Resolution No.: AC/II(23-24).2.RPS11

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for Masters of Science

Program: M.Sc. Zoology

Program Code: RPSZOO

As per the guidelines of NEP2020- Academic year 2024-25

Graduate Attributes

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.

GA	GA Description **A student completing Master's in Science program will be able to:**
GA 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.
GA 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.
GA 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.
GA 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.
GA 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.
GA 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.
GA 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.
GA 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOME

PO	Description A student completing Master's in Science program in the subject of Zoology will be able to:
PO 1	Identify, explore, understand the concept of ethology and compare the differences in the behavior.
PO 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.
PO 3	Understand and learn various behavioral patterns displayed by animals and interrelate to evolutionary pattern.
PO 4	Evaluate and analyse basics of chemical thermodynamics and various biochemical pathways with respect to metabolism.
PO 5	Analyse the various communication pathways taking place inside the cell and interrelate it with genetics.
PO 6	Compare and contrast between Mendelian inheritance, Extension of Mendelian genetics and non-Mendelian genetics
PO 7	Interpret and analyze how morphological change due to change in environment helps drive evolution over a period of time.
PO 8	Compare the different developmental stages of all the animals and connect it to the evolutionary link.
PO 9	Apply the fundamentals and techniques of molecular biology in various fields.
PO 10	Develop an ability to analyze present and interpret various concepts of Immune and Cancer Biology.
PO 11	Explain the broad concepts of Life processes, Endocrinology, Animal biotechnology, Bioprospecting and develop employable skills.
PO 12	Apply their knowledge in problem solving and future course of their career development in higher education and research.
PO 13	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	TYPE OF COURSE	COURSE TITLE	CREDITS
	I	**RPSZOOO501**	Discipline Specific Core I	**Comprehensive Zoology-I**	3
		RPSZOOPO501	Practical DSC I	**Comprehensive Zoology-I**	1
		RPSZOOO502	Discipline Specific Core II	**Biochemistry and Metabolism – I**	3
		RPSZOOPO502	Practical DSC II	**Biochemistry and Metabolism – I**	1
		RPSZOOO503	Discipline Specific Core III	**Bioanalytical techniques**	3
		RPSZOOPO503	Practical DSC III	**Bioanalytical techniques**	1
		RPSZOOO504	Discipline Specific Core IV	**IPR and Traditional Knowledge**	2
		RPSRMZOOO505	RM	**Research Methodology**	4
		RPSZOOO506	Discipline Specific Elective	**Aquarium Management**	3
		RPSZOOPO506	Practical DSE VI	**Aquarium Management**	1
	II	**RPSZOOE511**	Discipline Specific Core I	**Comprehensive Zoology-II**	3
		RPSZOOPE511	Practical DSC I	**Comprehensive Zoology-II**	1
		RPSZOOE512	Discipline Specific Core II	**Biochemistry and Metabolism- II**	3
		RPSZOOPE512	Practical DSC II	**Biochemistry and Metabolism- II**	1
		RPSZOOE513	Discipline Specific Core III	**Genetics and Molecular Biology**	3
		RPSZOOPE513	Practical DSC III	**Genetics and Molecular Biology**	1
		RPSZOOE514	Discipline Specific Core IV	**Bioinformatics and Molecular Modelling**	2
		RPSZOOE515	FP	**Field Project**	4
		RPSZOOE516	Discipline Specific Elective	**Marine Bioprospecting**	3
		RPSZOOPE516	Practical DSE	**Marine Bioprospecting**	1
		Total Credits			44

YEAR	SEM	COURSE CODE	TYPE OF COURSE	COURSE TITLE	CREDITS
	III	**RPSZOOO601**	Discipline Specific Core I	**Life Processes-I**	3
		RPSZOOPO601	Practical DSC I	**Life Processes-I**	1
		RPSZOOO602	Discipline Specific Core II	**Life Processes-II**	3
		RPSZOOPO602	Practical DSC II	**Life Processes-II**	1
		RPSZOOO603	Discipline Specific Core III	**Immunology and Cancer Biology**	3
		RPSZOOPO603	Practical DSC III	**Immunology and Cancer Biology**	1
		RPSEZOOO604	Discipline Specific Elective	DSE offered by Department of Zoology- **Introduction to Model organisms**	4
		RPSEZOOPO604	Practical DSE VI	DSE offered by Department of Zoology- **Introduction to Model organisms**	3
		RPSRPZOOO605	**RP**	**Research Project**	6
	IV	**RPSZOOE611**	Discipline Specific Core I	**Life Processes-III**	3
		RPSZOOPE611	Practical DSC I	**Life Processes-III**	1
		RPSZOOE612	Discipline Specific Core II	**Animal Biotechnology**	3
		RPSZOOPE612	Practical DSC II	**Animal Biotechnology**	1
		RPSEZOOE614	Discipline Specific Elective	**Clinical Toxicology**	3
		RPSEZOOPE614	Practical DSE	**Clinical Toxicology**	1
		RPSINTZOOE614	Internship	**Research Project/ Internship**	10
		Total Credits			44

Semester-I

Academic year 2024-2025

Paper Code	Unit	Topic	Credits
RPSZOOO501	**Comprehensive Zoology-I**		
	I	Animal Behavior-I	**3**
	II	Introduction to model organisms-I- *Hydra* & *Drosophila*	
	III	Developmental Biology	
RPSZOOO502	**Biochemistry and Metabolism – I**		
	I	Biomolecules- a structural and functional approach-I	**3**
	II	Metabolic pathways, Integration of Metabolism-I and Biochemical Thermodynamics	
	III	Regulation of metabolism and inborn errors of metabolism	
RPSZOOO503	**Bioanalytical techniques and IPR**		
	I	Microscopy	**3**
	II	Spectroscopy and PCR	
	III	Chromatography and Tracer Techniques	
RPSZOOO504	**IPR and Traditional Knowledge**		
	I	Intellectual Property Rights	**2**
	II	Traditional Knowledge	
RPSRMZOOO505	**Research Methodology**		
	I	Research Methodology-I	**4**
	II	Research Methodology-II	
	III	Research Methodology-III	
	IV	Biostatistics	
RPSZOOO506	**Aquarium Management**		
	I	Introduction to Aquarium Fish Keeping	**3**
	II	Creating the Aquatic Environment & Maintenance of Aquarium	
	III	Basics of Fish breeding	
Practical			
RPSZOOP.O501		Practical based on Comprehensive Zoology-I	**1**
RPSZOOP.O502		Practical based on Biochemistry and Metabolism – I	**1**
RPSZOOP.O503		Practical based on Bioanalytical techniques	**1**
RPSZOOP.O506		Practical based on Aquarium Management	**1**
Grand Total			**22**

Discipline Specific Core Course

Course Code: RPSZOOO501

Course Title: Comprehensive Zoology-I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Describe the broad concepts of animal behavior and its applications in various fields of Research.
CO 2	Compare and contrast the insights of behavioral patterns displayed by different animals.
CO 3	Interrelate the working and different systems and understand the role of model organisms in the field of research.
CO 4	Analyze different concepts in developmental biology.
CO 5	Enumerating the various aspects of regeneration.
CO 6	Maintain and handle different model organisms and demonstrate different experiments.

RPSZOO.O501	Title: Comprehensive Zoology-I	Credits/Hours
Unit: I	***Study of Animal Behavior*-I** • Development of behavior: Significance of animal behavior, influence of environment hormones and genes, Cognition. • Reflexes and complex behavior: Latency, after discharge, summation, warm up, fatigue inhibition and feedback control. • Instinctive Behavior - 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. • Biological communication- Role of pheromone- Insects social organization; pheromone effects in mammals- Lee Boot, Whitten, Bruce, Collidge and Castro-Vandenberg effects.	**1C/15H**
Unit: II	***Introduction to model organisms- Hydra & Drosophila*** • Hydra as a model organism: Setting up Artemia hatchery (temperature, salinity, pH, lifecycle and nutritional value), Hydra regeneration, Different types of cells in Hydra. • Drosophila as a model organism:	**1C/15H**

	Drosophila development: a. Embryonic development b. formation of body axes c. Segmentation genes d. Homeotic genes and their functions e. Larval stages f. Imaginal discs g. Pupa and metamorphosis h. Adult morphology	
Unit:III	***Developmental Biology*** • Basic concepts of Developmental Biology- Potency, induction, determination and differentiation; Apoptosis, Stem cells, genomic equivalence; imprinting; mutants and transgenic in analysis of development. • Cell aggregation and differentiation in *Dictyostelium* • Axis formation and pattern formation: *Xenopus* • Organogenesis • Vulva formation in *Caenorhabditis elegans*. • Regeneration as a replay of development stages (intro, brief account of epimorphogenesis, morphylaxis & compensatory regeneration).	**1C/15H**
RPSZOOPO501	**Practical based on: Comprehensive Zoology-I**	**Credit 1**
1.	Hydra media preparation.	
2.	Study of Hydra regeneration.	
3.	Culturing and maintaining *Drosophila*.	
4.	Visualizing different developmental stages of *Drosophila* embryogenesis.	
5.	Behavioral interaction between individuals of Siamese Fighter fishes (*Betta splendens*).	
6.	Nest construction behavior and altruism in green ants.	
7.	Field activities: field visits- zoos/sanctuaries/national parks.	

References:

1. Sinha, A.K, Adhikari S and Ganguly BB: Biology of Animals (vol. I & II), Central Book Agency, Kolkata
2. Alcock, J. (2001): Animal Behaviour, an Evolutionary Approach. Sinauer associates, INC. Sunderland, Massachusetts. USA
3. Bernard, C. (2004): Animal Behaviour, Mechanism, Development function and evolution. Pearson and Prentice Hall Publication. New York

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5. Goodenough, J.E., Mc Guire, B. and Wallace, R. A. (1993): Perspectives on Animal Behaviour. John Wiley and Sons, New York.
6. Mandal, F. B. (2010): Textbook of Animal Behaviour. PHI Learning Private Limited, Estern Economy Edition. New Delhi -110001
7. Manning, A. and Dawkins M.S. (1997): Introduction to Animal Behaviour, 5th edition, Cambridge University Press. UK.
8. Scott, G. (2005): Essential Animal Behaviour. Black Well Publishing, University of Hull, UK.
9. Stumpter, T. J. D. (2010): Collective Animal Behaviour; Princeton University Press. Oxford.
10. F Scott. Gilbert, Sinauer Associates Inc: Developmental Biology.
11. T. Subramanian: Developmental Biology; Narosa Publ.
12. Philip Grant: Biology of Developing System; Holt Saunders International Ed.
13. M. W. Strikberger: Evolution; CBS Publ.
14. Sumitra Sen and Dipak Kumar Kar: Cytology and Genetics; Narosa Publ.
15. R.M. Twyman, Bios: Instant Notes- Developmental Biology; Scientific Pub. Ltd.
16. Bier, E. 2005. Drosophila, the Golden Bug, Emerges as a Tool for Human Genetics. Nature Reviews Genetics 6: 9-23.
17.Fly: http://flybase.bio.indiana.edu:82/
18. Biology of Hydra: https://doi.org/10.1016/B978-0-12-145950-5.X5001-0
19. J.A.Pechenik: Biology of Invertebrates; 4th Ed, Tata McGraw Hill Publication.
20. Russell, W.D. Hunter, McMillan: Life of Invertebrates.
21. Bares, R.D: Invertebrate Zoology, Saunders Publication.
22. Barrington, E J W, (1976): Structure and Functions of Invertebrates.
23. Hyman, L.H: The invertebrates (all volumes), McGraw Hill, Philadelphia, USA

Discipline Specific Core Course

Course Code: RPSZOOO502

Course Title: Biochemistry and Metabolism – I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enumerate the classification, structures, and functions of Carbohydrates, Lipids and Nucleic acids.
CO 2	State the law of Biochemical thermodynamics, ETS chain reaction and oxidative phosphorylation concepts.

