; 1997; Rastogi Publ.
19. A.P. Jha: Genes and Evolution; MacMillon India.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOO104

Course Title: Applied Zoology-I

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and comprehend the principle, working and applications of Microtomy, Microscopy and centrifugation.
CO 2	Compare and contrast between different types of microscopes and centrifuges.
CO 3	Develop skills with regards to computer applications like data analysis and SPSS in biostats and solve problems based on t test, z test, chi square test, ANOVA etc.
CO 4	Develop skills to write research papers and literature reviews.

RPSZOO104	Applied Zoology-I	Credits 4
UNIT-I	***Instrumentation- Microtomy, microscopy, centrifugation-I*** • Microtomy: Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, staining- differential and specific. • Cryopreservation • Principles and applications of microscopy: Light microscopy, phase contrast microscopy, fluorescence microscopy, polarization microscopy, confocal scanning microscopy, transmission electron microscopy, specimen preparation for electron microscopy, scanning electron microscopy. • Principles and applications of centrifugation: Basic principles of centrifugation, Low speed and high-speed centrifuges, ultracentrifuge, application of centrifugation-preparative techniques, analytical measurements; care of centrifuges and rotors	15 Lectures
UNIT -II	***Biostatistics and computer application*** • Arithmetic mean, mode, median, range, variance, standard deviation and standard error, coefficient of variation. • Testing of hypothesis: Statement for testing the hypothesis, statistical validation using student's "t" test, 'z' test, chi square test, simple and multiple correlation, regression analysis, ANOVA, Meaning of level of significance. • Computer applications: MS word, EXCEL, Power point, SPSS uses.	15 Lectures
Unit- III	***Good Laboratory Practices and Research Methodology- I*** • Bio safety Levels- I, II and III (DBT guidelines has to be included) • Research methodology: Meaning of research; objective of research; motivation in research; types of research; research approaches; significance of research; research methods versus methodology; Research and scientific methods; Importance of knowing how research is done; Research process; Criteria for good research. • Research problem and research design: Selecting research problem; necessity of defining a problem; techniques involved in defining the problem; meaning of research design; need for research design; important concepts related to research design; different research designs; basic principles of experimental design; important experimental	15 Lectures

	designs. • Library: Structure of a scientific library, journals, books, Digital library and E books • Catalogue: Classification of books (Universal Decimal System). • Journals: Indexing journals, H-index, abstracting journals, research journals, review journals, e-journals. • Impact factor of journals, NCBI-Pub Med. • Reprints, Secondary storage devices, Internet, open access initiative, INFLIBNET, INSDOC. Google Scholar • Preparation of index cards: Author index and subject index; Open source, bibliography management system.	
Unit- IV	***Intellectual Property Rights*** • Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs. • International framework for the protection of IP. • IP as a factor in R&D; IPs of relevance to biotechnology and few case studies. • Introduction to history of GATT, WTO, WIPO and TRIPS. • Concept of 'prior art': invention in context of "prior art". • Patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.	**15 Lectures**
RSZOOP104	**Practical Title** **Applied Zoology-I**	**Credits 2**
	1. Identification of pictograms, symbols and signs of safety in laboratory practice. 2. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining 3. Determination of pKa of weak acid. 4. Colorimeter: Selection of best filter. 5. Colorimeter: Determination of unknown concentration of solute	

	6. Biostatistics problems- Z-Test. T-Test, Chi Square. 7. Determination of length-weight analysis in fishes. 8. Data analysis using MS Excel/ SPSS 9. Bio safety Cabinets pictures 10. Demonstration of free Plagiarism app/software. 11. Writing a Review Research Paper.	

References

1. Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou, Cambridge Univ. Press
2. Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
3. Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
4. An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
5. Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
6. Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I. Vogel. CBS Publ. and Distributors.
7. Research Methodology. Methods and Techniques; C.R.Kothari. Wiley Eastern Ltd. Mumbai.
8. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
9. Biotechnology and Patent laws: patenting living beings (2008) Sreenivasulu, N.S. and Raju C.B. Manupatra Publishers
10. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008).
11. An Overview of General divisions/csurv/geac/annex-5.pdf
12. Intellectual property law (2008) Lionel Bently, Brad Sherman. Oxford University Press.
13. International Union for the Protection of New Varieties of Plants. http://www.upov.int
14. Karen F. Greif and Jon F. Merz, Current Controversies in the Biological Sciences - Case Studies of Policy Challenges from New Technologies, MIT Press
15. Kuhse, H. (2010). Bioethics: An Anthology. Malden, MA: Blackwell.
16. National Biodiversity Authority. http://www.nbaindia.org
17. Bailey, N.T.J., 1994. Statistical Methods in Biology-II Ed., Cambridge University Press
18. Samuel, M.L., 1991.Statistics for Life Sciences, Dellen Publishing Co, San Francisco.
19. Arthur M. Lesk, 2002. Introduction to Bioinformatics, Oxford University Press, New York
20. Satish Jain, O level made simple: information Technology, BPB publications
21. Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education.
22. Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ. Press.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	20
2.	One class Test (multiple choice objective question)	.....

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **2hours 30 mins** duration.
2. Theory question paper pattern:

Paper Pattern:

Questions	Options	Marks	Questions on
Q.1	**Any 1 out of 2**	**12**	**Unit- I**
Q.2	**Any 1 out of 2**	**12**	**Unit- II**
Q.3	**Any 1 out of 2**	**12**	**Unit- III**
Q.4	**Any 1 out of 2**	**12**	**Unit- IV**
Q.5	**3 short notes out of 5**	**12**	**All Units**

Practical Examination Pattern:

C) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

Overall Examination & Marks Distribution Pattern

Semester-I

Course	RPSZOO101		RPSZOO102		RPSZOO103		RPSZOO104		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical	50		50		50		50		200

External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Semester II
Academic year 2021-2022

Paper Code	Unit	Topic	Credits
Paper I RPSZOO201		**Animal Systematics and Ethology – II**	
	I	Phylogeny, Systematics of non-chordates and assorted topic-II	4
	II	Phylogeny of Protochordates, Agnatha and assorted topics- II	
	III	Phylogeny, Systematics of Chordates and Assorted topics- II	
	IV	Animal behavior-II	
Paper II RPSZOO202		**Biochemistry and Metabolism- II**	
	I	Biomolecules- a structural and functional approach-II	4
	II	Enzymes and Enzyme kinetics	
	III	Metabolic pathways and Integration of metabolism	
	IV	Regulation of metabolism and inborn errors of metabolism	
Paper III RPSZOO203		**Molecular Biology, Syndromes and Evolution**	
	I	Molecular Biology- I	4
	II	Molecular Biology- II	
	III	Genetic basis of syndromes and disorders	
	IV	Evolution-II	
Paper IV RPSZOO204		**Applied Zoology-II**	
	I	Instrumentation-Principles and application of chromatography - II	4
	II	Instrumentation-Principles and application of chromatography and Electrophoresis- III	
	III	Research Methodology-II	
	IV	Bioinformatics	
RPSZOOP201		Animal Systematics and Ethology – II	2
RPSZOOP202		Biochemistry and Metabolism- II	2
RPSZOOP203		Molecular Biology, Syndromes and Evolution	2
RPSZOOP204		Applied Zoology-II	2
Grand Total			**24**

Course Code: RPSZOO201

Course Title: Animal Systematics and Ethology- II

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enumerate& classify the characteristics of different non-chordates and chordates.
CO 2	Compare and contrast between phylogeny of different protochordates.
CO 3	Interrelate the working and different systems of non-chordates and link it with their evolutionary process.
CO 4	Understand and comprehend the broad concepts of animal behaviour and its applications in various fields of research.
CO 5	Correlate the different aspects of animal behaviour, social behaviour and learning or memory to evolutionary aspect.

