Resolution No.: AC/II (20-21).2.RPS11

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for: PG

Program: M.Sc.

Program Code: Zoology (RPSZOO)

(Credit Based Semester and Grading System
for the academic year 2020–2021)

PROGRAM OUTCOMES

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

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

PROGRAM SPECIFIC OUTCOMES

PSO	Description A student completing Master's in Science program in the subject of Zoology will be able to:
PSO 1	Identify, explore, understand the classification of invertebrates and vertebrates and compare between the anatomy and physiology of different phylum.
PSO 2	Gain comprehensive knowledge about different animal species and appreciate the differences and similarities, thereby achieving proficiency in handling them experimentally or for research purposes.
PSO 3	Understand and learn various behavioural patterns displayed by animals and interrelate to evolutionary pattern.
PSO 4	Evaluate and analyse basics of chemical thermodynamics andvarious biochemical pathways with respect to metabolism.
PSO 5	Analyse the various communication pathways taking place inside the cell and interrelate it with genetics.
PSO 6	Compare and contrast between Mendelian inheritance, Extension of Mendelian genetics and Non-Mendelian genetics
PSO 7	Interpret and analyse how morphological change due to change in environment helps drive evolution over a period of time.
PSO 8	Compare the different developmental stages of all the animals andconnect it to the evolutionary link.
PSO 9	Apply the fundamentals and techniques of molecular biology in various fields.
PSO 10	Gain knowledge and understand various techniques in the field of environmental, medical and animal biotechnology
PSO 11	Understand the broad concepts of nutritional, endocrinology, reproduction biology, human pathology and develop employable skills with regards to clinical pathology.
PSO 12	Understand the broad concepts of plate tectonics, physico-chemical parameters of sea, Ocean currents and tides, biological life and fisheries and develop research based employable skills in the same field.
PSO 13	Apply their knowledge in problem solving and future course of their career development in higher education and research.
PSO 14	Develop critical thinking, planning and executing research projects and prepare themselves for various competitive examinations.

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 a Anatomical Study monitoring board which will be informed about the use of animals and that the usage will comply to the guidelines of ethical use and handling of animals.

- Students opting for specialization in Zoology M.Sc will be informed in advance about the inclusion of anatomical studies in the course work.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
M.Sc-I	I	RPSZOO101	Animal Systematics, Ethology and Ecology-I	4
		RPSZOO102	Biochemistry and Metabolism – I	4
		RPSZOO103	Genetics-I and Developmental Biology	4
		RPSZOO104	Applied Zoology- I	4
			Practical	
		RPSZOOP101	Animal Systematics, Ethology and Ecology-I	2
		RPSZOOP102	Biochemistry and Metabolism – I	2
		RPSZOOP103	Genetics-I and Developmental Biology	2
		RPSZOOP104	Applied Zoology- I	2
	II	RPSZOO201	Animal Systematics and Ethology – II	4
		RPSZOO202	Biochemistry and Metabolism- II	4
		RPSZOO203	Molecular Biology and Genetics–II	4
		RPSZOO204	Applied Zoology-II	4
			Practical	
		RPSZOOP201	Animal Systematics and Ethology – II	2
		RPSZOOP202	Biochemistry and Metabolism- II	2
		RPSZOOP203	Molecular Biology and Genetics–II	2
		RPSZOOP204	Applied Zoology-II	2
		Specialization- Animal Physiology		
M.Sc-II	III	RPSZOO301	Basics of Industrial & Environmental Biotechnology I	4
		RPSZOO302	Genetic Engineering Techniques And Its Applications	4
		RPSZOP303	Comprehensive Physiology-I	4
		RPSZOP304	Environmental and Applied physiology-I	4
			Practical	
		RPSZOOP301	Basics Of Industrial & Environmental Biotechnology I	2
		RPSZOOP302	Genetic Engineering Techniques And Its Applications	2
		RPSZOPP303	Comprehensive Physiology-I	2
		RPSZOPP304	Project	2
	IV	RPSZOO401	Basics of Industrial & Environmental Biotechnology- II	4
		RPSZOO402	Genome Management, Manipulation, Regulations And Patents In Biotechnology	4
		RPSZOP403	Comprehensive Physiology-II	4
		RPSZOP404	Environmental and Applied physiology-II	4
			Practical	
		RPSZOOP401	Basics of Industrial & Environmental Biotechnology- II	2
		RPSZOOP402	Genome Management, Manipulation, Regulations And Patents In Biotechnology	2