CO 3	Explain about the antioxidants and free radicals quenching to cancer research and anticancer activity.
CO 4	Differentiate between metabolic pathways and its significance.
CO 5	Analyse and understand the different inborn errors of metabolism.
CO 6	Demonstrate different biochemical assays to find out saponification and acid value of fats.
CO 7	Calculate Normality, Molarity and prepare solutions of different strengths.

RPSZOOO502	**Title: Biochemistry and Metabolism-I**	**Credits/Hours**
Unit: I	***Biomolecules- a structural and functional approach-I*** • Carbohydrates: Monosaccharides- structure, classification, D- and L-isomers, Anomers and mutarotation, open chain and ring forms, pyranose and furanose forms, reactions of monosaccharides, glycosidic bonds and nomenclature. Oligosaccharides, Polysaccharides- homo- and hetero-polysaccharides. • 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 glycerol's in glycerides, properties of triacylglycerol. • Complex lipids- Phospholipids, Sphingolipids, Sterols and waxes, Amphipathic lipids Membrane lipid bilayers. • Nucleic acids: Types of RNA and DNA- Components: Pentose, Nitrogenous bases, Nucleosides, tautomeric forms of purines and pyrimidines. different forms of DNA double helix. • Glycoproteins: Blood group substances • Glycolipids: Gangliosides • Lipoproteins: Classification and functions- chilomicrons, VLDL, LDL, HDL, and free fatty acid-albumin complex.	**1C/15H**
Unit-II	***Metabolic pathways, Integration of Metabolism-I and Biochemical Thermodynamics*** • 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.	**1C/15H**

	• 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. • 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.	
Unit: III	***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; **a.** Teratogens and their effects **b.** Sensitive period of teratogen **c.** Specificity of teratogen **d.** Thalidomide syndrome **e.** Teratocarcinoma and Teratoma **f.** Environmental teratogens **g.** Evaluation of teratogenicity of chemicals.	**1C/15H**
RPSZOOPO502	**Practical based on: Biochemistry and Metabolism – I**	**Credit 1**
1.	Determination of glycogen in the given tissue (liver/ skeletal muscle/ kidney/ brain).	
2.	Acid and enzyme hydrolysis of glycogen and colorimetric estimation of the products by 3,5-DNSA method.	
3.	Determination of acid value of fats/ oils.	

4.	Determination of saponification value of fats/ oils.	
5.	Agarose gel electrophoresis of DNA separated from suitable samples.	
6.	Solutions and Buffers: Mode of expressing concentration of solutions- Molarity (M), normality (N), Mass concentration, mass fraction, mass percentage: %(w/w), % (v/v), % (w/v) parts per million (ppm) with practical exercises.	

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.

Discipline Specific Core Course

Course Code: RPSZOOO503

Course Title: Bio analytical techniques

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain the basic principles, working and applications of microscopy.
CO 2	Determine the basic principles of tracer techniques and PCR and their applications.
CO 3	Illustrate the basic principles, working and applications of chromatography.
CO 4	Compare and contrast between the principles, working and applications of various bioanalytical techniques.
CO 5	Identify appropriate techniques to isolate and separate different biomolecules using suitable instrumentation technique.

RPSZOOO503	Title: Bioanalytical techniques	Credits/Hours
Unit: I	***Microscopy*** • Principles, instrumentation, working and applications of: a. Fluorescence microscopy, b. Polarization microscopy, c. Phase contrast microscopy, d. TEM, e. SEM • Biological sample preparation for electron microscopy.	**1C/15H**
Unit: II	***Spectroscopy and PCR*** • Principles, instrumentation, working and applications of: a. IR b. GC MS c. LC MS d. AAS e. ICP- AES, f. Plasma Emission spectroscopy, g. NMR, h. 2D NMR. • PCR: Principle, Steps in PCR, Constraints in PCR Modifications of PCR techniques and its applications.	**1C/15H**
Unit-III	***Chromatography and Tracer Techniques*** • General Principle of chromatography. • Techniques and applications of Ion exchange, Affinity Chromatography and HPLC Application / validation of herbal drugs using HPTLC. • Radioactive isotopes and autoradiography-Principle, instrumentation & technique: Geiger-Muller counter, Liquid scintillation counters. • Applications of isotopes in biology • PET scan, CT scan, Radionuclide imaging. • Blotting techniques- Southern blotting, Western blotting and Northern blotting.	**1C/15H**
RPSZOOP.O503	**Practical based on: Bio analytical techniques**	**Credit 1**
	1. Preparation of buffers of different pH using Henderson- Hasselbalch equation and its verification using pH meter (phosphate and acetate)	
	2. Determination of pKa.	
	3. Analysis of heavy metals from soil/plant sample by AAS.	
	4. Separation of pigments from leaves or flowers by adsorption Column	

	chromatography.	
	5. Separation and identification of amino acids by One/Two-dimensional Paper chromatography	
	6. Analysis of volatile oils by GC-MS.(Demonstration).	
	7. Separations of proteins by ion exchange chromatography.	
	8. Activity based learning: Anchrom Lab visit/ Ramnathan lab/TDM lab visit. (Demonstration of HPTLC technique using animal source)	
	9. DNA amplification using PCR.	

References:

1. Berlyn GP and Miksche JP. 1976. Botanical micro-techniques and cytochemisty
2. Chang R (1971). Basic principles of spectroscopy. McGraw Hill.
3. Garry D Christian, James E O'reilvy 1986. Instrumentation analysis. Alien and Bacon, Inc.
4. Gordon MH and Macrae M. 1987. Instrumental analysis in the biological sciences.
5. Henry B Bull (1971). An Introduction to physical biochemistry. F A Devis Co.
6. Wilson K and Walker JM.1994. Principles and techniques of practical biochemistry.
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8. Duddington, C.L, 1960. Practical microscopy. Pitman publ.
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11. Vanholdem K.E. and W.C.Johnson, 1998. Principles of Physical Biochemistry
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13. Heink, U and Kowarik,I. (2010) What criteria should be used to select biodiversity indicators . Biodiversity Conservation 19:3769-3797.
14. Ram Reddy,S. Surekha ,M. and Krishna Reddy,V (2016). Biodiversity Traditional Knowledge Intellectual Property Rights. Scientific Publishers.
16. Unnikrishna,P and Suneetha,M. (2012). Biodiversity, traditional knowledge and community health: strengthening linkages. Institute for Advanced Studies, United Nations University, Tokyo.
17. Wood, A., Pamela, S.E.and Johanna, M. (2000). The root causes of biodiversity loss. United Kingdom: Early –Scan Publications.

Discipline Specific Core Course

Course Code: RPSZOO.O504

Course Title: Traditional Knowledge and IPR

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	Upon successful completion of this course, learners will be able to;

CO 1	Learn the procedure of obtaining patents, copyrights, trade Marks & industrial design.
CO 2	Recall the importance of IP and basic concepts of Intellectual Property Rights.
CO 3	Understand the statutory provisions of different forms of IPRs in simple forms.
CO 4	Identify the significance of practice and procedure of patents.

RPSZOO.O504	**Title: IPR and Traditional Knowledge**	**Credits/Hours**
Unit: I	***Intellectual Property Rights*** • IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS. TRIPS & Patent laws: Introduction and standards for patent protection. • Different types of IPR's. • Patent Act 1970 – amendments of 1999, 2000, 2002 and 2005 Patentable subject matter, Patentability criteria, non-patentable inventions, Drafting a patent specification. • Prior art/ Novelty search: Free and paid databases. • Rights of patentee, Procedure for granting a patent and obtaining patents, Grounds for opposition, Working of Patents, Compulsory License Acquisition, Surrender, Revocation, restoration, Transfer of patent rights PCT, Types of patent applications, patent forms, guidelines, fee structure, priority date. • Patent protection: Pharmaceutical products and process, Patenting life forms. Patenting biotech inventions – minimum 5 case studies • Ethics in IPR: Public health and Intellectual Property Rights Case study—Novartis Pharmaceuticals • Bayer Pharmaceuticals • Meaning of Copyright: Idea Vs Expression Dichotomy, Copyright Vs Moral rights, Performer's right, Copyright in Literary, Drama, and musical works, Sound Records, Cinematograph films, computer programmes. • Copyright Act, 1957 – Salient features of the Act (Amendment Act 2012) - Ownership of copyright – Assignment of Copyright – Term of Copyright – Copyright Office – Copyright Board, Copyright: registration and duration.	**1C/15H**
Unit: II	***Traditional Knowledge*** • Protection of traditional knowledge– objective, concept of traditional knowledge, holders, issues concerning bio-prospecting and biopiracy; geographical indications, industrial designs, advantages of IPR, some case studies. • Recognition and Documentation of Traditional Knowledge –	**1C/15H**

	Databases – Traditional Knowledge Digital Library "TKDL" – AYUSH Systems of Medicines – Biodiversity Register. Prevention of plundering TK- neem, basmati and turmeric patents. • Traditional Knowledge as Property – Nature of Property in genetic Resources and associated traditional Knowledge - Ownership in Traditional Knowledge: Nature and Elements of Ownership – Exclusivity and Protection –Benefit Sharing. • International Depositary authority, Gene patenting, National gene bank. • Plant variety protection, farmer's rights, plant breeders' rights. • Protection of Plant Varieties and Farmers' Rights Act, 2001. Registration of Plant Varieties – Duration and effect of Registration, GM crops.	

Reference:

1. Conn, E. E., Stumpt, P. K., Bruencing, G. and Dol, R. G. (1995): Outlines of Biochemistry. John Wiley, Singapore.
2. 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.
3. Hamilton, C.(2006) Biodiversity, Biopiracy and Benefits: What allegations of Biopiracy tell us about intellectual property. Blackwell publishing Ltd., Oxford.
4. Heink, U and Kowarik,I. (2010) What criteria should be used to select biodiversity indicators . Biodiversity Conservation 19:3769-3797.
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7. Wood, A., Pamela, S.E.and Johanna, M. (2000). The root causes of biodiversity loss. United Kingdom: Early –Scan Publications.

Course Code: RPSRMZOOO505

Course Title: Research Methodology

Academic year 2024- 25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enlist the resources for accessing scholarly articles, published papers, abstract writing and bibliographic management.
CO 2	Illustrate the skills to design good research hypotheses and select an appropriate data analysis method.

CO 3	Make use of methods of data collection, tools for data analysis and ethical issues in educational research.
CO 4	Apply basic computer skills and required numerical skills necessary for the conduct of research.