RPSZOO201	Animal Systematics and Ethology – II	Credits 4
UNIT-I	***Phylogeny, Systematics of non-chordates and assorted topic-II*** • Platyhelminthes and Nemethelminthes • Acanthocephala • Annelida • Sipunculoidea • Arthropoda • *Onychophora - Peripatus, A connecting link between Annelida and Arthropoda.	**15 Lectures**
UNIT- II	***Phylogeny of Protochordates, Agnatha and assorted topics- II*** • Urochordates and its similarities with other subphyla. • Cephalochordates and its similarities with other subphyla • Vertebrate ancestry and origin of Vertebrates. • *Changes leading to first vertebrates. • Salient features and phylogeny of Ostracoderms. • Affinities of Cyclostomes- i. resemblance with Cephalochordates ii. differences from fishes iii. vertebrate characters specialized characters.	**15 Lectures**
UNIT-III	***Phylogeny, Systematics of Chordates and Assorted topics- II*** • *Warm blooded reptiles. Archaeopteryx- a connecting link between Reptiles and Aves. • Salient features of class Aves and classification up to subclass. • Origin of flight (theory of cursorial & arboreal origin). • *Birds as glorified reptiles. • Egg laying mammals- connecting link between reptiles and mammals. • Classification of mammals up to orders. • Dentition in mammals. • Walking gait (Plantigrade, Digitigrade, and Unguligrade)	**15 Lectures**

UNIT- IV	***Animal behavior-II*** • Development of behaviour: Significance of animal behaviour, influence of environment, hormones and genes. Cognition, neural control of behaviour, adaptiveness of behaviour. • Learning and memory: *Innate behaviour (orientation, kineses, taxes, motivation, tropism, reflex and nest building), learned behaviour (sensitization and habituation, associative learning, imprinting, reasoning, trial-and-error, discrimination, biased and language learning), neural mechanism of learning. Memory- nature, types and anatomy of memory, and memory storage. • Evolution and Genetics of behaviour: *Genes and behavioral evolution, Hamilton's rule, kin selection, cost and benefits of sex and sexual selection, phylogeny of behaviour, genetic control of behaviour (single and multiple gene effect). Genetics of burrow shape in Oldfield mouse and Deer mouse. • Social behaviour: Types of social groups, advantages of grouping, *origin and roots to sociality, social organization-primates. Cost and benefits of sociality, and *evolution of eusocial behavior.	**15 Lectures**
RPSZOOP201	**Practical Title** **Animal Systematics and Ethology – II**	**Credits 2**
	1. Study of animal type*: *Periplanata americana:* Morphology, digestive system, nervous system, reproductive system and life history. Mountings of- cornea, salivary glands, gonapophyses, spermatheca 2. Study of systematics and major features of: i. Helminthes (Planaria, Liverfluke, Tapeworm, Ascaris, Trichinella) ii. Annelida (Nereis, Earthworm, Leech). iii. Sipunculoidea: (Sipunculus), iv. Arthropoda (Lobster, Balanus, Crab, Lepas, Scorpion, Spider, Limulus, Centipede, Millipede, Beetle) v. Urochordata (Simple Ascidian, Salpa/ Doliolum). vi. Cephalochordata (Amphioxus). 3. Study of Larval forms: Larvae of Helminthes- Miracidium, Sporocyst, Redia, Cercaria, Metacercaria; Trochophore, Crustacean larvae, Ascidian tadpole. 4. Study of nervous system of prawn. 5. Organoleptic test for fishes.	

	6. To study the repellent activity of lemon extract against the cockroach (*Periplaneta americana*).	

References:

1. K.V. Kardong, Vertebrate comparative anatomy, Function, Evolution, 3rd Ed. Tata McGraw Hill Publication.
2. F.H.Pough, C.M.Janis, J.B.Heiser: Vertebrate Life: 6th Ed. Pearson Education.
3. K.F.Liem, W.E.Bemis, W, F.Walker, L. Grande : Functional Anatomy of Vertebrates. An evolutionary perspective. 3rd Ed. Harcourt College Publishers.
4. J.Z. Young: The Life of Vertebrates, ELBS-Oxford Univ. Press.
5. T.J. Parkar and W.A.Haswell, McMillan: A Text Book of Zoology.
6. E.L.Jordan and P.S.Verma, S. Chand & Company: Chordate Zoology.
7. J.A.Pechenik: Biology of Invertebrates; 4th Ed, Tata McGraw Hill Publication.
8. Milton Hildebrand Wiley: International Analysis of Vertebrate Structure.
9. Russell, W.D. Hunter, McMillan: Life of Invertebrates.
10. Bares, R.D: Invertebrate Zoology, Saunders Publication.
11. Barrington, E J W, (1976): Structure and Functions of Invertebrates.
12. Hyman, L.H: The invertebrates (all volumes), McGraw Hill, Philadelphia, USA
13. Huston, AM: Biological Diversity, Cambridge University Press, Cambridge
14. Kapoor V.C: Theory and Practice of Animal Taxonomy, Oxford and IBH Publ., Delhi
15. McNeely, JA: Economics and Biological Diversity, IUCN, Gland, Switzerland
16. Miller,S.A. and Harley,J.P. (2005) : Zoology. 6th Ed. McGraw Hill Higher Education, Boston, Toronto,Sydney
17. Prasad S.N: Life of Invertebrates, Vikas Publ. New Delhi
18. Sinha, A.K, Adhikari S and Ganguly BB: Biology of Animals (vol. I & II), Central Book Agency, Kolkata
19. Young, J.Z: Life of Vertebrates, Clarendon Press, Oxford.
20. Alcock, J. (2001): Animal Behaviour, an Evolutionary Approach. Sinauer associates, INC. Sunderland, Massachusetts. USA
21. Bernard, C. (2004): Animal Behaviour, Mechanism, Development function and evolution. Pearson and Prentice Hall Publication. New York
22. Dunlap, J. C., Loros J. J. and Decoursey P. J. (2004): Chronobiology Biological Timekeeping. Sinuaer Associates, Inc. publishers, Sunderland, Massachusetts, USA
23. Goodenough, J.E., Mc Guire, B. and Wallace, R. A. (1993): Perspectives on Animal Behaviour. John Wiley and Sons, New York.
24. Mandal, F. B. (2010): Textbook of Animal Behaviour. PHI Learning Private Limited, Estern Economy Edition. New Delhi -110001
25. Manning, A. and Dawkins M.S. (1997): Introduction to Animal Behaviour, 5th edition, Cambridge University Press. UK.
26. Scott, G. (2005): Essential Animal Behaviour. Black Well Publishing, University of Hull, UK.
27. Stumpter, T. J. D. (2010): Collective Animal Behaviour; Princeton University Press. Oxford.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOO202

Course Title: Biochemistry and Metabolism- II

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and analyse the classification, structures, and functions of Proteins and enzymes.
CO 2	Enumerate and understand the concept of enzyme kinetics.
CO 3	Compare and contrast between competitive, non-competitive, and uncompetitive mechanism of enzyme kinetics and correlate it with Vmax and Km.
CO 4	Compare and contrast between different metabolic pathways and understand its significance.
CO 5	Analyse and understand the different inborn errors of metabolism.

RPSZOO202	Biochemistry and Metabolism- II	Credits 4
UNIT –I	***Biomolecules- a structural and functional approach- II*** • Proteins as polymers of amino acids Amino acids: structure, classification based on structure, polarity, nutritional requirement and metabolic fate; properties of amino acids; derivatives of amino acids, non-transcribed amino acids as protein constituents, D-amino acids. • Organization of protein structure: Primary structure and peptide bond, secondary, tertiary and quaternary structure; conjugate proteins- haemoglobin, cytochromes, myoglobin; bonds involved in protein organization. • Properties of proteins: classification, denaturation and protein folding. • Biological functions of proteins. Biologically important peptides: glutathione, octa-, nona-, and deca-peptides. • Ramachandran plot.	**15 Lectures**
UNIT – II	***Enzymes and Enzyme kinetics*** • Enzyme kinetics: i. Mechanism of enzyme catalysis. ii. enzyme activation and inhibition. iii. factors affecting enzyme activity. iv. Michaelis Menton equation. v. Lineweaver-Burk plot. vi. significance of Vmax and Km (including non-competitive, Uncompetitive and competitive inhibitions); • Regulatory enzymes: covalently modulated, allosteric regulation, Isoenzymes (LDH, CK, ALP, ADH) • Non-protein enzymes- Ribozymes, Ribonucleas & Peptidyl transferase.	**15 Lectures**
UNIT – III	***Metabolic pathways and Integration of metabolism*** • Protein Metabolism: Metabolism of amino acids: Amino acid pool, transamination; oxidative and non- oxidative	**15 Lectures**

	deamination; metabolism of branched chain amino acids; fate of carbon skeleton of amino acids. • Metabolism of ammonia: Urea cycle. • Metabolism of nucleic acids: Synthesis of ribo nucleotides- a brief idea of *de novo* pathway and salvation pathway. Conversion of ribo nucleotides to deoxyribo nucleotides. Degradation of nucleotides • Integration of Metabolism, Energy demand and supply. Integration of major metabolic pathways of energy metabolism; Intermediary metabolism; Organ specialization and metabolic integration. Metabolism in starvation	
UNIT –IV	***Regulation of metabolism and inborn errors of metabolism*** • Carbohydrate metabolism: Glycogen storage disease, G-6-PD deficiency • Lipid metabolism: Metabolic disorders of cerebrosides. • Protein metabolism: PKU, Albinism, Cysteinurea • Purine metabolism: Primary Gout • Mineral metabolism and diseases: Hypocalcimia, Hypercalcimia, Osteoporosis • Teratology i. Teratogens and their effects ii. Sensitive period of teratogen iii. *Specificity of teratogen iv. Thalidomide syndrome v. *Teratocarcinoma and Teratoma vi. Environmental teratogens vii. Evaluation of teratogenicity of chemicals	**15 Lectures**
RPSZOOP202	**Practical Title** **Biochemistry and Metabolism- II**	**Credits 2**
	1. Determination of total cholesterol and HDL cholesterol from serum. 2. Colorimetric estimation of protein by Peterson-Lowry method 3. Detection of conformation of BSA by viscosity measurement and effect of varying concentration of urea on viscosity of BSA 4. Determination of creatinine in serum. 5. Determination of urea in serum. 6. SDH specific activity 7. Enzyme kinetics - pH variation & Temperature-fungal amylase.	