		RPSZOPP403	Comprehensive Physiology-II	2
		RPSZOPP404	Project	2
		Specialization- Oceanography		
M.Sc-II	**III**	RPSZOO301	Basics of Industrial & Environmental Biotechnology I	4
		RPSZOO302	Genetic Engineering Techniques and Its Applications	4
		RPSZOG303	General, Physical, Chemical And Biological Oceanography	4
		RPSZOG304	Planktology, Fish, Fishery Science, Immunology of Fish And Aquaculture	4
			Practical	
		RPSZOOP301	Basics of Industrial & Environmental Biotechnology- I	2
		RPSZOOP302	Genetic Engineering Techniques and Its Applications	2
		RPSZOGP303	General, Physical, Chemical And Biological Oceanography	2
		RPSZOGP304	Project	2
	IV	RPSZOO401	Basics of Industrial & Environmental Biotechnology- II	4
		RPSZOO402	Genome Management, Manipulation, Regulations and Patents In Biotechnology	4
		RPSZOG403	Oceanographic Instruments and Expeditions, Marine Ecology, Marine Pollution and Biological Resources	4
		RPSZOG404	Planktology, Fish, Fishery Science and Biology Of The Ocean	4
			Practical	
		RPSZOOP401	Basics of Industrial & Environmental Biotechnology- II	2
		RPSZOOP402	Genome Management, Manipulation, Regulations And Patents In Biotechnology	2
		RPSZOGP403	Oceanographic Instruments and Expeditions, Marine Ecology, Marine Pollution and Biological Resources	2
		RPSZOGP404	Project	2

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Syllabus for: Semester- I& II

Program: M.Sc

Program Code: Zoology (RPSZOO)

(Credit Based Semester and Grading System
for the academic year 2020–2021)

Semester-I
Academic year 2020-2021

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

Course Code: RPSZOO101

Course Title: Animal Systematics, Ethology and Ecology-I

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed Syllabus

RPSZOO101	Title: Animal Systematics, Ethology and Ecology-I	Credits 4
Unit–I	**Animal Taxonomy and Systematic**	**15 Lectures**
	Introduction to taxonomy – Principles, stages, importance and rise of taxonomy.	
	Taxonomic Procedures – Traditional or evolutionary method, Phonetic and Cladistic Methods.	
	ICZN regulations and Zoological Nomenclature including use of suffixes ‘i’, ‘orum’, ‘ae’, ‘arum’, ‘ensis’ and ‘iensis’. oidea, idea, inae,; Tautonyms, synonyms and Homonyms.	
	Concept of species- Different Species concepts, sub-species and other intra-specific categories.	
	New trends in taxonomy: Ecological, Ethological, Cytological and Biochemical approaches and Numerical taxonomy	
	Molecular basis of animal taxonomy- DNA hybridization, Restriction analysis and sequencing of nucleotides.	

	Systematics of Porifera up to classes	
	Systematics of Coelenterate up to classes	
	Systematics of Ctenophora up to classes	
Unit–II	**Phylogeny, Systematics of non-chordates, Hemichordata & assorted topics**	**15 Lectures**
	Phylogeny, salient features, classification (wherever applicable) up to classes of the following phyla- • Mollusca • Bryozoa • Brachiopoda • Echinodermata • Chaetognatha	
	Systematic position and affinities of Hemichordata.	
	Economic importance of Protozoa.	
	Mesenteries in Coelenterata.	
	Sense organs in Arthropoda.	
	Spines and Pedicellariae in Echinodermata.	
	Invertebrate larvae- larval forms of free living invertebrates, larval forms of parasites, Strategies and evolutionary significance of larval forms.	
Unit–III	**Study of Animal Behavior**	**15 Lectures**
	Descriptive versus experimental approaches.	
	Reflexes and complex behaviour- Latency, after discharge, summation, warm up, fatigue inhibition and feedback control.	
	Instinctive Behaviour– Fixed action pattern, Types of sign stimuli and releasers as triggers, Genetic basis of instinctive behavior.	
	Learning- Classical conditioning experiment, latent and insight learning. Social learning; Altruism.	
	Anti predator behaviour – avoiding detection through colour and Markings (Mullerian mimicry), Warning coloration, Batesian mimicry.	
	Biological communication: Forms of signals, vision, audition and chemicals; Role of pheromone-Insects social organization;	

	pheromone effects in mammals- Lee Boot, Whitten, Bruce, Collidge and Castro-Vandenberg effect/s .	
Unit –IV	**Ecological Principles**	**15 Lectures**
	The Environment: Physical environment; biotic environment; biotic and abiotic interactions	
	Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.	
	Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *k* selection); concept of meta population – demes and dispersal, interdemic extinctions, age structured populations	
	Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis	
	Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.	
	Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax stage, Succession after Fire	
	Ecosystem Ecology: Ecosystem structure; primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).	
	Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.	
RPSZOOP101	**PRACTICAL** **Animal Systematics, Ethology and Ecology-I**	**Credits 2**
1.	Study of anatomy: Sepia: Morphology, digestive system, nervous system, reproductive system. Mounting of: jaws, radula, statocyst and spermatophore	
2.	Study of systematic and major features of: • Protozoa -Amoeba, Paramoecium, • Porifera - Grantia, Euplectella • Coelenterata- Porpita, Sea-anemone • Mollusca- Chiton, , Mytilus • Echinodermata- Starfish, Sea urchin, Sea cucumber • Hemichordata (Balanoglossus)	