RPSRMZOOO505	**Title: Research Methodology**	**Credits/Hours**
Unit: I	***Research Methodology- I*** • Introduction: Research design principles, execution of work, interpretation of results. • Review of literature • Library: Types of sources, 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 for biological sciences, INFLIBNET, INSDOC, Google Scholar, Ruia Library OPAC, OATD, Shodhganga, Shodhgangotri & N-LIST. • Research Metrics – Impact factor of journals, H-index, Indexing databases – Web of Science, Scimago, Indian Citation Index etc.	**1C/15H**
Unit-II	***Research Methodology- II*** • Introduction to scientific writing: Meaning of Scientific and non-scientific writing; Scientific Vocabulary and grammar. Synopsis, Dissertations, Thesis, Posters. • Correspondence: Formal letters, cover letters, drafting emails, replying to reviewers. • Writing a Research paper: Title, Abstract, Introduction, Review of literature, Methodology, Observations, Results, Discussions, Summary, Conclusion, and Bibliography (Referencing and citation styles). Supplementary data. • Writing a Research Grant Proposal: Funding agencies, guidelines, structure of research proposals – Setting a budget (Manpower, Consumables, Equipment, Travel, Contingencies, Overheads) with justifications, expected outcomes, Cost benefit analysis, Work plan, and Time schedule of activities. • Bioethics: Definition – moral, values, ethics and ethics in biology; Role and importance of ethics in biology; Legal and regulatory issues;	**1C/15H**

	Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research. • Scientific misconduct: Fabrication, Authorship conflicts, Salami, Plagiarism, imalas publication.	
Unit: III	***Research Methodology- III*** • Literature review: Search, query formulation and organization of review. • Reference management tools: Using Mendeley/ EndNote/ Zotero. (Validation of methods/selecting appropriate method for analysis) • Interpretation of result • Word Processing systems: Microsoft Word, Google Docs, LATEX. • Image Editors: Guidelines for publishing images, Inkscape, GIMP, Image J. Creating a multi-panel vector and raster image for research paper publishing. • Graphing & Statistics: Using Microsoft Excel, Google Sheets, GraphPad Prism, MaxStat, IBM SPSS and R. • Presentation and Design: Microsoft PowerPoint, Google Slides, Microsoft Publisher. Presenting numerical data - Graphical, Tabular, Animations, Slides, etc. • Creating a website for scientific communication: Google sites, Wix website design and publishing. • Miscellaneous Tools and AI.	**1C/15H**
Unit: IV	***Biostatistics*** • Hypothesis testing: Theory of errors – Type I and Type II errors • Null Hypothesis & Alternate Hypothesis • Z-test • Test of significance • Introduction to ANOVA, One-way & Two-way ANOVA • Randomized Block Design and Latin Square. (5 problems to be solved in each category) • Dunett's test.	**1C/15H**

Reference:

1. Anderson J, Durston B H, Poole 1970. Thesis and assignment writing. Wiley eastern.
2. Bedekar V. H.1982. How to write assignment and research papers, dissertations and thesis. Kanak publications.
3. Kothari– C.R. 2004. Research Methodology –Methods and Techniques, New Age International Ltd. Publishers, New Delhi.
4. Goon, A.M., Gupta, M.K. and Dasgupta, B.1986. Fundamentals of Statistics (Vol.2). The world press Private limited, Calcutta. 17. Gupta, S.C. and Kapoor, V .K.1993. Fundamentals of applied statistics. Sultan Chand and Sons, New Delhi 18.

5. Gupta,S.P. 2001. Statistical methods. Sultan Chand and Sons, New Delhi.
6. Khan I and Khanum (2008) Fundamentals of Biostatistics, Ukaaz Publications, Hyderabad.
7. S. C. Gupta and V.K. Kapoor; 3rd Edition; Sultan Chand and Sons (2001): Fundamentals of Applied Statistics and Fundamentals of Mathematical Statistics.
8. Introduction to Biostatistics (Second Edition-2005) N. Gurumani M J PPublishers.

Discipline Specific Elective

Course Code: RPSZOOO506

Course Title: Aquarium Management

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Comprehend the key skills needed to set up and successfully maintain a fresh water aquarium.
CO 2	Identify and differentiate aquarium/ornamental fishes, invertebrates and aquatic plants.
CO 3	Enlist the various feeding habits and nutritional requirements of different fishes and invertebrates Comprehend the various fish diseases and their treatment options.
CO 4	Describe the breeding peculiarities of various fishes and fresh water invertebrates and establish a small breeding and hatchery setup at lab level.
CO5	Obtain a broader view pertaining to scope of commercial aspects of establishing a small commercial setup.

RPSZOOO506	Title: Aquarium Management	Credits/Hours
Unit: I	***Introduction to Aquarium Fish Keeping*** • Introduction: History, Why Set Up an Aquarium, advantages – Personal, Family, Social, Creativity, Proximity to Nature, New Learning, Different Than Keeping Other Pets, Easy to Do It, Hobby for Lifetime. • Before you start: Myths and Realities of Aquarium Keeping, Types of Aquariums, Choosing Right. • Aquarium, Choosing right Location, Background Preparation, Safety and Precautions, Do's and Don'ts aquarium. • A Delicate Balanced Ecosystem What Is Ecosystem, Elements of Aquatic Ecosystem, Substrate – Aerobic and Anaerobic Conditions, Water – Temp, Ph, Hardness, Clarity, Gases – CO2, O2, Nitrogen Cycle, Ammonia, H2S, Methane, Light – Photoperiod, Aquatic Animals – fish, shrimp, snails, Aquatic Plants and Mosses. • Introduction to the Aquarium Hardware: Reverse Osmosis filters for pure source of water, UV Sterilizers, Importance of Filtration, Types of Filters, Filtration Media, Aerators, Thermometers, Heaters, Pressurized CO2 System, DIY CO2 System. • Lighting -Its Importance – Types of Lighting, Water Testing Equipment and Kits, timers, Auto Feeders etc.	**1C/15H**

Unit: II	***Creating the Aquatic Environment & Maintenance of Aquarium*** • Types Of Aquatic Biotopes, Principles of Aqua scaping, Types of Aquascapes, Types of Substrates, Use of Rocks, Driftwoods, How to Set Up an Aquarium Step Wise Guidelines, Do's and Don'ts, Cycling of Aquarium, Water quality requirements: PH, hardness, Maintenance and Temperature control Testing of Water. Assembling a tank, Equipment and accessories. • Balanced aquarium: Choosing the bed, Decor and background, Final preparations. • Aquarium Maintenance: Myths and Realities, Dos and Don'ts, Maintenance Schedule, Daily, Weekly, Monthly and Annual Maintenance Schedule, Water Change, Cleaning of Glass and Other Articles. Taking Care of Aquarium While on Vacation, Maintenance tool kit. • Choosing the Right Fish, Stocking of Fish, Choosing Healthy fish, Handling of Fish, Acclimatization, Quarantine Tank, Fish Care, Avoiding Cruelty to Fish Due to Ignorance, Irresponsible Petting. • Introduction To Common Tropical Aquarium Fishes, Their Origin, Habitat Details, typical characters and sexual dimorphism And Care. • Endemic Aquarium Fishes – Zebra Danio & Honey Gourami, Freshwater ornamental fishes - Guppy, Siamese Fighter fish, Gold fish and Angel fish. • Brackish ornamental fishes - Black Molly and Sword tail. • Marine and brackish water ornamental fish introduction. • Ornamental Fresh water Aquarium Plants. • Introduction to different types of stem plants, Rosette plants, Epiphytic plants and their importance and role in Aquarium environment. Foreground, midground, background plants. • Emersed and Immersed grown plants vs Tissue cultured plants for aquariums. • Procurement, precautions, planting, pruning and maintenance and propagation of aquatic plants. Liquid fertilizers and plant growth additives. • Common Fish Feeding Behaviors as per their morphology & origin / habitat • Live food options – Tubifex worms, Chironomus larvae, Mosquito larvae, Daphnia, Moina, and Brine Shrimps, Live fish in case of larger carnivorous fish. Processed food / dry feed options – fish feed formulations.	**1C/15L**

	• Identification of Common Fish Diseases: Root cause of fish diseases in aquariums, types of common fish diseases, White Spot, Fin rot, Dropsy, Head in the hole, Flukes and worm infestation, Planaria etc • Treatment: Treatment options with temperature control, Methylene Blue, Malachite Green, Chloromycetin, Common salt etc.	
Unit: III	***Basics of Fish breeding*** • Live bearers - Sexual Dimorphism, Selection, Preparation & Isolation of Brood stock, Preparing Breeding Tank for Live Bearers, Breeding of Live Bearers, Isolating Fries, Cross Breeding of Livebearers, Avoiding interbreeding, Breeding of Guppies, Platys, Mollies, Sword tails. • Egg Layers Types – Sexual Dimorphism, Selection, Preparation & Isolation of Brood stock, Preparing Breeding Tank For egg layers Scatterers, Floaters, Adherers, Nest Builders, Breeding Of common egg laying fishes like Zebras, Angels, Fighters, Gourami's, barbs and carps. • Preparation of Feed for Young Fries, Care of fries and juveniles, Handling, Packaging and transport of fish, shrimps and aquatic plants. • Introduction to Entrepreneur opportunities in Freshwater. • Aquarium Industry: Overview – Aquarium Industry & its Stake holders (govt agencies, banks and financial institutions and organized commercial players and unorganized commercial players) New pet rules and its implications on aquarium industry in near future Opportunities ahead for developing professionals and entrepreneurs in Aquarium industry (retail shops and aqua scaping, Wholesale shops, Import export trading, Aquarium dry goods manufacturing and supply etc.)	**1C/15H**
RPSZOOPO506	**Practical based on: Aquarium Management**	**Credit 1**
1.	Setting of freshwater aquarium tank.	
2.	Activity based learning: Preparation Wet and dry fish food	
3.	Measuring the physical and chemical water parameters: a. Dissolved Oxygen, b. Nitrites and Nitrates, c. Temperature, d. pH, e. Salinity, f. Hardness	
4.	Identify and describe food and its Types.	

5.	Identify and describe aquarium plants (any five).	
6.	Identify and describe aquarium fishes (Freshwater, Marine and Brackish water).	

References:

1. Aquarium: Fish Keeping C B L Srivastava Published by Kitab Mahal.
2. Marine Aquarium (Fish: Keeping and Breeding Them in Captivity) Boruchowitz, Davie. Published by Chelsea House Publications (1998).
3. Aquarium Setting Up (Fish: Keeping and Breeding Them in Captivity) Axelrod, Herbert R. Published by Chelsea House Publications (1998).
4. The Tropical Freshwater Aquarium Problem Solver: Practical and Expert Advice on Keeping Fish and Plants Sand ford, Gina Published by Voyageur Press (MN) (1998).
5. Aquariums: The Complete Guide to Freshwater and Saltwater Aquariums, Jan 2009 by Thierry Maitre-alain (Author), Chrisitan Piednoir (Author)

Modality of Assessment

- ***Modality of Assessment-DSC/DSE***

Theory Examination Pattern:

A) Internal Assessment- 30 Marks

Sr. No	Evaluation type	Marks
1	Class Test (Multiple Choice Based Questions & Subjective)	20
2	Project / Assignment / Presentation	10
	TOTAL	**30**

B) External Examination (Semester End)- 60%- 45 Marks

1. Duration – The duration for these examinations shall be of two hours.
2. Theory question paper pattern:

Semester End Theory Examination Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Any 3 out of 4	15	Unit-I
Q.2	Any 3 out of 4	15	Unit-II
Q.3	Any 3 out of 4	15	Unit-III
	TOTAL	**45**	

- ***Practical Examination Pattern*:**

Sr No	Evaluation type	Marks
1	Journal	2
2	Viva & Practical Tasks	23
	TOTAL	**25**

Duration – The duration for these examinations shall be of **4 hours**.