	8. SDS PAGE of milk protein or blood plasma.	

References:

1. U. Satyanarayan: Biochemistry- 2nd Ed. 2002, Books and Allied Publ.
2. S.C. Rastogi: Biochemistry- 2nd Ed., Tata McGraw Hill.
3. J.I.Jain, S. Chand and Co. Publ : Fundamentals of Biochemistry- 3rd Ed. 1988.
4. Lehninger, A. L., Nelson, D. L. and Cox, M. M., 2nd Edn.: Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
5. Conn, E. E., Stumpt, P. K., Bruencing, G. and Dol, R. G. (1995): Outlines of Biochemistry. John Wiley, Singapore.
6. Murray, RK.Garner, D.K., Mayes P.A. and Rodwell, V.W. (2003): Harper's Illustrated Biochemistry, 26th Edn. Lange Medical Books, McGraw Hill, New York.
7. www.enzymesIndia.com

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOO203

Course Title: Molecular Biology, Syndromes and Evolution

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and comprehend the concepts of DNA replication, DNA repair and protein synthesis.
CO 2	Correlate the concept of genetic disorders and chromosomal variations.
CO 3	Understand and analyse the concepts of allelic frequencies, natural selection and heterosis.
CO 4	Apply the principle of genetics to calculate gene frequencies and allelic frequencies.

RPSZOO203	**Molecular Biology, Syndromes and Evolution**	**Credits 4**
UNIT –I	***Molecular Biology- I*** • DNA replication, repair and recombination- Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. • Ribosome- formation of initiation complex, initiation factors and their regulation	**15 Lectures**
UNIT –II	***Molecular Biology- II*** • RNA synthesis and processing- transcription factors and machinery, formation of initiation complex transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport • Protein synthesis and processing- Ribosome, Formation of initiation complex, Initiation factors & their regulation, elongation and elongation factors, termination, genetic code, Aminoacylation of tRNA, t-RNA identity, Aminoacyl of tRNA synthetase, Translational proof reading • Post translational modifications.	**15 Lectures**
UNIT –III	***Genetic basis of syndromes and disorders*** • Autosomal dominant -Huntington diaease • Autosomal recessive -Cystic fibrosis • Genetic disorders of Haemopoietic systems - Sickle cell anemia • X linked disorders- Genetic disorders of eye colour blindness. • Muscle genetic disorders (Duchenne Muscular Dystrophy, *Myasthenia gravis*) • Genome imprinting syndromes (Prader-Willi & Angelman syndromes • *Chromosomal disorders -aneuploidy, structural variations • *Mitochondrial disorders • *Multifactorial disorders – diabetes (detailed study), Obesity • Polygeneic congenital heart diseases • *Cognitive disabilities- Schizophrenia • Neurogenetic disorders - Parkinson disease	**15 Lectures**

UNIT –IV	**Evolution-II** • Additive gene action and continuous variation • Heterosis and inbreeding depression: measuring inbreeding, the effects of inbreeding. • Processes that change allelic frequencies: mutation, migration, natural selection, directional selection, stabilizing and disruptive selection, heterozygote advantage, balance between selection and mutation; genetic drift- random genetic drift. • Environmental variation: causes of environmental variation; genotype by environmental interaction. • Broad sense heritability: i. Effect of dominance, epistasis and environmental variations on selection. ii. Quantitative trait loci and DNA markers. iii. Realized heritability. • Limits on natural selection • Concepts of evolutionary ecology	**15 Lectures**
RPSZOOP203	**Practical Title** **Molecular Biology and Genetics–II**	**Credits 2**
	1. Quantitative estimation of DNA in a suitable tissue-comparative study- by diphenyl amine method. 2. Quantitative estimation of RNA in a suitable tissue-comparative study by orcinol method. 3. Extraction of Genomic DNA from *Drosophila.* 4. Temporary preparation of buccal smear to study sex chromatin in human. 5. Squash preparation from mutagen treated onion root tips for study of aberrations. 6. Pedigree analysis 7. Analysis of proteins by two-dimensional gel electrophoresis. (Demonstration) 8. Preparation of LB agar plate, slant and butt method.	

References:

1. Robert H. Tamarin: Prin. Of Genetics; 7th Ed. Tata McGraw Hill
2. Elaine Johansen Mange and Arthur Mange: Basic Human Genetics; Indian Reprint; 1997; Rastogi Publ.
3. A.P. Jha: Genes and Evolution; MacMillon India
4. William S. Kluge: Concepts of Genetics; M.R.Cummings, Pearson Edu

5. F Scott. Gilbert, Sinauer Associates Inc: Developmental Biology.
6. T. Subramanian: Developmental Biology; Narosa Publ.
7. Philip Grant: Biology of Developing System; Holt Saunders International Ed.
8. M. W. Strikberger: Evolution;CBS Publ.
9. Sumitra Sen and Dipak Kumar Kar: Cytology and Genetics; Narosa Publ.
10. R.M. Twyman, Bios: Instant Notes- Developmental Biology; Scientific Pub. Ltd.
11. Epstein, R. J. (2003): Human Molecular Biology. Cambridge Univ. Press, Cambridge
12. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, (2004). Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India.
13. Alberts, B, Johnson, J Lewis, M. Raff, K Roberts and P. Watter. (2014): Molecular Biology of the cell. 6th edition. Garland Science, New York.
14. Lodish, H., A. Berk, C.A Kaiser, M.P. Scott, A Bretscher, H. Ploegh, P. Matsudaira. (2016): 8th Edition, Molecular Cell Biology. W. H. Freeman and Co., N. Y.
15. Brachet, J. (1985) Molecular Cytology, Academic Press, N. Y.
16. Pollard, T. D. and W. C. Earnshaw. (2002): Cell Biology. Saunders
17. Daniel J. Fairbanks and W.R. Anderson: Genetics; Wadsworth Publ.
18. Elaine Johansen Mange and Arthur Mange: Basic Human Genetics; Indian Reprint; 1997; Rastogi Publ.
19. A.P. Jha: Genes and Evolution; MacMillon India.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOO204

Course Title: Applied Zoology- II

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and comprehend the principle, working and applications of Chromatography and electrophoresis techniques.
CO 2	Recognise the resources for accessing research papers and develop the skill of writing review articles.
CO 3	Evaluate and understand broad concepts of bioinformatics.
CO 4	Demonstrate efficacy studies in the experimental techniques for any biological project.
CO 5	Understand the ethical aspects of research.

RPSZOO204	Applied Zoology-II	Credits 4
UNIT –I	***Instrumentation-Principles and application of chromatography - II*** • Planar chromatography (Paper and Thin layer): Preparation of stationary support, solvent, detection and measurement of components, applications. • Column chromatography: Packing and operation of column, loading the column, eluting the column, collection of elluent, detection of elluent, application. • Ion exchange chromatography: Ion exchange resins, selection of ion-exchanger, choice of buffers, preparation and use of ion-exchangers, storage of resins. • Gel chromatography: Theory of gel filtration; physical characteristics of gel chromatography, chemical properties of gel, selection of gel, gel preparation and storage, operation of gel column, application • Affinity chromatography: Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedures and application. • Gas chromatography (GC): Instrumentation, selection of operating conditions, analysis of data and application. • HPLC • HPTLC	15 Lectures
UNIT –II	***Instrumentation-Principles and application of Electrophoresis- III*** • Electrophoresis • Theory of electrophoresis • Horizontal agarose gel electrophoresis • Vertical polyacrylamide gel electrophoresis • Pulse field electrophoresis • Capillary electrophoresis • Isoelectric focusing of proteins • Two-dimensional electrophoresis	15 Lectures

UNIT –III	***Good Laboratory Practices and Research Methodology- II*** • Interpretation and report writing: Meaning of interpretation; technique of interpretation; precautions in interpretation; significance of report writing, layout of research report; types of reports; Presentation of research work- oral, poster and writing research paper; Precautions for writing research report. • Review of related literature: Understanding the role of review; how to begin a search for related literature- Library reference, recording and indexing, classification of references, internet sites for biological references; downloading the information through internet; requests for reprints through e-mail and post; classification and filing of reprints. • Writing research proposal: Characteristics of a proposal; content and organization of a proposal; weakness in proposal seeking funding.	**15 Lectures**
UNIT –IV	***Bioinformatics*** • Specialized databases: EST, GSS, KEGG, OMIM Conserved regions in nucleotide and protein sequences • Gene finding and motif finding. System biology and Bioinformatics, Biological pathway analysis • System biology database and tools: Reactome, Pathway commons Bioinformatics and functional genomics and proteomics • Introduction to Protein and DNA microarray • Data analysis in Microarray using bioinformatics. • GEO database: functional genomics data repository • Bioinformatics and structural proteomics- Visualization and comparison of protein structure; Prediction of Secondary and tertiary structure of protein.	**15 Lectures**
RPSZOOP204	**Practical Title** **Applied Zoology-II**	**Credits 2**
	1. Identification of lipids in a given sample by TLC. 2. Separation of pigments from leaves or flowers by adsorption Column chromatography.	

	3.Separation and identification of amino acids by 2D paper chromatography 4. Study of genetic diseases using OMIM database Tools for gene and motif finding. 5. Visualization of biological pathway- KEGG Pathway, Plant Reactome. 6. BLAST and its variants: Phi and Psi blast 7. Visualization of protein structure – Rasmol and PyMol 8. Protein structure prediction: Homology modelling based structure prediction tool-SWISS model 9. Submission of Poster and presenting/ Attending the Local/State/ National/International Seminars/workshops/ Conferences.	

References:

1. Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education.
2. Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ. Press.
3. Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou, Cambridge Univ. Press
4. Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
5. Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
6. An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
7. Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
8. Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I. Vogel. CBS Publ. and Distributors.
9. Research Methodology. Methods and Techniques; C.R.Kothari. Wiley Eastern Ltd. Mumbai.
10. Bioinformatics: concepts skills and applications (2004). S.C. Rastogi, N. Mendiratta and P. Rastogi.
11. Bioinformatics: A modern approach. (2005) V.R. Srinivas.
12. Essential Bioinformatics (2006). J. Xiong.
13. Statistical methods in Bioinformatics: An introduction. (2005). W. Even and G. Grant
14. Bioinformatics: A Practical Approach 2007 Shui Qing (Chapman & Hall/CRC Mathematical and Computational Biology)

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Modality of Assessment

Theory Examination Pattern:

B) Internal Assessment- 40%- 40 Marks

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	20
2.	One class Test (multiple choice objective question)	.....

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **2hours 30 mins** duration.
2. Theory question paper pattern:

Paper Pattern:

Questions	Options	Marks	Questions on
Q.1	**Any 1 out of 2**	**12**	**Unit- I**
Q.2	**Any 1 out of 2**	**12**	**Unit- II**
Q.3	**Any 1 out of 2**	**12**	**Unit- III**
Q.4	**Any 1 out of 2**	**12**	**Unit- IV**
Q.5	**3 short notes out of 5**	**12**	**All Units**

Practical Examination Pattern:

D) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

Overall Examination & Marks Distribution Pattern

Semester-II

Course	RPSZOO201		RPSZOO202		RPSZOO203		RPSZOO204		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical	50		50		50		50		200

External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Semester-III
Academic year 2021-2022

Paper Code	Unit	Topic	Credits
RPSZOPP301	**Life Processes -I**		
	I	Nutritive System	4
	II	Physiology of Respiration	
	III	Circulation and fluid mechanics	
	IV	Neurophysiology	
RPSZOPP302	**Immunology and Cancer Biology**		
	I	Immunology-I	4
	II	Immunology-II	
	III	Cancer Cell Biology	
	IV	Vaccines	
RPSZOPP303	**Reproduction Biology**		
	I	Male reproductive physiology	4
	II	Female Reproductive Physiology	
	III	Assisted Reproductive Technique-I	
	IV	Assisted Reproductive Technique-II	
RPSZOPP304			
	I	**INTERNSHIP/PROJECT WORK**	4
	II		
	III		
	IV		
Practical			
RPSZOPP301		**Life Processes -I**	2
RPSZOPP302		**Immunology and Cancer Biology**	2
RPSZOPP303		**INTERNSHIP/PROJECT WORK**	2
RPSZOPP304			2
Grand Total			**24**

Course Code: RPSZOP301

Course Title: Life Processes-I

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the nutritive system food processing, nutritive types and significance of Probiotics in therapeutic nutrition.
CO 2	Discern chemistry of respiration, comparative study of respiratory system in vertebrates and to study the role of medulla in respiration process.
CO 3	Understand about Rheology, comparative account of circulation in vertebrates and gaining knowledge about the common circulatory disorders in human.
CO 4	Comprehend structural, functional dimensions of neurophysiology, physiology of addiction and Neurophysiological disorders.
CO 5	Gain hands on experience operate the sphygmomanometer and apply their knowledge of blood pressure monitoring during various physiological conditions.

RPSZOP301	**Title: Life Processes-I**	Credits 4
UNIT- I	***Nutritive System*** • Filter feeding - Pisces, Flamingoes • *Reptiles (Jacobson's organ) • Specialized compartmentalization of digestive system in vertebrates- i. Intestinal modification in herbivore and carnivore ii. Intestine in fish, bird and mammal • Comparative study of mechanical or physiological digestion – gill rakers, Dentition in Pisces, Amphibians, Reptiles, Birds and Mammals(human) • Absorptive adaptation of the Gut. • *Micro-biome of human gut and its significance. • Metabolic transition between meals. • *Probiotics and their role in therapeutic nutrition.	**15 Lectures**
UNIT- II	***Physiology of Respiration*** • Comparative study of Respiratory system in vertebrates: i. Aquatic, terrestrial, gas exchange in terrestrial eggs ii. *Reparative adaptations in African lungfish • Chemistry of respiration i. Composition of atmospheric and expired air ii. Aerodynamic Sub-division of air in the lungs iii. Regulation of lung breathing. iv. Transport of gases in the blood v. Diffusion of gases in the lungs vi. Transport of CO2 in the blood vii. Haldane effect- Partial pressure of gases • *Dissociation of Oxyhaemoglobin and factors affecting it (temperature, electrolytes, CO2 & Carboxyhaemoglobin) • *Bohr's effect • *Role of medulla oblongata in respiration i. Chemoreceptor ii. Mechanoreceptor and Ventilation reflexes iii. Oxygen equilibrium curve and its significance • Manifestation of variation in hemoglobin saturation i. Oxygen toxicity ii. *Carbon monoxide poisoning iii. Reparative distress during Fire hazards.	**15 Lectures**
UNIT- III	***Circulation and fluid mechanics*** • Rheology: i. Viscosity, Poiseuille (PI)	**15 Lectures**

	ii. Hagen flow formula iii. Laminar and turbulent flow Resistance iv. Pressure, velocity and gravity • Comparative account of Circulation in Vertebrates i. Lung fish ii. Amphibians iii. Reptiles iv. Bird v. Special reference to Aortic arches, hepatic portal and renal portal circulations. • *Introduction to Human circulatory system i. Heart structure, working and major blood vessels ii. Cardiac cycle iii. Stroke volume SV iv. Cardiac output CO v. ECG vi. Sphygmomanometer • *The buffer system of the blood i. Haemoglobin buffer ii. The Chloride shift • Selective distribution of blood flow • Circulatory disorders in humans – Varicose veins, PAD, *tachycardia, *bradycardia and Thrombosis • Physiology of therapeutic control of blood pressure. i. Beta blockers ii. ACE inhibitors iii. Calcium channel blockers	
UNIT: IV	***Neurophysiology*** • Excitable membranes- Membrane potential, Ions as current carriers (Protons, Calcium, Potassium) • Structure of Cation - Permeable channels, Chloride channels • Primitive nervous system • Quorum sensing in prokaryotes • *Irritability in Paramecium i. Nerve nets ii. Ladder like nervous system of Platyhelminthes iii. Gangliolated nervous system of Annelida and Arthropods • *Nervous tissue- Neurons, Glial cells and its type. • Integrative neurophysiology: Interneuron's, Neural circuits • *Neurotransmitters i. Excitatory ii. Inhibitory • Brain plasticity	**15 Lectures**

	• Neurophysiological disorders i. Alzheimer ii. Parkinson iii. Dementia • Physiology of addiction. i. Alcohol addiction ii. Addiction to psychotic drugs (Cocaine, Opioids, Ecstasy)	
RPSZOPP301	**Practical Title** **Life Processes- I**	**Credits 2**
	1. Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin in suitable animals (e.g. prawn/ crab/ cockroach/ chicken, etc.) 2. LDH isoenzymes isolation and detection using agarose gel electrophoresis in heart /skeletal muscle of any suitable animal (e.g., Chicken heart) 4. Detection and measuring of heart beats (Manually) in Daphnia. 5. Effect alpha blocker/ beta blockers on heart rate of 48 hours of chick. 6. Effect of xenobiotics on digestive enzyme activity of any suitable animal (cockroach). 7. Study of nerve cells and neurosecretory cells of cockroach. *8.* Study of irritability in *Paramaecium.* 9. Problems related to Cardiac output. 10. Hands on training sphygmomanometer and recording the pulse rate of the patient. (Compare supine, walking, sleeping and 5 mins jogging variations in BP)	