- ***Modality of Assessment-DSC – 2credit***

Question	Unit	Options	Marks
Q.1	I	Any two out of three	20
Q.2	II	Any two out of three	20
Q.3	I & II	Short notes: Any two out of three	10
Total			**50**

Modality of Assessment-Research Methodology:

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	Class Test (Multiple Choice Based Questions & Subjective)	20
2	Project / Assignment / Presentation	20
	TOTAL	**40**

B) External Examination (Semester End)- 60%- 60 Marks
Semester End Theory Examination:

- Duration – The duration for these examinations shall be of **two and half hours**.
- Theory question paper pattern:

Paper Pattern for Research Methodology:

Question	Options	Marks	Questions Based on
1	Any 3 out of 4	15	Unit I
2	Any 3 out of 4	15	Unit II
3	Any 3 out of 4	15	Unit III
4	Any 3 out of 4	15	Unit IV
	TOTAL	**60**	

Overall Examination and Marks Distribution Pattern

Semester-I

Course	**RPSZOOO501 RPSZOOO502 RPSZOOO503 RPSZOOO506**		**Total of 4 Courses**		**RPSZOOO504**	**RPSRMZOOO505**		**Grand Total**
	Int	**Ext**	**Int**	**Ext**	**External**	**Int**	**Ext**	
Theory	**30**	**45**	**120**	**180**	**50**	**40**	**60**	**450**
Practical	**25**		**100**		**---**	**---**		**100**
Grand Total								**550**

Semester II

Academic year 2024-2025

Paper Code	Unit	Topic	Credits
RPSZOOE511	**Comprehensive Zoology-II**		
	I	Animal behavior-II	3
	II	Introduction to model organisms- *C. elegans* and *Danio rerio* - II	
	III	Cell Communication	
RPSZOOE512	**Biochemistry and Metabolism- II**		
	I	Bio-molecules- a structural and functional approach-II	3
	II	Enzymes and Enzyme kinetics	
	III	Metabolic pathways and Integration of metabolism	
RPSZOOE513	**Genetics and Molecular Biology**		
	I	Genetics	3
	II	Molecular Biology- I	
	III	Molecular Biology- II	
RPSZOOE514		**Bioinformatics and Molecular Modeling**	2
	I	Bioinformatics	
	II	Molecular Modeling & Molecular Dynamics simulations	
RPSZOOE515		**Field Project**	4
RPSZOOE516	**Marine Bioprospecting**		
	I	Introduction and Bioprospecting from Marine organism	3
	II	Marine Nutraceuticals, Cosmeceuticals and Pharmaceuticals	
	III	Isolation and Separation Techniques- Marine Extract	
RPSZOOPE511		Practical based on Comprehensive Zoology-II	1
RPSZOOPE512		Practical based on Biochemistry and Metabolism- II	1
RPSZOOPE513		Practical based on Genetics and Molecular Biology	1
RPSZOOPE516		Practical based on Marine Bioprospecting	1
Grand Total			**22**

Discipline Specific Core Course

Course Code: RPSZOOE511

Course Title: Comprehensive Zoology-II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Comprehend the broad concepts of animal behavior and its applications in various fields of research.
CO 2	Correlate the different aspects of animal behavior, social behavior and learning or memory to evolutionary aspect.
CO 3	Interrelate the working and different systems and explain the role of model organisms in the field of research.
CO 4	Justify the different cell signaling pathways and apply it in the field of cancer genetics.
CO 5	Maintenance of model organisms.

RPSZOOE511	Title: Comprehensive Zoology-II	Credits/Hours
Unit: I	***Animal behavior-II*** • Learning and memory: Innate behavior (orientation, kineses, taxes, motivation, tropism, reflex and nest building), learned behavior (sensitization and habituation, associative learning, imprinting, reasoning, trial-and-error,discrimination, biased and language learning), Memory-nature, types of memory, Evolution and Genetics of behavior: Hamilton's rule, kin selection, cost and benefits of sex and sexual selection. Genetics of burrow shape in Oldfield mouse and Deer mouse. • Social behavior: Types of social groups, advantages of grouping, social organization- primates, Cost and benefits of sociality, Eusocial behavior.	**1C/15H**
Unit: II	***Introduction to model organisms- C. elegans and Danio rerio - II*** • *C.elegans* as a model organism: Lifecycle, different larval forms,	**1C/15H**

	preparation of media, culturing and maintenance of *C. elegans*. • *Danio rerio* (Zebrafish) as a model organism: Zebrafish husbandry and setting up of tank, identification of sex, lifecycle, breeding techniques. Studying zebrafish developmental stages of embryos. Nutritional requirements. • Importance of zebra fish in research.	
Unit: III	***Cell Communication*** • Cell signaling: Cell surface receptor- G-Protein Coupled Receptor (GPCR), Inotropic Receptor, Enzyme Linked Receptor. Lipid and Steroid based receptor- Intra cellular receptor, Cytoplasmic receptor. Signaling, secondary messenger and regulation through G-protein coupled receptors. Hormones and their receptors, Bacterial and plant two-component systems, Light signaling in plants, Bacterial chemotaxis and quorum sensing. • General principles of cell communication- Cell adhesion molecules (cadherins, selectin, immunoglobin super family, integrin). • Cell Junctions- occluding junction (tight junction septate junction), anchoring junction (adherens junction, focal adhesion, desmosomes, hemi-desmogens), communication junction (Gap junction, Plasmo-desmata).	**1C/15H**
RPSZOOPE511	**Practical based on: Comprehensive Zoology-II**	**Credit 1**
1.	To study the repellent activity of lemon extract against the pest.	
2.	Culturing and maintaining *C. elegans*.	
3.	Studying the different larval stages of *C. elegans*.	
4.	Maintaining the tank of Zebra fish.	
5.	To study different behavioral patterns of Zebra fish: a. Light and dark test, b. Novel tank test, c. Natural diving response, d. Mirror biting test, e. Predator avoidance,	

References:

1. Alcock, J. (2001): Animal Behaviour, an Evolutionary Approach. Sinauer associates, INC. Sunderland, Massachusetts. USA

2. Bernard, C. (2004): Animal Behaviour, Mechanism, Development function and evolution. Pearson and Prentice Hall Publication. New York

3. Dunlap, J. C., Loros J. J. and Decoursey P. J. (2004): Chronobiology Biological Timekeeping. Sinuaer Associates, Inc. publishers, Sunderland, Massachusetts, USA

4. Goodenough, J.E., Mc Guire, B. and Wallace, R. A. (1993): Perspectives on Animal Behaviour. John

Wiley and Sons, New York.
5. Mandal, F. B. (2010): Textbook of Animal Behaviour. PHI Learning Private Limited, Estern Economy Edition. New Delhi -110001
6. Manning, A. and Dawkins M.S. (1997): Introduction to Animal Behaviour, 5th edition, Cambridge University Press. UK.
7. Scott, G. (2005): Essential Animal Behaviour. Black Well Publishing, University of Hull, UK.
8. Stumpter, T. J. D. (2010): Collective Animal Behaviour; Princeton University Press. Oxford.
9. Howe K et al. The zebra fish reference genome sequence and its relationship to the human genome. Nature 2013.
10. Pennisi, E. (1998). Worming secrets from the C. elegans genome. Science, 282,1972-1974.
11. Fly: http://flybase.bio.indiana.edu:82/
12. Worm: http://www.expasy.ch/cgi-bin/lists?celegans.txt. http://www.wormbook.org/
13.Zebrafish: http://www.ncbi.nlm.nih.gov/genome/guide/D_rerio.html
14. Robert H. Tamarin: Prin. Of Genetics; 7th Ed. Tata McGraw Hill.
15. Elaine Johansen Mange and Arthur Mange: Basic Human Genetics; Indian Reprint; 1997; Rastogi Publ.
16. A.P. Jha: Genes and Evolution; MacMillon India.
17. William S. Kluge: Concepts of Genetics; M.R.Cummings, Pearson Edu .

Discipline Specific Core Course

Course Code: RPSZOOE512

Course Title: Biochemistry and Metabolism- II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain the classification, structures, and functions of Proteins and Enzymes.
CO 2	Enumerate the concept of enzyme kinetics.
CO 3	Differentiate 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	Determine the levels of creatinine, HDL and urea from the given sample using appropriate method.
CO 6	Demonstrate enzyme kinetics experiment.

RPSZOOE511	Title: Biochemistry and Metabolism- II	Credits/Hours
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 quaternarystructure; conjugate proteins- hemoglobin, cytochromes, myoglobin; bonds involved in protein organization. • Properties of proteins: classification, denaturation and protein folding. • Biological functions of proteins. Biologically important peptides:glutathione, octa-, nano-, and deca-peptides. • Ramachandran plot.	**1C/15H**
Unit: II	***Enzyme kinetics*** • Enzyme kinetics: a. Mechanism of enzyme catalysis. b. enzyme activation and inhibition. c. factors affecting enzyme activity. d. Michaelis Menton equation. e. Lineweaver-Burk plot. • 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, Ribonuclease & Peptidyl transferase.	**1C/15H**
Unit: III	***Metabolic pathways and Integration of metabolism*** • Protein Metabolism: Metabolism of amino acids: Amino acid pool, transamination; oxidative and non- oxidative deamination; metabolismof 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 ideaof *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	**1C/15H**

	major metabolic pathways of energy metabolism;Intermediary metabolism; Organ specialization and metabolic integration. Metabolism in starvation.	
RPSZOOP.E512	**Practical based on: Biochemistry and Metabolism- II**	**Credit 1**
1.	Determination of total cholesterol and HDL cholesterol from serum.	
2.	Colorimetric estimation of protein by Peterson-Lowry method	
3.	Determination of creatinine in serum.	
4.	Determination of urea in serum.	
5.	SDH specific activity.	
6.	Enzyme kinetics - pH variation & Temperature-fungal amylase	
7.	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

Discipline Specific Core Course

Course Code: RPSZOOE513

Course Title: Genetics and Molecular Biology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Identify different cell cycle checkpoints and correlate them with cancer.
CO2	Justify the concept of non-disjunction as a genetic anomaly with different genetic disorders and maternal age.

CO 3	Illustrate the concepts of DNA replication, DNA repair and protein synthesis.
CO 4	Discuss the concepts of RNA synthesis and processing, Protein synthesis.
CO 5	Demonstrate the isolation and analyze the separation of Plasmid DNA by performing agarose gel electrophoresis.

RPSZOOE513	**Title: Genetics and Molecular Biology**	**Credits/Hours**
Unit: I	***Genetics*** • 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. • Significance of telomeres; telomeres and cancer • Genetics of cancer- Relationship of cell cycle to cancer, Oncogenes, Tumor suppressor genes, Mutator genes, Chemicals and radiations as carcinogens. • Alleles and phenotypes: a. Incomplete or partial dominance and co-dominance b. Epistasis – Dominant and Recessive c. Complementation analysis d. Multiple alleles • Lethal alleles (recessive and dominant lethal alleles)-Penetrance and expressivity • Quantitative inheritance: a. Traits controlled by many loci. b. Location of polygenes c. 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.	**1C/15H**
Unit: II	***Molecular Biology- I*** • DNA replication, repair and recombination- Meselson-Stahl experiment, Enzymes involved in prokaryotic and eukaryotic	**1C/15H**

	replication, Structure of DNA polymerase-III(Prokaryotes), Unit of replication (Prokaryotic and Eukaryotic replication process)- Initiation, Elongation and termination fidelity of replication, extrachromosomal replicons (Plasmid and Mitochondria). • DNA damage and repair mechanisms (Direct repair- Photoactivation, Alkylation and Methyltransferase; Single stranded repair- Base excision repair, Nucleotide excision repair and Mis-match repair), Double stranded repair- homologous and non-homologous repair, site-specific recombination.	
Unit: III	***Molecular Biology- II*** • RNA synthesis and processing- Structure and function of different types of RNA, RNA transport transcription factors and machinery (Prokaryotes and Eukaryotes), formation of initiation, elongation andtermination complex. RNA polymerases, capping, RNA processing, RNA editing, splicing, and polyadenylation. • Protein synthesis and processing- Ribosome, Prokaryotes and Eukaryotes- Formation of initiation complex, Initiation factors & theirregulation, elongation and elongation factors, termination. • Genetic code, Aminoacylation of tRNA, t-RNA identity, Aminoacyl oftRNA synthetase, Translational proof reading. • Post translational modifications.	**1C/15H**
RPSZOOPE513	**Practical based on: Genetics and Molecular Biology**	**Credit 1**
1.	Temporary squash preparation of onion/garlic root tip cells to study stages of mitosis.	
2.	Temporary squash preparation of Tradescantia pollen to study stages of meiosis.	
3.	Temporary preparation of polytene chromosomes from salivary gland cells of Chironomus larva	
4.	Quantitative estimation of DNA in a suitable tissue- comparative study- by diphenyl amine method.	
5.	Quantitative estimation of RNA in a suitable tissue-comparative study by orcinol method.	
6.	Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis.	
7.	Restriction-digest the given DNA sample & demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided.	

References:

1. Epstein, R. J. (2003): Human Molecular Biology. Cambridge Univ. Press, Cambridge
2. 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.
3. Alberts, B, Johnson, J Lewis, M. Raff, K Roberts and P. Watter. (2014): Molecular Biology of the cell. 6th edition. Garland Science, New York.
4. 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.
5. Brachet, J. (1985) Molecular Cytology, Academic Press, N. Y.
6. Pollard, T. D. and W. C. Earnshaw. (2002): Cell Biology. Saunders.
7. Forensic Science in India and the World, Deepak Ratna and Mohd. Zaidi, Alia Law Agency, Allahabad.
13. Fundamentals of Forensic Science, Second Edition, Max M. Houck and Jay A Siegel, Academic Press.
14. Forensic Science, Third Edition, Stuart H James and Jon. J. Nordby.
15. Forensic Biology, Richard Li, CRC Press.
16. Forensic Science: An introduction to Scientific and Investigative Techniques by S. H James, J. J. Nordby.
17. Illustrated Guide to Home Forensic Science Experiments by Robert Bruce Thompson and Barbara Fritchman Thompson, First Edition. (Online Pdf available)

Discipline Specific Core Course

Course Code: RPSZOOE514

Course Title: Bioinformatics and Molecular Modeling

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOMES	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Evaluate the broad concepts of Bioinformatics.
CO2	Demonstrate efficacy studies in the experimental techniques for any biological project.
CO 3	Enumerate the broad concept of molecular modeling, chirality & stereochemistry.
CO 4	Illustrate the molecular dynamics simulation, its major steps and various simulation models.

RPSZOOE514	Title: Bioinformatics and Molecular Modeling	Credits/Hours
Unit: I	***Bioinformatics***	**1C/15H**

	• 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.	
Unit: II	***Molecular Modeling & Molecular Dynamics simulations*** • Concept of molecular modeling, chirality & stereochemistry. • Theory and practice of energy minimization, Monte Carlo. Definition of the potential energy surface of a molecule, force field and generic form of a force field. Differences between molecular mechanics energy and the quantum mechanical energy of a system. • Differences between Class I, Class II and Class III force fields**.** Parametrization of a forcefield. • Molecular dynamics simulation: Major steps, simulation models such as coarse grained, bead rod and bead spring models, Ensembles- microcanonical, canonical, isobaric-isothermal & grand canonical ensembles.	**1C/15H**

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1**.** Bioinformatics: concepts skills and applications (2004). S.C. Rastogi, N. Mendiratta and P. Rastogi.
2. Bioinformatics: A modern approach. (2005) V.R. Srinivas.
3. Essential Bioinformatics (2006). J. Xiong.
4. Statistical methods in Bioinformatics: An introduction. (2005). W. Even and G. Grant
5. Bioinformatics: A Practical Approach 2007 Shui Qing (Chapman & Hall/CRC Mathematical and Computational Biology.
6. P. Clote and R. Backofen. 2000. Computational Molecular Biology: an Introduction. Wiley and Sons.
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8. A. Leach. 2001. Molecular modeling- principles and applications. Pearson Education Ltd.
9. F. J. Burkowski. 2008. Structural bioinformatics: An algorithmic approach. CRC Press.
10. A. K. Konopka and M. J. Crabb. 2004. Compact handbook of computational biology. Marcel Dekker, New York.

Course Code: RPSZOOE515

Course Title: Field Project

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Gain practical and theoretical knowledge about particular area of bioprospecting, toxicology, ecology and interdisciplinary studies.
CO2	Be able to set the work in the context of work done by other experimentalists, and provide a concise summary of relevant literatures.
CO 3	To design experiments to answer the particular question posed, and critically aanalyses and interpret research findings using statistical tools, instrumentation techniques and biochemical analysis.
CO 4	Communicate personal ideas and thoughts which will help them to work independently and as part of a team.

RPSZOOE515	**Field Project**	**Credits 4**

Discipline Specific Elective

Course Code: RPSZOOE516

Course Title: Marine Bioprospecting

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Summarize about the advancements in the field of bioprospecting, specifically focusing on marine bioprospecting.
CO2	Enumerate the significance of marine organisms in bioprospecting.
CO 3	Enlist the significance of marine bio actives in marine nutraceuticals, pharmaceuticals and cosmeceuticals.
CO 4	Explore new technologies involved in extraction of marine bioactive.
CO 5	Performing suitable techniques for the extraction of oil from different marine fishes and performing the transesterification technique to detect different fatty acids present in the extracted sample using the GCMS instrumentation technique.
CO 6	Perform qualitative estimation of secondary metabolites from molluscan.

RPSEZOOE614	Title: Marine Bioprospecting	Credits/Hours
Unit: I	***Introduction and Bioprospecting from Marine organism*** • Introduction to Bioprospecting • Marine Ecosystems and its functioning • Marine organisms' diversity in marine environment (Invertebrates and Vertebrates) • Scope and Significance of marine organisms in bioprospecting • Recent trends in marine bioprospecting • Marine organisms: a new biomedical resource and their Bioactive metabolites • Discussion and prospects for the future.	**1C/15H**
Unit: II	***Marine Nutraceuticals, Cosmeceuticals and Pharmaceuticals*** • Introduction to Marine sources as healthy foods: Seaweeds, Microalgae, Fish and Fish by-products, Crustaceans, Marine fungi and bacteria	**1C/15H**

	• Brief introduction of Marine derived ingredients with biological properties: Polysaccharides, Proteins, Peptides and amino acids, Fatty acids, Pigments, Phenolic compounds. • Marine Cosmeceuticals: Components of cosmetics a) Target organ and cosmetic delivery system b) Biological activities of cosmeceuticals: Photoprotective and anti-photoaging, Anti-wrinkling and skin regeneration, Depigmenting or whitening, antimicrobial activity. • Ethical aspects of utilizing marine flora and fauna for bioprospecting. • Pharmaceutical compounds from marine flora and fauna: Marine toxins, Marine antiviral, Marine Biotoxins • Approved Marine Drugs as Pharmaceuticals a) Ziconotide b) Eccteinascidins c) Cytarabine and Vidarabin • Marine Natural Products in Advanced Clinical trials	
Unit: III	***Isolation and Separation Techniques- Marine Extract*** • Introduction • Separation Techniques: a) Water soluble constituents b) Electrophoresis- Protein/Nucleic acid c) Reverse-phase (RP) columns d) High/medium pressure chromatography e) Combination of ion-exchange and size-exclusion chromatography • Bioassay Directed Fractionation • General Fractionation • Isolation Procedures: a) Amino acids and simple peptides b) Peptides c) Nucleosides d) Cytokinins e) Alkaloids	**1C/15H**
RPSEZOOPE 614	**Practical Title: Marine Bioprospecting**	**Credit 1**
1.	Extraction of Chitosan and Chitin from Crustacean shell waste.	
2.	To estimate the antioxidant activity of a marine extract.	
3.	Preparation of any one marine extract using a marine invertebrate. (*Natica / Nerita*).	
4.	Comparative evaluation and extraction of fish oil using dry and wet mackerel samples using Soxhlet method.	

5.	Comparative evaluation and extraction of fish oils using any two fish samples available on Mumbai coast. (Oil sardine / Shark liver)	
6.	Qualitative estimation of secondary metabolites (Alkaloids, Flavonoids, Tannins, Saponins) from a marine organism extract.	
7.	Gas Chromatography Mass Spectroscopy (GCMS) working, analysis and interpretation of data. (Demonstration practical).	
8.	HPLC working, analysis and interpretation of data. (Demonstration practical).	
9.	Culturing of algae.	
10.	Visit to one research institute (related to practical).	
11.	Visit to shore or intertidal areas.	

References:

1. Pharmaceutical and bioactive natural products, volume 1; Attaway and zaborsky, Plenum press, New york and London
2. Marine Microbiology: Ecology and applications. 2nd edition, Colin Munn, Garland science, Taylor and Francis group, LLC
3. Marine Biotechnology: Pharmaceutical and bioactive natural products, volume 1; Attaway and zaborsky, Plenum press, New york and London
4. Marine Microbiology: Ecology and applications. 2nd edition, Colin Munn, Garland science, Taylor and Francis group, LLC
5. Marine Biotechnology, 1st Edition, HPH, Shobha Govil, 2021
6. Bioactive Marine Natural Products, Springer, D.S. Bhakuni and D.S. Rawat, 2005, ISBN 1-4020-3484-9 (e-book)
7. Standard Methods of Biochemical Analysis, Thimmaiah S.K., 2nd Edition, Kalyani Publishers, ISBN-13 : 978-9327264463

Modality of Assessment

Modality of Assessment-DSC/DSE

Theory Examination Pattern:

A. Internal Assessment- 40%- 30 Marks

Sr. No	Evaluation type	Marks
1	Class Test/ Project / Assignment / Presentation	20
2	Class Test/ Project / Assignment / Presentation	10
	TOTAL	**30**

B. External Examination (Semester End)- 60%- 45 Marks

Semester End Theory Examination:

Duration – The duration for these examinations shall be of two hours.

Theory Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Any three out four	15	Unit-I
Q.2	Any three out four	15	Unit-II
Q.3	Any three out four	15	Unit-III
	TOTAL	**45**	

C. Practical Examination Pattern- 25 Marks

Sr No	Evaluation type	Marks
1	Journal	2
2	Viva & Practical Tasks	23
	TOTAL	**25**

Modality of Assessment-DSC – 2credit

Question	Unit	Options	Marks
Q.1	I	Any two out of three	20
Q.2	II	Any two out of three	20
Q.3	I & II	Short notes: Any two out of three	10
Total			**50**

Overall Examination and Marks Distribution Pattern
Semester-II

Course	RPSZOOE511 RPSZOOE512 RPSZOOE513 RPSZOOE516		Total of 4 Courses		RPSZOOE514	RPSZOOE515	Total
	Int	Ext	Int	Ext	External	Field Project	
Theory	**30**	**45**	**120**	**180**	**50**	**100**	**450**
Practical	**25**		**100**		**---**	**---**	**100**
Grand Total							**550**

Semester-III
Academic year 2024-2025

Paper Code	Unit	Topic	Credits
RPSZOOO601		**DSC- Life Processes -I**	
	I	Nutritive System	3
	II	Physiology of Respiration	
	III	Circulation and fluid mechanics	
RPSZOOO602		**DSC- Life Processes-II**	3
	I	Neurophysiology	
	II	Sensory and Effector Physiology	
	III	Endocrinology	
RPSZOOO603		**DSC- Immunology and Cancer Biology**	3
	I	Immunology-I	
	II	Immunology-II	
	III	Cancer Cell Biology	
RPSEZOOO604		**DSE offered by Department of Zoology- Introduction to Model organisms**	3
	I	Hydra and Drosophila	
	II	Zebrafish	
	III	*Caenorhabditis elegans*	
RPSEBOTO604		**DSE offered by Department of Botany- Bioprospecting for Industrial Molecules**	3
	I	Bioprospecting for crop protection and anti-microbial products	
	II	Algal Biomass for high-value biomolecules	
	III	Bioprospecting for flavours and fragrance	
RPSELScO604		**DSE offered by Department of Life science- Environmental Biology, Evolution and Astrobiology**	3
	I	Environmental biology	
	II	Current Environmental Issues in India and Biodiversity Management	
	III	Evolution and Astrobiology	
Practical			
RPSZOOPO601		**Life Processes -I**	1
RPSZOOPO602		**Life Processes -II**	1
RPSZOOPO603		**Immunology and Cancer Biology**	1
RPSEZOOPO604		**Introduction to Model organisms/ Bioprospecting for Industrial Molecules/ Environmental Biology, Evolution and Astrobiology**	1
RPSRPZOOO605		**Research Project**	6
Grand Total			**22**

Course Code: RPSZOOO601

Course Title: Life Processes-I

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Outline the nutritive system, food processing, nutritive types and significance of Probiotics in therapeutic nutrition.
CO 2	Explain the chemistry of respiration and analyse the behavior of respiratory system in vertebrates and role of medulla in respiration process.
CO 3	Analyse the behavior of respiratory system in vertebrates and role of medulla in respiration process.
CO 4	Justify rheology, comparative account of circulation in vertebrates and circulatory disorders in human.
CO 5	Perform the gut physiology and determine activities of digestive enzymes from suitable organism.
CO 6	Demonstrate the effect of beta blockers on heart rate of 48 hours chick.