Reference:

1. Biology of Animals --- Cleveland P. Hickman JR Larryds. Roberts
2. Darnell, Loddish, Baltimore: "Molecular Cell Biology" Scientific American Books.
3. C. A. Keil, E. Neil & E.N. Joeb (1982): "Samson Wright, Applied Physiology" Oxford Univ. \ Press.
4. R. Eckert& D. Randall (1982): "Animal Physiology: 2nd Ed." W. H. Freeman & Co.
5. W. A. Hoar (1982): "General & Comparative Animal Physiology 3rd Ed." Prentice Hall Inc.
6. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
7. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology" "Comparative Animal Physiology", 4th Ed. Wileg – Liss Publ.
8. C. Ladd Prosser Ed. (1991): "Environmental & Metabolic Animal Physiology" "Comparative Animal Physiology" 4th Ed. Wileg – Liss Publ.
9. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College

Publishing.
10. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
11. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
12. Harold Harper: "Review of Physiology Chemistry" 4th Ed. Maruzen Asian Ed. Lang Medical Publ
13. OECD guideline for testing of chemicals - https://www.oecd-ilibrary.org/environment/test-no-425-acute-oral-toxicity-up-and-down-procedure_9789264071049-en
14. Animal Physiology ----- Samson & Writy
15. Animal Physiology ----- Nelsion & Nelsion
16. Animal Physiology ----- Medical Physiology-Guiton
17. Textbook of Animal Physiology ----- Nagbhushenen
18. Textbook of Animal Physiology ----- Geise
19. Textbook of Animal Physiology ----- A.K. Berry
20. Textbook of Endocrine Physiology -----James E. Griffin and Sergio R. Ojeda, Oxford University
21. Handbook of Neuroendocrinology --- Mandal A. (1994). EMKY Publication
22. Wilson and Walker – Principles and Techniques of Practical Biochemistry. Cambridge Univ.Press

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOP302

Course Title: Immunology and Cancer Biology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the immune response in human systems.
CO 2	Comprehend about the camel nanobodies and its significance in human healthcare.
CO 3	Understanding the monoclonal antibodies and its role in hybridoma technology and therapeutics.
CO 4	Explore various factors involved in development of Cancer.
CO 5	Compare and contrast between different types of vaccines and its application in human health care with special reference to various COVID-19 vaccines.

RPSZOP302	Title: Immunology and Cancer Biology	Credits 4
UNIT: I	***Immunology-I*** • *Overview of the immune systems i. Components of the immune system, ii. Principles of innate (non-specific) and adaptive(acquired) immunity, iii. Antigen and immunogenicity, iv. Clonal selection theory. v. Antibodies (vertebrates & invertebrates) • Antigen recognition by immune cells: i. Innate Immunity- Pattern recognition in the innate immune system, ii. TLRs and their role in innate immune response iii. Adaptive immunity-Antibody structure iv. Antigen recognition by B lymphocytes v. Molecular mechanism behind BCR formation vi. B lymphocyte development and survival. • Structure and function of MHC complex: i. Antigen processing cells, ii. Antigen processing and presentation to T lymphocytes, iii. MHC restriction. • Camel nanobodies (Mini- antibodies) and their significance in human healthcare • Monoclonal antibodies**:** Hybridoma technology, Commercial production, Clinical applications (overview), Therapeutic MABs, (e.g., Tacilizumab, Basiliximab, blinatumomab).	**15 Lectures**
UNIT: II	***Immunology-II*** • TCR structure and function: i. T-cell receptor gene rearrangement. ii. T-lymphocyte development and survival. iii. Antigen recognition by T-cells, iv. signalling through TCR and T-cell activation, v. co- receptors and their role in T –cell functioning. vi. Co-stimulation. • Effector mechanisms and regulation of immune responses: i. Induced innate response to infection, ii. *Innate memory, iii. *Complement system, iv. *NK and NKT cell functions, v. *Humoral immune response, vi. Production of effector T- cells,	**15 Lectures**

	vii. Cytotoxic T- cell effector mechanisms viii. *Interferons, cytokines, chemokines in immune response ix. Cytokine storm • *Immunity in health and disease: Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases, Immunity and Infection, Tumour-immunology, Transplantation.	
UNIT: III	***Cancer Cell Biology*** • Extracellular control of cell division • Cell growth and apoptosis • Morphological and biochemical features of apoptosis • Necroptosis • Caspases (effector molecules) • Executioners of the apoptosis process • Extrinsic and intrinsic apoptotic pathway • Cell death effectors released from mitochondria. • Poly – ADP –ribose Polymerase (PARP) proteolysis as an indicator of cell death • Senescence and cancer • Chemoresistance and cancer • Immunogenicity of cancer cell death • Autophagy and Role of autophagy in tumor survival, oncogenic genes that regulate Autophagy. • Cancer diagnosis &treatment using antibodies radiolabeled MABs, Immunotherapy for cancer management.	**15 Lectures**
UNIT: IV	***Vaccines*** • Sub-unit Vaccine- Herpes simplex, Bovine foot &mouth disease virus • Peptide vaccines-synthetic drugs (engineered proteins) • Genetic immunization-DNA vaccines, Antisense DNA, Therapeutic ribozymes • Live recombinant vaccines • *Attenuated vaccines against Cholera, Salmonella sp. • *Vector Vaccines-Vaccine directed against viruses-Rabies virus G-protein, Hepatitis B surface antigen. • Anti-idiotypic vaccine for cancer treatment. • Multivalent subunit vaccine. • Microbiome • Vaccines in Epidemics & Pandemics: Overview of types of vaccines, Overview of steps in vaccine production, Vaccine for COVID -19; (mRNA, adenovirus based, recombinant protein, attenuated), Nasal vaccines and their significance.	**15 Lectures**

RPSZOPP302	**Practical Title** **Immunology and Cancer Biology**	**Credits** **2**
	1. Performance of Ouchterlony technique to demonstrate immune diffusion. 2. Demonstration of single radical immune-diffusion of antibody and antigen. 3. Study of counter-current immune-electrophoresis 4. Study of Agglutination Reaction: i. Tube Agglutination Reaction ii. Slide Agglutination Reaction iii. Indirect Agglutination Inhibition Reaction 5. Separation of Lymphocytes. 7. Identification of histological slides of lymphoid tissue: i. Spleen ii. Thymus iii. Lymph node iv. Bone marrow v. Payers patches vi. Bursa of Fibricus 8. Antibiotic Sensitivity test 9. Identification of tools used in Artificial Insemination in cows.	

Reference:

1. Immunology - Introductory Textbook; Shetty, N.; New Age International; 2005
2. Immunology – Essential and Fundamental; Pathak, S., &Palan, U.; Science Publishers;2005
3. Immunology: A textbook; Rao, C. V.;Alpha Science Int'l Ltd.; 2005
4. Ananthanarayan and Paniker's textbook of microbiology; C.J. Paniker (Ed.); Ananthanarayan, R.; Orient Blackswan; 2005
5. Textbook of Immunology; Haleemkhan, Rajendra Sagar, Sadguna
6. Prescott's Microbiology;Ninth Edition; JoanneM.Willey,Linda M. Sherwood & Christopher J.Woolverton; McGraw-Hill Education; 2014
7. Cellular and molecular immunology; Abbas, A. K., Lichtman, A. H. &Pillai S.; Elsevier Health Sciences; 2014
8. Roitt's essential immunology (Vol. 20); Delves,P. J., Martin, S. J., Burton, D. R., &Roitt, I.M.;JohnWiley& Sons; 2011
9. The elements of immunology; Khan,F. H.; Pearson Education, India; 2009
10. Janeway's Immunobiology; Murphy,K., &Weaver, C.; Garland Science;2016
11. Fundamental Immunology; Paul, W.E.; Philadelphia: Lippincott-Raven;1999
12. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.
13. Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Pub

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOP303

Course Title: Reproduction Biology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Exploring the field of Reproductive Biology and Physiology.
CO 2	Gain the knowledge about the hormonal control of spermatogenesis, sperm maturation and about the potential male contraceptives.
CO 3	Understanding the various Molecular Events of fertilization, Implantation Process, Pregnancy, Parturition and Lactation.
CO 4	Compare and contrast between different IVF techniques, gamete collection process and sensitise regarding ethical issues involved in this field.
CO 5	Explore the skills required in the field of Assisted Reproductive technology.