RPSZOOO601	Title: Life Processes-I	Credits/Hours
Unit: I	***Nutritive System*** • Filter feeding - Pisces, Flamingo • Reptiles (Jacobson's organ) • Specialized compartmentalization of digestive system in vertebrates- a) Intestinal modification in herbivore and carnivore b) Intestine in fish, bird and mammal • Digestion: a) Bulk movement and peristalsis • b) Comparative biochemistry of digestion c) Neural and hormonal regulation of secretion of digestive enzymes.	**1C/15H**

	• 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.	
Unit: II	***Physiology of Respiration*** • Comparative study of Respiratory system in vertebrates: a) Aquatic, terrestrial, gas exchange in terrestrial eggs b) Reparative adaptations in African lungfish • Chemistry of respiration: a) Composition of atmospheric and expired air b) Aerodynamic Sub-division of air in the lungs c) Regulation of lung breathing. d) Transport of gases in the blood e) Diffusion of gases in the lungs f) Transport of CO2 in the blood g) 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 a) Chemoreceptor b) Mechanoreceptor and Ventilation reflexes c) Oxygen equilibrium curve and its significance • Manifestation of variation in hemoglobin saturation a) Oxygen toxicity b) Carbon monoxide poisoning c) Reparative distress during Fire hazards.	**1C/15H**
Unit: III	***Circulation and fluid mechanics*** • Rheology: a) Viscosity, Poiseuille (PI) b) Hagen flow formula c) Laminar and turbulent flow Resistance d) Pressure, velocity and gravity • Comparative account of Circulation in Vertebrates a) Lung fish b) Amphibians c) Reptiles	**1C/15H**

	d) Bird e) Special reference to Aortic arches, hepatic portal and renal portal circulations. • Introduction to Human circulatory system: a) Heart structure, working and major blood vessels b) Cardiac cycle c) Stroke volume SV d) Cardiac output CO e) ECG f) Sphygmomanometer • The buffer system of the blood a) Haemoglobin buffer b) 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. a) Beta blockers b) ACE inhibitors c) Calcium channel blockers	
RPSZOOPO601	**Practical Title: Life Processes-I**	**Credit 1**
1.	Determination of activities of digestive enzymes viz. Amylase, Trypsin in suitable animals (e.g., prawn/ crab/ cockroach/ chicken, etc.)	
2.	Effect of xenobiotics on digestive enzyme activity of any suitable animal (cockroach).	
3.	To study Drosophila gut physiology.	
4.	LDH isoenzymes isolation and detection using agarose gel electrophoresis in heart /skeletal muscle of any suitable animal (e.g., Chicken heart)	
5.	Effect alpha blocker/ beta blockers on heart rate of 48 hours of chick.	
6.	Problems related to Cardiac output.	

References:

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2. Darnell, Loddish, Baltimore: “Molecular Cell Biology” Scientific American Books.
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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.
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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.
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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

Course Code: RPSZOOO602

Course Title: Life Processes- II

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Contrast the structural, functional dimensions of neurophysiology, physiology of addiction and Neurophysiological disorders.
CO 2	Explain the different types of senses and its physiology.
CO 3	Evaluate curious questions on COVID 19 related loss of sense of smell and taste.
CO 4	Explain the various endocrine glands of vertebrates, their position, microanatomy, hormones and complex interrelationship between them and develop employable skill related to endocrine glands.
CO 5	Perform the anatomical study of nervous system from the suitable organism.

CO 6	Determine the levels of glucose before and after eyestalk ablation in crab and will be able to conclude and interpret their findings.

RPSZOOO602	**Title: Life Processes-II**	**Credits/Hours**
Unit: I	***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 a) Nerve nets b) Ladder like nervous system of Platyhelminthes c) Gangliolated nervous system of Annelida and Arthropods • Nervous tissue- Neurons, Glial cells and its type. • Integrative neurophysiology: Interneuron's, Neural circuits • Neurotransmitters a) Excitatory b) Inhibitory • Brain plasticity • Neurophysiological disorders a) Alzheimer b) Parkinson c) Dementia • Physiology of addiction. a) Alcohol addiction b) Addiction to psychotic drugs (Cocaine, Opioids, Ecstasy).	**1C/15H**
Unit: II	***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 thermoreceptors.	**1C/15H**

	• 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.	
Unit: III	***Endocrinology*** • 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: Thymus, Placenta, Corpus Luteum, GI tract, Kidney, Heart.	**1C/15H**
RPSZOOPO602	**Practical Title: Life Processes-II**	**Credit 1**
1.	Study the nervous system from the suitable organism.	
2.	Estimation of blood glucose before and after eye stalk ablation in Crab.	
3.	Estimation of calcium level in given blood sample.	
4.	Estimation of acetylcholinesterase activity to evaluate the toxicity of xenobiotic compounds.	
5.	Effect of adrenaline on fish chromatophores.	
6.	Preparation and submission of slides of adrenal, ovary and testis in vertebrate (Goat / Chicken) using microtomy techniques.	

Reference:

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.
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12. Norris: Vertebrate Endocrinology 4th Ed.2007 Elsevier)
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14. Chandra S. Negi (2015). Introduction to Endocrinology - PHI Learning, Pvt.Ltd. New Delhi.
15. Endocrinology-P.R.Yadav, Discovery publishing House Ltd. New Delhi.
16. Endocrinology, Hormones and Human Health-Prakash S. Lohar, MJP Publisher, Chennai.
17. Franlyn F. Bolander, Molecular Endocrinology – (Third Edition), Academic Press, An Imprint of Elsevier, California, U.S.A.
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21. Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi.
22. Hochachka, P.W. and Somero, G.N. 1984. Biochemical Adaptation. Princeton University Press, New Jersey.
23. Ian Kay.1998. Introduction to Animal Physiology. Bios Scientific Publishers Ltd., Oxford, UK
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25. Knut Schmidt-Neilsen. 1997. Animal physiology: Adaptations and Environment Cambridge University Press
26. Moyers, D.C and Schulte,P.M. 2007. Principles of Animal Physiology (2nd edn). Benjamin Cummings, CA, USA
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28. Randall, D., Burgrenn, W. and French, K. 1997. Eckert Animal physiology. W.H. freeman & Co,New Yok.

Course Code: RPSZOOO603

Course Title: Immunology and Cancer Biology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain the immune response in human systems.
CO 2	Summarize the camel nanobodies and its significance in human health care.
CO 3	Comment on monoclonal antibodies and its role in hybridoma technology and therapeutics.
CO 4	Evaluate various factors involved in development of Cancer.

CO 5	Compare different types of vaccines and its application in human health care with special reference to various COVID-19 vaccines.
CO 6	Perform the experiments based on antibody and antigen reactions based on precipitation and agglutination reaction.

RPSZOOO603	**Title: Immunology and Cancer Biology**	**Credits/Hours**
Unit: I	***Immunology-I*** • Overview of the immune systems: Antigen and immunogenicity, Clonal selection theory, Antibodies (vertebrates & invertebrates). Camel nanobodies (Mini- antibodies) and their significance in human healthcare • Antigen recognition by immune cells: Innate Immunity- Pattern recognition in the innate immune system, TLRs and their role in innate immune response, Adaptive Immunity-Antibody structure, Antigen recognition by B lymphocytes, Molecular mechanism behind BCR formation, B lymphocyte development and survival. • Production of effector T-lymphocyte development and survival, Antigen recognition by T-cells, T- cells, Cytotoxic T- cell • Effector mechanisms and regulation of immune responses: Induced innate response to infection, Innate memory, Complement system, NK and NKT cell functions, Humoral immune response, Interferons, cytokines, chemokines in immune response, Cytokine storm. • Structure and function of MHC complex: Antigen processing cells, Antigen processing and presentation to T lymphocytes, MHC restriction. • TCR structure and function: Signaling through TCR and T-cell activation, co- receptors and their role in T –cell functioning, Co-stimulation.	**1C/15H**
Unit: II	***Immunology-II*** • Monoclonal antibodies**:** Hybridoma technology, Therapeutic MABs, (e.g., Tacilizumab, Basiliximab, blinatumomab) • Immunity in health and disease: Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases, Immunity and Infection, Tumor-immunology, Transplantation. • Types of Vaccines: Live recombinant vaccines and Attenuated vaccines • Vector Vaccines-Vaccine directed against viruses-Rabies virus G-	**1C/15H**

	protein, Hepatitis B surface antigen. Anti-idiotypic vaccine for cancer treatment, Multivalent subunit vaccine. • 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	
Unit: III	***Cancer 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.	**1C/15H**
RPSZOOPO 603	**Practical Title: Immunology and Cancer Biology**	**Credit 1**
1.	Performance of Ouchterlony technique to demonstrate immune diffusion.	
2.	Demonstration of single radical immune-diffusion of antibody and antigen.	
3.	Study of Tube Agglutination Reaction.	
4.	Study of Slide Agglutination Reaction.	
5.	Study of Indirect Agglutination Inhibition Reaction.	
6.	Antibiotic Sensitivity test.	

References:

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

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12. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.
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Discipline Specific Elective Course offered by Department of Zoology

Course Code: RPSEZOOO604

Course Title: Introduction to Model organisms

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enlist the different types of Hydras and its advantages as a model organism.
CO 2	Explain the Symbiotic association of *Hydra* with algae and Different types of cells in *Hydra*
CO 3	Summarise topics like Embryonic development, body axis formation, Larval stages, and metamorphosis and adult morphology of Drosophila.
CO 4	List the advantages of using Drosophila as a model organism.
CO 5	Differentiate male and female zebrafish and comprehend the developmental stages of zebrafish.
CO 6	Comprehend the importance of zebrafish as a versatile research and education model.
CO 7	Brief the anatomy and lifecycle of *Caenorhabditis elegans.*
CO 8	Perform the maintenance of Hydra, Drosophila, Zebrafish and C. elegans.

RPSEZOOO604	Title: Introduction to Model organisms	Credits/Hours
Unit: I	***Hydra & Drosophila*** • **Hydra as a model organism**: a) Introduction to *Hydra as a model system* b) Advantages of *Hydra* as model organism c) Different types of *Hydras* d) Basic requirement to set up *Hydra* system e) Symbiotic association of *Hydra* with algae f) Setting up Artemia hatchery (temperature, salinity, pH, lifecycle and nutritional value), g) *Hydra* regeneration, h) Different types of cells in *Hydra* • **Drosophila as a model organism**: a) Introduction to *Drosophila* as a model system b) Advantages of *Drosophila* as model organism c) Basic requirement to set up *Drosophila* lab d) Adult morphology e) Embryonic development f) Formation of body axis g) Larval stages and metamorphosis • Importance of *Hydra* & *Drosophila* as a versatile research and education model.	**1C/15H**
Unit: II	***Zebrafish*** • Introduction to zebrafish as model system • Advantages of zebrafish model organism • Basic requirement to set up zebrafish lab • Setting up zebrafish husbandry • To prepare zebrafish feed and culture *Paramecium* • Nutritional requirements • Handling zebrafish, identify male and female zebrafish • Breeding, Egg collection and study of developmental stages starting from the zygote - cleavage - blastula - gastrula - segmentation, pharyngula, hatching and early larval development. • Importance of zebrafish as a versatile research and education model. • Genetic and morphological homology with humans.	**1C/15H**
Unit: III	***Caenorhabditis elegans*** • Introduction to *C. elegans* as model system	**1C/15H**

	• Anatomy of *C. elegans* • Lifecycle and different larval forms, • Advantages of *C. elegans* as model organism • Basic requirement to set up *C. elegans* system • Use of *C. elegans* as model system	
RPSEZOOPO 604	**Practical Title: Introduction to Model organisms**	**Credit 1**
1.	*Hydra* media preparation.	
2.	Study of *Hydra* regeneration.	
3.	Setting up Artemia hatchery.	
4.	Culturing and maintaining *Drosophila*.	
5.	Study of life cycle and developmental stages of *Drosophila melanogaster.*	
6.	To study different mutants of *Drosophila.*	
7.	To set up a zebrafish maintenance system.	
8.	Setting up breeding for zebrafish.	
9.	To study different behavioural patterns of zebrafish: Novel tank test, Mirror biting test, Predator avoidance, Light and dark test.	
10.	Culturing and maintaining *C. elegans.*	

References:

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2. Sunita Joshi, S. and Dhamija, N. (2016) Rediscovering Genetics, IK International, 1st edition, ISBN: 9789384588984
3. Westerfield, M. (2000). The Zebrafish book. A guide for laboratory use of Zebrafish (Danio rerio). 4th ed., Univ. of Oregon Press, Eugene. USA
4. Mudgal, P., Bhasin, C., Joshi A., Gupta, R. (2021) Zebrafish, a versatile learning tool. Resonance: Journal of science education, 26(11), 1499-1521
5. Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B. and Schilling, T.F. (1995), Stages of embryonic development of the zebrafish. Dev. Dyn., 203: 253-310. https://doi.org/10.1002/aja.1002030302
6. http;//www.zfic.org
7. Westerfield, M.; The zebrafish book; A guide for the laboratory use of zebrafish (Danio rerio) 4th edition (2000), University of Oregon Press, Eugene.
8. Hedges, S. B.; The origin and evolution of model organisms. Nat. Rev. Genet.3; 838- 849 (2002).
9. Grimmelikhuijzen, C.J.P. and Schaller, H. C.; "Hydra as a model organism for the study of morphogenesis." Trends in Biochemical Sciences 4, 12; 265-267 (1979).
10. Galliot, B.; Hydra, a fruitful model system for 270 years; International Journal of Developmental Biology, 56, 411-423 (2012).