RPSZOP303	Title: Reproduction Biology	Credits 4
UNIT: I	***Male reproductive physiology*** • *Functional morphology of mammalian testis. • *Brief description of histomorphology and hormonal control of male accessory organs *viz*., epididymis, vas deferens, seminal vesicles, ventral prostate, bulbourethral gland and preputial gland • Sperm maturation – morphological and biochemical events, influence of accessory organ secretions; capacitation • Biochemistry of semen • Kinetics of spermatogenesis – wave and cycle, Stem cell renewal • Hormonal control of spermatogenesis • Ultrastructure of spermatozoa • Abnormalities of sperm • Potential Male contraceptives**:** E.g., Cyproterone acetate, Cotton Seed, papaya seed extract etc.	**15 Lectures**
UNIT: II	***Female Reproductive Physiology*** • Onset of puberty in human female, factors affecting onset of puberty. • *Estrous cycle and it is hormonal regulation. • *Menstrual cycle and it is hormonal regulation. • Fertilization – Molecular Events of fertilization • Implantation – Process, Types and hormonal control • Pregnancy – length of gestation, hormonal control • Parturition – Process of birth and influence of hormones • Lactation – Hormonal control of mammary gland development and lactogenesis • Female contraceptives: Pills, Spermicides, Copper T, Mechanical barrier (diaphragm)	**15 Lectures**
UNIT: III	***Assisted Reproductive Technique-I*** • Maintaining an IVF laboratory. i. Setting up an ART laboratory ii. Quality Control • Gamete Collection & Analysis i. Serum Analysis: - Sperm count, Motility, Morphology and abnormality ii. Physical parameters: - Coagulation/viscosity, Liquification, appearance, odour, volume, pH, presence of other cell debris iii. Semen preparation technique: Swim up, Density gradient.	**15 Lectures**

UNIT: IV	***Assisted Reproductive Technique-II*** • Intrauterine Insemination (IUI) • Oocyte Retrieval: - oocyte corona cumulus complex evaluation, Oocyte nuclear maturity evaluation. • Intracytoplasmic sperm Injection (ICSI) • Cryopreservation of ovum and cord blood • Preimplantation genetic screening- PGS • Ethical issues • Case Study- Designer baby (Ethical and legal aspects)	**15 Lectures**
RPSZOPP303	**Internship / Project Work**	**Credits 2**

Reference

1. Martin H. Johnson,Essential Reproduction, Wiley-Blackwell Publication.
2. E. L. Marieb,Human Anatomy and Physiology, Pearson Education Low PriceEdition
3. Taylor, Green and Stout, Biological Science, Cambridge Publication
4. E. P. Solomon, L. R. Berg, D. W. Martin, Biology, Thompson Brooks/Cole
5. Daniel D Chiras Jones and Bartlett, Human Biology
6. E.K.Nobil and J. U. D.Neil,The Physiology of Reproduction Vol I & II, Raven Press,New York.
7. David Gardner, Ariel W and et.al, Textbook of Assisted Reproductive Technologies, Third Edition.
8. Examination and Processing of human semen, WHO laboratory manual.
9. Dr. Kamini A. Rao, Principles and Practice of Assisted Reproductive Technology

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOP304

Course Title: Internship / Project Work

Academic year 2021-22

RPSZOP304	**Internship / Project Work**	**Credits 4**
RPSZOPP304	**Internship / Project Work**	**Credits 2**
	Total Credits- 8 **Marks- 200**	

Modality of Assessment

Theory Examination Pattern:

C) Internal Assessment- 40%- 40 Marks

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	20
2.	One class Test (multiple choice objective question)	—

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

3. Duration - These examinations shall be of **2hours 30 mins** duration.
4. Theory question paper pattern:

Paper Pattern:

Questions	Options	Marks	Questions on
Q.1	**Any 1 out of 2**	**12**	**Unit- I**
Q.2	**Any 1 out of 2**	**12**	**Unit- II**
Q.3	**Any 1 out of 2**	**12**	**Unit- III**
Q.4	**Any 1 out of 2**	**12**	**Unit- IV**
Q.5	**3 short notes out of 5**	**12**	**All Units**

Practical Examination Pattern:

E) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

Overall Examination & Marks Distribution Pattern
Semester-III

Course	RPSZOP301		RPSZOP302		RPSZOP303		RPSZOP304	Grand Total
	Internal	External	Internal	External	Internal	External	Internship / Project	
Theory	40	60	40	60	40	60	150	400
Practical	50		50		50			200

External Examination- 60%- 60 Marks
Semester End Theory Examination: (Deviation from the usual modality)
Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Semester-IV
Academic year 2021-2022

Paper Code	Unit	Topic	Credits
RPSZOPP401		**Animal Biotechnology**	
	I	Laboratory Animals in Biotechnology	4
	II	Testing for Endocrinological and Reproductive Biological studies	
	III	Animal Tissue Culture	
	IV	Animal Biotechnology & Human therapies	
RPSZOPP402		**Life Processes-II**	
	I	Thermoregulation	4
	II	Muscle Physiology	
	III	Osmoregulation and Excretion	
	IV	Sensory and Effector Physiology	
RPSZOPP403		**Endocrinology**	
	I	Introduction to invertebrate endocrinology	4
	II	General Endocrinology	
	III	Phylogeny and Ontogeny of endocrine glands	
	IV	Study of endocrine glands	
RPSZOPP404		**Biological Rhythm and Ecophysiology**	
	I	Physiology of Migration	4
	II	Biological rhythms & sleep	
	III	Environmental Radiation	
	IV	Temperature as environmental factor	
Practical			
RPSZOPP401		**Animal Biotechnology**	2
RPSZOPP402		**Life Processes-II**	2
RPSZOPP403		**Endocrinology**	2
RPSZOPP404		**Biological Rhythm and Ecophysiology**	2
Grand Total			**24**

Course Code: RPSZOP401

Course Title: Animal Biotechnology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand various animal models and instruments used for Animal tissue culture.
CO 2	Demonstrate an understanding of media preparations and passaging techniques for animal tissue culture.
CO 3	Explain and contrast the various animal models used in biotechnology and understand their applications.
CO 4	Gain an experience at handling laboratory animals and their maintenance and care.
CO 5	Develop a holistic appreciation on animal biotechnology and human therapies.
CO 6	Engage in various practical activities related to techniques involved in animal tissue culture.

RPSZOP401	Title: Animal Biotechnology	Credits 4
UNIT: I	***Laboratory Animals in Biotechnology*** • Animal Care and Management of Laboratory Animals i. Rat ii. Mouse iii. Rabbit iv. Guinea pig • *Animal House – Necessities Design and maintenance: Infrastructure, Cages, Conditions and other requirements for Maintenance, Biology of four laboratory animals • Breeding cycles and breeding and maintenance- Rat/ Mouse • Nutritional requirements for normal breeding and maintenance. • Modifications for nutritional experimental work (at least two examples viz protein deficient diet and supplementation) • Animal ethics and associated laws and issues. • Physiological models and their use in drug testing • Animal ethics and CPCACA guidelines.	**15 Lectures**
UNIT: II	***Testing for Endocrinological and Reproductive Biological studies*** • In vivo studies of estrous cycle, implantation, pregnancy • Gonadectomy, Adrenalectomy, Hypophysectomy, and Sham operated rats • *Drug induced liver toxicity- CCl4 model, paracetamol model, cirrhosis model • Aging Models: Drug induced models (Galactosamine), Naturally aged animals • Models for diabetes • Hypercholesterolemia Models • Thyroidectomized rat • Models to study immunological phenomena	**15 Lectures**
UNIT: III	***Animal Tissue Culture*** • Equipment and Materials for animal Cell Culture Technology • Basic Aseptic Techniques • Design of Tissue Culture Laboratory • Equipment: Laminar Flow Hoods, Bio safety cabinets, CO2 incubator, Open and closed cultures, Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous small items of Equipment, Materials, filters, Miscellaneous Items, Cryopreservatives. • Characters of cells: Cells in primary culture, Established Cell lines, Tumor/cancer originated cells.	**15 Lectures**

	• Nutritional Requirements of Cells and growth media- Basal salt solution (BSS), Minimum Essential Medium, Serum dependent defined media, Serum independent defined media, Natural and Artificial media, Cell specific media. • Media preparation (anyone) • Passaging of cell Lines- adherent and non-adherent	
UNIT: IV	***Animal Biotechnology & Human therapies*** • Transgenic animals and their applications: i. Mice as model system for human diseases and as test case model ii. Cows, pigs, sheep, goats as biopharmaceuticals, iii. Transgenic insects and birds. • Recombinant DNA technology to prevent animal diseases. • Regulation of transgenic animals and patenting genetically engineered animals. • Knockout mice (Cre- loxP system) • Human therapies i. Tissue engineering: Skin, liver, pancreas ii. Xenotransplantation	**15 Lectures**
RPSZOPP401	**Practical Title** **Animal Biotechnology**	**Credits 2**
	1. Handling and feeding of the animals. 2. To study Estrous cycle and breeding. 3.Preparation of glass wares for cell culture 4. Separation of cells by suitable methods- Trypsinization (Demonstration Practical) 5. Viable cell count 6. Paracetamol toxicity in fish in vitro. 7. Passaging and Trypsinization techniques. (Hands on Demo) 8. Animal house maintenance group project. 9. Cage side observation of experimental animals	