11. Beckingham, K. M., Armstrong, J. D., Texada, M. J., Munjaal, R. and Baker, D. A.; Drosophila melanogaster: The model organism of choice for the complex biology of multi- cellular organisms. Gravitational and Space Research, 18(2) (2007).

Discipline Specific Elective Course offered by Department of Botany

Course Code: RPSEBOTO604

Course Title: Bioprospecting for Industrial Molecules

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Describe the role of entomotoxic proteins in crop protection.
CO 2	Enumerate the different extraction methods of natural sources for flavours and fragrances.
CO 3	Interpret the role of algae and plant products in bioprospecting.
CO 4	Comment on the economic potential of biological resources for obtaining industrial molecules of pharmaceutical, bioceutical & agricultural value.
CO 5	Elaborate on the plant resources as antimicrobials by testing their antimicrobial activity.
CO 6	Separate proteins using PAGE and check its anti-insecticidal activity.
CO 7	Extract essential oil from a crude material by hydro-distillation.

RPSEBOTO 604	Title: Bioprospecting for Industrial Molecules	Credits/Hours
Unit: I	***Bioprospecting for crop protection and anti-microbial products*** • Introduction to Bioprospecting, its significance and recent trends in bioprospecting. • Entomotoxic proteins to control the crop insect pests and mechanism of insecticidal activity: • Lectins, Ribosome-Inactivating Proteins (RIPs), Arcelins, Defensins, Cyclotides (two examples of each) • Use of plant products as antimicrobials: Historical perspective. • Major groups of Plant-derived antimicrobial compounds: a. Phenols and Phenolic acids, Terpenes and Essential oils, b. Alkaloids (any two examples of each) • Mechanisms of Antimicrobial activity: Plant extracts with efflux Pump Inhibitory Activity, Bacterial, Quorum Sensing Inhibitory Activity, Biofilm Inhibitory Activity.	**1C/15H**
Unit: II	***Algal Biomass for high-value biomolecules*** Algae in high-value biomolecule production:	**1C/15H**

	• Polyphenols • Polysaccharides • Fatty acids • Pigments	
Unit: III	***Bioprospecting for flavours and fragrance*** Physiological mechanism of biosynthesis of essential oils: • Metabolic cycles of biosynthesis of Phenolic compounds. • Methods of extraction of natural sources for flavours and fragrances. • Designing of flavours and fragrance. • Sensory evaluation	**1C/15H**
RPSEBOTPO604	**Practical Title: Bioprospecting for Industrial Molecules**	**Credit 1**
1	Anti-microbial activity of plant extracts by disc diffusion method/ well diffusion method/ MIC method.	
2	Protein profiling by PAGE (seed proteins).	
3	Applications of proteins to control insect pests.	
4	Fractional distillation of essential oils (mint/citronella/Chafa).	
5	Creation of flavours & fragrances and practical demonstration.	
6	Estimation of fragrance / flavours	
7	Application of fragrances in cosmetics, food Agarbatti, Soap, Cream, Talcum Powder etc.	

References:

1. Ramya Krishnan, Sudhir P. Singh, and Santosh Kumar Upadhyay. 2021. An introductionto Plant Biodiversity and Bioprospecting. Wiley Publications.

2. Surjeet Kumar Arya, Shatrughan Shiva, Santosh Kumar Upadhyay. 2021. Entomotoxic Proteins from Plant Biodiversity to Control the Crop Insect Pests. Wiley Publications.

3. Pankaj Kumar Verma, Shikha Verma, Nalini Pandey, and Debasis Chakrabarty. 2021.Antimicrobial products from plant Biodiversity. Wiley Publications.

4. Dinesh Kumar Yadav, Ananya Singh, Variyata Agrawal, Neelam Yadav. 2021. AlgalBiomass: A Natural Resource of High-Value Biomolecules. Wiley Publications.

5. Monica Butnariu. 2021. Plants as Source of Essential Oils and Perfumery Applications.Wiley Publication

Discipline Specific Elective Course offered by Department of Life Science

Course Code: Course Code: RPSELScO604

Course Title: Environmental Biology, Evolution and Astrobiology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain ecological concepts, national and international environmental issues and concepts in evolution which forms the basis of phenomena like antibiotic resistance as well as cancer progression.
CO 2	Apply ecological concepts to their day-to-day life to benefit the environment and use various essential software that will help them in their respective careers.
CO 3	Explain the magnitude and distribution of biodiversity and its economic value. Describe the concepts of bioprospecting, ecotourism, and biodiversity management approaches. Examine the biodiversity of India and the importance of its conservation.
CO 4	Identify the major events and dates that provide the structure for geologic time on Earth.
CO 5	Analyse the age of fossils with the help of radio dating techniques.
CO 6	Explain the concepts of astrobiology, including the planetary habitability, extremophiles, abiogenesis, research on surviving extreme habitats, evolution of advanced life, and the astrobiology of Mars.
CO 7	Arrange data and determine diversity indices for a population study and perform probit analysis for toxicological studies.
CO 8	Identify and explain features of various fossils and aquaculture specimens.

RPSELScO 604	Title: Environmental Biology, Evolution and Astrobiology	Credits/Hours
Unit: I	***Environmental biology*** • Ecosystems: Types of ecosystems [terrestrial (Tropical evergreen forests, Tropical deciduous forests, Deserts, Chaparral, Temperate grasslands, Savannahs and thorn forests, Temperate deciduous forests, Boreal forests/ Taiga, Tundra) and aquatic (Lentic, Lotic, Oceans, Estuaries, Coral reefs)], Habitat fragmentation and niche overlap,	**1C/15H**

	Competitive exclusion principle, resource partitioning, character displacement and resource management and conservation. • Community ecology: Nature of communities; fundamental properties of biological communities (Productivity, Diversity, Complexity, Resilience, Stability, Structure); levels of species diversity and its measurement (Simpson, Shannon and Sorensen indices); edges and ecotones, Succession, disturbances and invasion. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. • Population ecology**:** Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation, demes and dispersal. • Toxicology: Basic principles of toxicology including LD50 and ED50, management of acute intoxication.	
Unit: II	***Current Environmental Issues in India and Biodiversity Management*** • Biodiversity**:** Concept, characterization, generation, maintenance and loss, Magnitude and distribution of biodiversity, economic value, bioprospecting, ecotourism and biodiversity management approaches. Biodiversity of India. • Conservation biology: Principles of conservation, major approaches to management, conservation strategies. • Forest Conservation – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register. • Wild life conservation projects: Project Tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision. • Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States. • Water conservation- Watersheds, Rain water harvesting and ground water recharge. • National river conservation plan – Namami Gange and Yamuna Action Plan. • Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India. • Soil erosion, desertification and Save Soil Movement**.** • Climate change - adaptability, energy security, food security and sustainability. Carbon sequestration and carbon credits. • Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Tragedy, 1984, Chernobyl Disaster, 1986, Fukusima	**1C/15H**

	Daiichi nuclear disaster, 2011. • Local environmental issues – Mithi river pollution, Destruction of mangroves, Coastal aquafarming and challenges, Air quality index of Mumbai, Dumping grounds, Urban development projects at Aarey colony and Sanjay Gandhi National Park.	
Unit: III	***Evolution and Astrobiology*** • Emergence of evolutionary thoughts**:** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Types of selection; Speciation – Punctuated equilibrium and phyletic gradualism; Modern evolutionary synthesis. Origin of cells and unicellular evolution • Palaeontology and evolutionary history**:** Introduction to time scales, origins of unicellular and multicellular organisms; major groups of plants and animals; Mass extinction events; Adaptive radiation, convergent evolution and coevolution; Primate evolution, Carbon dating, fossils. • Molecular Evolution**:** Concepts of neutral evolution, molecular divergence and molecular clocks; origin of new genes and proteins; gene duplication and divergence, molecular taxonomy. • Astrobiology**:** Concepts, planetary habitability, extremophiles, abiogenesis, research on surviving extreme habitats, evolution of advanced life, astrobiology of Mars.	**1C/15H**
RPSELS cPO604	**Practical Title: Environmental Biology, Evolution and Astrobiology**	**Credit 1**
1.	Analysing the floral origin of pollen grains in honey.	
2.	Determination of the Simpson's diversity index/ Shannon index of a given population.	
3.	Effect of toxicity on *Daphnia* / *C. elegans* / Yeast / Pollen grains and Probit analysis.	
4.	Effect of space vacuum/ cosmic radiation on bacteria	
5.	Identification of fossil specimens.	

References:

1. The Cambridge Encyclopedia of Human Evolution (Cambridge Reference Book) by Steve Jones.
2. Evolution by Monroe W. Strickberger, CBS publishers and distributors.
3. Astrobiology: An Introduction by Alan Longstaff, CRC Press.
4. Astrobiology: A brief introduction by Kevin W. Plaxco and Michael Gross, The Johns Hopkins University Press.
5. Biodiversity, Wilson E.O. (Ed.), National Academy Press, Washington, D. C.
6. Understanding Biodiversity by David Zeigler (May 30, 2007): Amazon Press.
7. Fundamentals of Ecology by E.P. Odum, Cengage publishers.

8. Ecology and environment by P.D. Sharma, Rastogi publications.
9. Elements of Ecology by Smith and Smith, Pearson publishers.
10. Environmental Biology edited by Mike Calver*et al*: Cambridge University Press.
11. Molecular Environmental Biology by Seymour J. Garte, Lewis Publishers (1994)
12. Basic Environmental Toxicology, Lorris G. Cockerham& Barbara S. Shane, CRC Press.
13. Environmental Toxicology, David Wright and Pamela Welbourn, Cambridge university press

Course Code: RPSRPZOOO605

Course Title: Research Project

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Gain practical and theoretical knowledge about particular area of bioprospecting, toxicology, ecology and interdisciplinary studies.
CO2	Set the work in the context of work done by other experimentalists, and provide a concise summary of relevant literatures.
CO 3	Design experiments to answer the particular question posed, and critically aanalyses and interpret research findings using statistical tools, instrumentation techniques and biochemical analysis.
CO 4	Communicate personal ideas and thoughts which will help them to work independently and as part of a team.

RPSRPZOOO605	**Research Project**	**Total Credits 6**
	Marks- 150	

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 30%- 30 Marks

Sr. No.	Evaluation type	Marks
1.	Two Assignments/Case study/Project/Research paper review	10
2.	One class Test (multiple choice objective question+ Subjective)	20

B) External Examination- 45%- 45 Marks

Semester End Theory Examination:

- Duration - These examinations shall be of **2 hours** duration.