Reference:

1. Bruce Albert et al "Molecular Biology of the Cell"
2. Cell and Tissue Culture
3. Methods in enzymology (Cell culture).
4. Animal Cell Culture: A practical approach by R.I. Freshney, IRL press.
5. A manual of basic techniques by R.I. Freshney, Willy-Liss and Sons publication.
6. Animal cell culture technique by Martin Clynes, Springer publication.
7. Freshney, R.I: Culture of Animal cells, Wiley Publications, New York. Edi. Jhon R.W. Masters: Animal cell culture- practical approach, Oxford University press, Oxford. Ed.
8. R. Basega : Cell growth and division : A practical approach , IRL press Oxford University

press, Oxford.
9. Ed. Martin Clynes: Animal cell culture techniques, Springer- Verlag, New York. F.Grasveld, George V. Kallias: Transgenic Animals, Academic press, Sandiego, USA.
10. Asok Mukhopadhyay: Animal cell technology, IK International publishing House, New Delhi.
11. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOP402

Course Title: Life Processes-II

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the process of thermoregulation and temperature compensation in homeotherms and poikilotherms.
CO 2	Compare and contrast between the physiology of skeletal, smooth and cardiac muscle.
CO 3	Explain and contrast between the various physiologies of osmoregulation of freshwater, marine and terrestrial animals.
CO 4	Explore some of the exciting and curious questions on COVID 19 related loss of sense of smell and taste.
CO 5	Analyse and understand the detailed process of Dialysis and Kidney care.
CO 6	Critically analyse, interpret and evaluate information relevant to animal physiology.

RPSZOP402	Title: Life Processes-II	Credits 4
UNIT: I	***Thermoregulation*** • Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. • Impact of temperature on the rate of biological functions. • Arrhenius equilibrium, Q 10. • Temperature compensation and temperature regulation in poikilotherms and homeotherms. • *Adaptations for extreme environments, aestivation, hibernation, Diapause and Awakening.	**15 Lectures**
UNIT: II	***Muscle Physiology*** • Comparative physiology of skeletal, smooth and cardiac muscles. • Skeletal muscle- ultra structure and molecular organization. Red and white muscles, muscle proteins. • *Mechanism of muscle contraction and relaxation. • *Energetics of muscle contraction. • Effect of exercise on muscles. • Catch muscle and fibrillar muscle. • Physiology of muscle cramps and its management • Physiology of Sprinting and Marathon running.	**15 Lectures**
UNIT: III	***Osmoregulation and Excretion*** • Osmoregulation in fresh water, marine and terrestrial animals. • Excretion in vertebrates. • *Physiology and regulation of urine formation, Hormonal regulation of urine formation. • Regulation of water balance, electrolyte balance and acid-base balance. • Dialysis (artificial kidney), kidney transplantation, Dialysis water (requirements)	**15 Lectures**
UNIT: IV	***Sensory and Effector Physiology*** • Classification of somatic senses and somatic receptors, exteroceptors, interoceptors, modality of sensation, secondary sense cells, transduction, relationship between stimulus, intensity and response, sensory coding. • Chemical senses: taste, smell, mechanism of reception, COVID 19 and loss of taste and smell. • Mechanoreceptors: hair cell, organs of equilibrium, vertebrate ear, mechanism of hearing, electro and	**15 Lectures**

	thermoreceptors. • Vision: Structure of invertebrate and vertebrate eye. Physiology of vision. • Pain: pain receptors, headache and thermal senses, pain suppression (analgesia). • Tactile sensation: touch receptors, Physiological role of touch and environment in premature infants- Kangaroo care.	
RPSZOPP402	**Practical Title** **Life Processes- II**	**Credits 2**
	1. Observation of decreasing PO2 of water on the respiratory rate of a fish. 2. Effect of decreasing PO2 of water on Lactic acid in the muscle. 3. Estimation of salt loss and gain in an aquatic animal when it is transferred to a salt- free medium and to natural medium. 4. Preparation of glycerinated muscle fibre and study of its properties. 5. Influence of sub lethal concentration (50-60ppm) ammonia (as liquor ammonia / ammonium hydroxide / ammonium chloride) on a suitable fish exposed to ammonia stress for 3 / 7 / 15 days with reference to the following parameters: a. Level of excretory ammonia b. Level of activity of hepatic glutamate dehydrogenase 6. Histology of Sense organs. 7. Histology of Striated and Non striated muscle fibre.	

Reference:

1. Bentley,P.J. 1998. Comparative Vertebrate Endocrinology (3rd edn). Cambridge University Press
2. Bray, J.J., Cragg, P. A, Macknight, A.D, Mills, R.S and Taylor, D.W 1986. Lecture Notes on human Physiology. ELBS, New Delhi
3. Brijlal Gupta and J.A. Ramsay, 1977. Transport of Ions and Water in Animals. Academic Press, New York.
4. Chatterjee, C.C. 1997. Human Physiology. Medical allied agency, Calcutta.
5. Ganong, W.F 1987. Review of Medical physiology. Appleton and lang, Norwalk.
6. Hill, W.R., Wyse, G.A and Anderson, M. 2007. Animal Physiology (2nd edn). Sinauer Associates Inc. Publishers, MA, USA.
7. Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi.
8. Hochachka, P.W. and Somero, G.N. 1984. Biochemical Adaptation. Princeton University Press, New Jersey.
9. Hochachka, P.W. and Somero, G.N 2002. Biochemical Adaptation: Mechanism and Process in Physiological Evolution. Oxford University Press, New York.
10. Ian Kay.1998. Introduction to Animal Physiology. Bios Scientific Publishers Ltd., Oxford, UK
11. Keele, C.A, Neil, E. and Joels, N. 1982. Samson Wright's Applied Physiology. Oxford

University Press
12. Knut Schmidt-Neilsen. 1997. Animal physiology: Adaptations and Environment Cambridge University Press
13. Moyers, D.C and Schulte,P.M. 2007. Principles of Animal Physiology (2nd edn). Benjamin Cummings, CA, USA
14. Prosser, C.L and Brown, F.A. 1973. Comparative Animal Physiology. W.B Saunders Company, Philadelphia
15. Randall, D., Burgrenn, W. and French, K. 1997. Eckert Animal physiology. freeman & Co,New York

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOP403

Course Title: Endocrinology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand & comprehend the invertebrates' endocrine organs & systems, its anatomical organization, hormones and role of hormones in complex physiological process like reproduction, development, metamorphosis.
CO 2	Understand and gain the knowledge about neuro endocrine integration and reflexes and a deep insight about hormones and its types. Understand working of hormones at target site.
CO 3	Compare & contrast developmental and phylogenetic relationship of endocrine glands between different vertebrates' group.
CO 4	Understand the various endocrine glands of vertebrates, their position, microanatomy, hormones and complex interrelationship between them.
CO 5	Develop employable skill related to endocrine glands. Explore new technologies in studying the endocrine glands

RPSZOP403	Title: Endocrinology	Credits 4
UNIT: I	***Introduction to invertebrate endocrinology*** • Scope of invertebrate endocrinology • *Anatomical organization • *Structure of endocrine glands in invertebrates • Endocrine glands of invertebrates i. Corpora cardiac ii. Corpora allata iii. Moulting glands iv. X-organ and Y-organ of Crustaceans v. Green gland, Epitracheal gland and Inka cells vi. Mandibular organs in crustaceans • Reproduction, development, somatic retinal and pigmentation and metamorphosis (including diapause and molting) in insects. • Hormonal control of metabolism, retinal and somatic pigmentation, reproduction and moulting in Crustaceans.	15 Lectures
UNIT: II	***General Endocrinology*** • *General introduction to hormone • Neuroendocrine integration i. Afferent pathways ii. Integration center's iii. Efferent pathways • Neuroendocrine reflex i. First order ii. Second order iii. Third order • *Hormones as messengers. • Hormones and eukaryotic metabolic regulation • Classification and Discovery of hormones i. Protein hormones ii. Steroid hormones • Hormonereceptors • Cascade of reaction linked to signal transduction. • Prostaglandins	15 Lectures
UNIT: III	***Phylogeny and Ontogeny of endocrine glands*** • Phylogeny of Pituitary, Pancreas, Adrenal, Thyroid, parathyroid and Pineal gland in Pisces, Amphibia, Reptiles and Mammals • Ontogeny of Pituitary, Pancreas, Adrenal, Thyroid, parathyroid and Pineal gland in Pisces, Amphibia, Reptiles and Mammals	15 Lectures