Theory Question Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Any three out four	15	Unit-I
Q.2	Any three out four	15	Unit-II
Q.3	Any three out four	15	Unit-III
	TOTAL	**45**	

Practical Examination Pattern:

External Examination: 25

Particulars	Marks
Journal	02
Experimental tasks/ Viva	23
Total	25

Overall Examination and Marks Distribution Pattern
Semester-III

Course	RPSZOOO601 RPSZOOO602 RPSZOOO603 RPSZOOO604		**Total of 4 Courses**		**RPSRPZOOO605**	**Total**
	Int	**Ext**	**Int**	**Ext**	**Research Project 150**	
Theory	**30**	**45**	**120**	**180**		**400**
Practical	**25**		**100**			**150**
Grand Total						**550**

Semester IV

Academic year 2024-2025

Paper Code	Unit	Topic	Credits
RPSZOOE611	**DSC- Life Processes-III**		
	I	Thermoregulation	3
	II	Muscle Physiology	
	III	Osmoregulation and Excretion	
	DSC- Animal Biotechnology		
RPSZOOE612	I	Laboratory Animals in Biotechnology	3
	II	Testing for Endocrinological and Reproductive Biological studies	
	III	Animal Tissue Culture	
RPSEZOOE613	**DSE- Clinical Toxicology**		
	I	Basic toxicology	3
	II	Organ toxicity	
	III	Clinical trials	
Practical			
RPSZOOPE611		Practical based on Life Processes-III	1
RPSZOOPE612		Practical based Animal Biotechnology	1
RPSEZOOPE613		Practical based on Clinical Toxicology	1
RPSINTZOOE614		Research Project/ Internship	10
Grand Total			**22**

Course Code: RPSZOOE611

Course Title: Life Processes-III

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Summarize the process of thermoregulation and temperature compensation in homeotherms and poikilotherms.
CO 2	Compare between the physiology of skeletal, smooth and cardiac muscle.
CO 3	Explain the physiology of vertebrate and invertebrate excretion and osmoregulation.
CO 4	Interpret the detailed process of Dialysis and Kidney care.
CO 5	Differentiate between the various physiologies of osmoregulation of freshwater, marine and terrestrial animals.
CO 6	Demonstrate the effect of temperature stress on angiogenesis using chick embryo.
CO 7	Perform the study of sub lethal concentration of ammonia on suitable organism.

RPSZOOE611	Title: Life Processes-II	Credits/Hours
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.	**1C/15H**
Unit: II	***Muscle Physiology*** • Physiology of movement and locomotion: a) Biochemistry of contractile proteins. b) Physiology of non-muscular contractile elements: Axoplasmic movement, Chromosome involvement • Physiology of skeletal muscle fibre: a) Sarcotubular system b) Actomyosin complex c) Source of energy for muscle contraction	**1C/15H**

	d) Sliding filament theory e) Excitation of contraction and mechanism of regulation of contraction by calcium f) Mechanism of relaxation • Comparative physiology of invertebrate muscle: a) Polyneural innervation in anthropod muscle b) Insect non-oscillatory postural muscle • Physiology of muscle cramps and its management • Physiology of Sprinting and Marathon running.	
Unit: III	***Osmoregulation and Excretion*** • Osmoregulation in fresh water, marine and terrestrial animals. • Invertebrate excretory organs and physiology: Epithelial exchange, Coelom, Coelom ducts, Malphigian tubules, Protonephridia and metanephridia, Molluscan kidney, Antennal gland in crustacean • Variation in vertebrate kidneys a) Nitrogen Metabolism: Formation of nitrogenous excretory products b) Amino-N Metabolism c) Nucleic Acid Metabolism d) Other nitrogenous waste products • Relationship of regulation of water balance with reference to blood volume, blood pressure, electrolyte balance, acid-base balance. • 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)	**1C/15H**
RPSZOOPE611	**Practical Title: Life Processes-II**	**Credit 1**
1.	Estimation of salt loss and gain in an aquatic animal when it is transferred to a salt- free medium and to natural medium.	
2.	Preparation of glycerinated muscle fiber and study of its properties.	
3.	Influence of sub lethal concentration (50-60 ppm) 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	
4.	Effect of decreasing PO_2 of water on Lactic acid in the muscle.	
5.	To study the effect of temperature/ electrolyte stress on angiogenesis using chick embryo.	
6.	Assessing nephrocyte activity of Drosophila larva using AgNO3 uptake assay.	

References:

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.
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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

Course Code: RPSZOOE612

Course Title: Animal Biotechnology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Summarize the holistic approach of animal biotechnology and human therapies.
CO 2	Interpret techniques involved in animal tissue culture.
CO 3	Employ different media preparations and passaging techniques for animal tissue culture.
CO 4	Choose the various animal models used in biotechnology and understand their applications.
CO 5	Demonstrate handling of laboratory animals and their maintenance and care.
CO 6	Analyse various animal models and instruments used for Animal tissue culture.

RPSZOOE612	Title: Animal Biotechnology	Credits/Hours
Unit: I	***Laboratory Animals in Biotechnology*** • Animal Care and Management of Laboratory Animals a. Rat b. Mouse c. Rabbit d. 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.	**1C/15H**

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	**1C/15H**
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. • 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	**1C/15H**
RPSZOOPE612	**Practical: Animal Biotechnology**	**Credit 1**
1.	Handling and feeding of the animals.	
2.	Animal house maintenance group project.	
3.	Separation of cells using Trypsinization method.	
4.	To study Estrous cycle and breeding.	

5.	Effect of administration of xenobiotic in suitable organism with reference to the following parameters: a) Total lipid and free fatty acid content of liver c) Level of activity of the following enzymes: ALT and ACP	

References:

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

Discipline Specific Elective

Course Code: RPSEZOOE613

Course Title: Clinical Toxicology

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Comprehend and apply the use of LD50, LC50, ED50 using suitable organism.
CO 2	Summarize the concept of NOAEL (No Observed Adverse Effect Level), Safety factor and ADI (Acceptable Daily Intake).
CO 3	Enlist the different levels of target organ toxicity and significance of biochemical assays.
CO 4	Explain OECD guidelines and ethical and regulatory permissions involved in Human trails.

CO 5	Determine the toxicity of given xenobiotic on zebrafish embryo by observing developmental defects.
CO 6	Demonstrate the toxicity of paracetamol on suitable organism and determining its level of toxicity using different biochemical parameters.

RPSEZOOE613	**Title: Clinical Toxicology**	**Credits/Hours**
Unit: I	***Basic toxicology*** • Introduction to toxicology – brief history, different areas of toxicology, principles and scope of toxicology. • Toxins and Toxicants – Phytotoxins, Mycotoxins Zootoxins, Xenobiotics • Types of Toxicity – Acute toxicity, Sub-acute toxicity, Sub-chronic toxicity and Chronic toxicity, Duration of exposure, Frequency of exposure, Site of exposure and Routes of exposure. • Concept of LD50, LC50, ED50 • Dose Response relationship – Individual / Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety. • Dose translation from animals to human – Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)	**1C/15H**
Unit: II	***Organ toxicity*** • Target organ toxicity: a) Hepatotoxicity: susceptibility of the liver, types of liver injury, histopathological changes. b) Neurotoxicity: vulnerability of nervous system, histopathological changes examples of neurotoxicants c) Nephrotoxicity: susceptibility of kidney, histopathological changes, examples of nephrotoxicants. d) Reproductive toxicity: histopathological changes seen in male and female reproductive organs. e) Cardiac and spinal cord poison • Biochemical Assays: Importance of various biochemical assays of parameters such as glucose, glycogen, total lipids, cholesterol and enzymes- ACP, ALP, ALT, AST, GGT, SOD, GSH, lipid peroxidase, catalase.	**1C/15H**

Unit: III	***Clinical Trials*** • Introduction to OECD: a) Guidelines for the testing of chemicals b) Description of the method c) Selection of animal species d) Housing and feeding conditions, preparation of animals for experiment, preparation of doses • Human clinical trials: a) Phases of human clinical trials b) Informed consent; Case report form; investigator's brochure (Ib) c) Ethical and regulatory submission; roles and responsibilities of clinical research professionals d) Clinical Trials: The regulation of therapeutic products and the phases (I-IV) of clinical trial that a drug must pass through before registration, Clinical Trial Design, aims, design, controls and placebo, blinds, randomization procedures, sample size, statistics, endpoints and ethics.	**1C/15H**
RPSEZOOPE613	**Practical Title: Clinical Toxicology**	**Credit 1**
1.	Effect of administration of paracetamol toxicity in fish in vitro with reference the following enzymes: a. SDH b. AST c. ALT	
2.	Estimation of LC50 of a xenobiotic/ pesticide on suitable organism (Artemia cysts/Daphnia).	
3.	Determination of pesticide residues in soil or water.	
4.	Measure developmental abnormalities in zebrafish embryos due to toxicity of target environmental chemicals.	
5.	Effect of xenobiotic in suitable organism with reference to: a. peroxidase enzyme b. catalase enzyme	

Reference:

1. Goodman & Gilman's the pharmacological basis of therapeutics by Laurence Brunton and John Lazo and Keith Parker; Ed. 11th; McGraw-Hill Professional; Ed 2011
2. Martindale: The Complete Drug Reference, Brayfield, Alison, Thirty-ninth edition
3. Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed. 7th; McGraw Hill; New York; 2007.
4. Essential of medical pharmacology; 6thEd. By K.D. Tripathi; Jaypee Brothers;
5. Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed. 5th; Churchill Livingstone.

6. Integrated Pharmacology: With Student Consult Access by Clive P. Page and M.J. Curtis and M.C. Sutter and M.J. Walker and B.B. Hoffman; Ed. 3rd; Mosby; 2006.
7. Principles of toxicology by Karen E. Stine and Thomas M. Brown; Ed. 2nd; CRC Press; 2006.
8. Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C.Lu and Sam Kacew; Ed. 5th; Informa Healthcare; 2009.
9. Toxicology by Hans Marquradt and S.G. Schafer and R.D. McClellah and Academic Press; 1999.
10. Principles and practice of toxicology in public health by Ira R. Richards; Jones and Bartlett Publishers; 2007.
11. Handbook of human toxicology, E.J. Massaro; CRC Press; 1997.
12. The Handbook of Clinically Tested Herbal Remedies, Marilyn Barrett, 2 Volume set 1st edition.

Course Code: RPSINTZOOE614

Course Title: Internship

Academic year 2024-25

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explore career alternatives prior to post graduation and integrate theory and practice.
CO2	Assess interests and abilities in their field of internship.
CO 3	Develop work habits and attitudes necessary for job success which will enhance their communication, interpersonal and other critical skills in the job interview process.
CO 4	Acquire employment contacts leading directly to a full-time job following post-graduation from college.

RPSINTZOOE614	**Internship** **Total Marks- 250**	**Total Credits 10**

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 30%- 30 Marks

Sr. No.	Evaluation type	Marks
1.	One Assignments/Case study/Project/Research paper review	10
2.	One class Test (multiple choice objective question+ Subjective)	20

B) External Examination- 45%- 45 Marks

Semester End Theory Examination:

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

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	**Any three out four**	**15**	**Unit-I**
Q.2	**Any three out four**	**15**	**Unit-II**
Q.3	**Any three out four**	**15**	**Unit-III**
	TOTAL	**45**	

Practical Examination Pattern:

C) External Examination: 25 Marks

Particulars	Marks
Journal	02
Experimental tasks/ Viva	23
Total	25

Overall Examination & Marks Distribution Pattern

Semester-IV

Course	RPSEZOOE611		RPSEZOOE612		RPSEZOOE613		RPSINTZOOE614 (Internship)	Total
	Int	Ext	Int	Ext	Int	Ext	250	300
Theory	30	45	30	45	30	45		
Practical	25		25		25			250
Grand Total								550