	• Caudal neurosecretory system in fishes- Dahlgren cells • Corpuscles of Stannius	
UNIT: IV	***Study of endocrine glands*** • Endocrine glands - Anatomy and Microstructure and disorders of - Pituitary, Thyroid, Parathyroid, Ultimobranchial glands, Adrenal, Pancreas, Pineal • Role of hypothalamus and the higher brain centers in reproductive behavior • *Special endocrine organs i. Thymus ii. Placenta iii. Corpus Luteum iv. GI tract v. Kidney vi. Heart	**15 Lectures**
RPSZOPP403	**Practical Title** **Endocrinology**	**Credits 2**
	1. Demonstration and localization of endocrine glands of vertebrate group (rat / mice). (Simulation / Photographs / ICT) 2. Study of histology of vertebrate endocrine glands (comparative aspects). i. Pituitary ii. Thyroid iii. Adrenal, iv. Pancreas v. Pineal, vi. Parathyroid. 3. Preparation and submission of slides of adrenal, ovary and testis in vertebrate (Goat / Chicken) using microtomy technique. (Student activity- to be submitted at the time of exam) 4. Estimation of calcium level in given blood sample. 5. Estimation of glucose level in given blood sample. 6. Estimation of blood glucose before and after eye stalk ablation in Crab/ Prawns. 7. Effect of acetylcholine / Adrenalin on fish chromatophores. 8. Study of Endocrine disorders in human (Slides / Photographs / TC tools / models / charts / photographs) 9. Phytosteroids that mimics animal steroids: (Soybean, Ashwagandha, Shatavari, Dioscorea)	

References:

1. Mandal A. (1994). Handbook of Neuroendocrinology, EMKAY Publications.
2. Comparative Endocrinology of the Invertebrates, Kenneth C. Highnam, Second Edition, ELBS Low price Edition.
3. Tambhare D. B. (2012). Invertebrate Endocrinology, Himalaya Publication House.
4. Invertebrate Endocrinology-Tombes, Academic Press. 5. Insect Endocrinology-Edited by Lawrence I Gilbert, Academic Press.
5. Barington (1979) Hormones and Evolution Vol. I&II Academic Press, New York.
6. Bentley P.J. (1994) Comparative Vertebrate Endocrinology-II Cambridge University Press, New York. 3. Johnf-Laycock and Peter H. Wise, Essential of Endocrinology.
7. Wiliamas R.H. (1974) Textbook of Endocrinology V. Ed. Saunders Press. London.
8. Turner C.D. and Bugnara J.T. (2013). General Endocrinology, sixth Edition, W.B. Saunders. EPW East West Press Pvt. Ltd. New Delhi.
9. Endocrinology –Hadley
10. The physiology of reproduction, Vol I&II E.K. Nobil and JU.D. Neil, Raven Press, New York.
11. Benjamin Levin-Gene VII, Oxford University Press.
12. Lodish et.al. Molecular Cell Biology
13. Mammalian Endocrinology, Ashok Kumar Boral, New Central Book Agency (P) Ltd. London
14. Zarrow M.X. and Mc Carthy J.L. (1964). Experimental Endocrinology, Academic Press, New York.
15. Norris D.O. (1996). Vertebrate Endocrinology IIIrd Ed. Academic Press,
16. Norris: Vertebrate Endocrinology 4th Ed.2007 Elsevier)
17. Mammalian Endocrinology, Manoj Yadav, (2008). Discovery publishing House Ltd. New Delhi.
18. Chandra S. Negi (2015). Introduction to Endocrinology - PHI Learning, Pvt.Ltd. New Delhi.
19. Endocrinology-P.R.Yadav, Discovery publishing House Ltd. New Delhi.
20. Endocrinology, Hormones and Human Health-Prakash S. Lohar, MJP Publisher, Chennai.
21. Franlyn F. Bolander, Molecular Endocrinology – (Third Edition), Academic Press, An Imprint of Elsevier, California, U.S.A.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Course Code: RPSZOP404

Course Title: Biological rhythm and Ecophysiology

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand & comprehend the deep insight of migration amongst animal and complex biochemical and physiological process that regulate it.
CO 2	Learn and understand about the complex physiological processes that govern sleep, dream and biological rhythms.
CO 3	Learn and analyse the effects of radiation at the cellular & molecular level, role & example of biomolecules involves in trapping the light energy in living being also understand the phenomenon of radioprotection.
CO 4	Understand & learn about temperature as an important environmental factor, temperature and types of animals and biochemical adaptation of animals at different thermal range.
CO 5	Develop practical skill related to temperature on some physiological aspects of animals. Students also learn a deep insight about some remarkably interesting migratory animals, sleep and sleep disorder.

RPSZOP404	Title: Biological rhythm and Ecophysiology	Credits 4
UNIT: I	***Physiology of Migration*** • Physiological stimulus of Migration • Orientation and Navigation • Energetic • Timing • Synthesis • *Migration for food, reproduction, territory • Migration as factor in life cycle • Adaptations for Migration • Communication during Migration.	**15 Lectures**
UNIT: II	***Biological rhythms & sleep*** • The nature of sleep and dreams • The functions of sleep • Mechanism of sleep and arousal • Biological rhythms • Disruption of sleep and rhythms • Chronobiology: Experiments to study human circadian rhythms; subterranean rooms, deep cave dwelling etc.	**15 Lectures**
UNIT: III	***Environmental Radiation*** • Radiation as an environmental parameter. • *The solar spectrum • *Biomolecules involved in perception and trapping of solar radiations: Chlorophyll, Bacterio-rhodospin, Rhodospin and Vitamin A. Adaptations of animals to absence of solar radiations. • Effects of Ionizing radiations at the cellular and molecular level. • Phenomenon of radioprotection.	**15 Lectures**
UNIT: IV	***Temperature as environmental factor*** • Temperature Regulation/ Response to temperature fluctuations: • Thermal limits of survival • Temperature and Structural effects with response to biological molecules and biological membranes. • Temperature and rate effects: Temperature dependent E~Saffinity, Lipoprotein enzymes. • Thermal resistance of dormant and active cells. • *Ectothermy and endothermy. • *Endothermy in invertebrates.	**15 Lectures**

	• Biochemical adaptations of Ectothermy: Antifreeze substances, Heatshock proteins.	
RPSZOPP404	**Practical Title** **Biological rhythm and Ecophysiology**	**Credits 2**
	1. To study the effect of temperature on respiratory rate of any suitable fish. 2. Study of effect of electrolyte stress on angiogenesis using chick embryo. 3. Study of migration in animals in relation to food, reproduction and environment. (Olive Ridley turtle, Monarch butterfly, Amur Falcon, Bar headed geese, Artic tern, Siberian crane) 4. Central Asian Flyway and its location on map. 5. To study the effect of temperature on the activity of human saliva. 6. To different types of sleep disorders. i. Sleep Apnea ii. Narcolepsy iii. Sleep walking iv. Restless leg Syndrome v. Sleep Paralysis vi. Snorting	

Reference:

1. W. A. Hoar (1982): "General & Comparative Animal Physiology 3rd Ed." Prentice Hall Inc.
2. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
3. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology" "Comparative Animal Physiology", 4th Ed. Wileg – Liss Publ.
4. C. Ladd Prosser Ed. (1991): "Environmental & Metabolic Animal Physiology" "Comparative Animal Physiology" 4th Ed. Wileg – Liss Publ.
5. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
6. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
7. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
8. P. W. Hochachka& G. M. Somero (1973): "Strategies of Biochemical Adaptation".
9. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
10. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
11. H. Wagner & K. Silber: Physiological Psycology.

- **Star marked (*) topics should be considered as Class Assignment topics for Internal Assessment.**

Modality of Assessment

Theory Examination Pattern:

D) Internal Assessment- 40%- 40 Marks

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	20
2.	One class Test (multiple choice objective question)	—

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

5. Duration - These examinations shall be of **2hours 30 mins** duration.
6. Theory question paper pattern:

Paper Pattern:

Questions	Options	Marks	Questions on
Q.1	**Any 1 out of 2**	**12**	**Unit- I**
Q.2	**Any 1 out of 2**	**12**	**Unit- II**
Q.3	**Any 1 out of 2**	**12**	**Unit- III**
Q.4	**Any 1 out of 2**	**12**	**Unit- IV**
Q.5	**3 short notes out of 5**	**12**	**All Units**

Practical Examination Pattern:

F) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

Overall Examination & Marks Distribution Pattern

Semester-IV

Course	RPSZOP401		RPSZOP402		RPSZOP403		RPSZOP404		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical	50		50		50		50		200

External Examination- 60%- 60 Marks

Semester End Theory Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.