	• Cephalochordata (Amphioxus) • Agnatha- Petromyzon. • Pisces- Hippocampus, Eel • Amphibia- Caecilian, Toad • Reptilia -Viper, Rattle snake, Crocodile/Alligator/Gharial	
3.	Study of invertebrate (earthworm /crab) heart.	
4.	Effect of temperature on water loss in cockroach.	
5.	Determination of length-weight analysis in fishes.	
6.	Grooming behaviour in cockroaches/house flies	
7.	Social organization in insects: Termite nest and caste system.	
8.	Nest construction behaviour and altruism in red ants.	
9.	Culture of Daphnia & Rotifers as fish food animals.	
10.	Behavioral interaction between individuals of Siamese Fighter fishes (*Betta splendens*)	
11.	Planting and maintaining of larval host plants of different butterfly species.	
12.	Field activities: field visits- zoos/sanctuaries/national parks.	

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Course Code: RPSZOO102

Course Title: Biochemistry and Metabolism – I

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed Syllabus

RPSZOO102	**Paper: II** **Biochemistry and Metabolism – I**	**Credits 4**
Unit-I	**Biomolecules- a structural and functional approach-I**	**15 Lectures**
	Concepts: • Biological Macromolecules. • Polymerization and macromolecules. • Central role of carbon. • Common functional groups. • Common ring structure and isomerization in biological molecules.	
	Carbohydrates: • Classification: mono-, oligo- and poly-saccharides. • Monosaccharides- structure, classification, D- and L-isomers, Anomers and mutarotation, open chain and ring	

	forms, pyranose and furanose forms, reactions of monosaccharides, glycocydic bonds and nomenclature. • Oligosaccharides, Polysaccharides- homo- and hetero-polysaccharides. • Biological functions of carbohydrates.	
	Lipids: • Classification: simple and complex lipids • Fatty acids- Even and odd carbon fatty acids, numbering the carbon atoms, saturated and unsaturated fatty acids, cis- and trans-configuration, nomenclature and short hand representation of fatty acids. • Acylglycerols- Mono-, di- and tri-glycerides, stereospecific numbering of glycerols in glycerides, properties of triacylglycerol. • Complex lipids- Phospholipids, Sphingolipids, Sterols and waxes, Amphipathic lipids Membrane lipid bilayers. • Biological functions of lipids.	
	Nucleic acids: Types- RNA and DNA. • Components: Pentose, Nitrogenous bases, Nucleosides, tautomeric forms of purines and pyrimidines. • Structure of DNA: Watson and Crick model; different forms of DNA double helix. • Structure, types and functions of RNA.	
	Complex biomolecules	
	Glycoproteins: Blood group substances	
	Glycolipids: Gangliosides	
	Lipoproteins: Classification and functions- chilomicrons, VLDL, LDL, HDL, and free fatty acid-albumin complex.	
Unit-II	**Biochemical Thermodynamics**	**15 Lectures**
	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	**Metabolic pathways and Integration of metabolism-I**	**15 Lectures**
	Metabolism: Concept; Definitions; Catabolism; Anabolism.	
	Carbohydrate Metabolism: • Glycolysis: Reaction sequence, flow of carbon, conversion of pyruvate to lactate and Acetyl coenzyme-A, significance of pyruvate-lactate interconversion, aerobic and anaerobic glycolysis and energetic of glycolysis. Regulation of glycolysis. • Gluconeogenesis: Reaction sequence from pyruvate, gluconeogenesis from amino acids, glycerol, propionate, lactate. Regulation of gluconeogenesis. • Glycogen metabolism: Glycogenesis, Glycogenolysis. Regulation of the two pathways. • Significance of following pathways: Hexose monophosphate shunt as a multifunctional pathway, Uronic Acid Pathway; Glyoxalate cycle.	
	Lipid Metabolism: • Dynamics of body lipids, mobilization of fats, regulation of hormone sensitive TG- lipase, fate of glycerol and free fatty acids. • Fatty acid metabolism: Oxidation of even-carbon and odd-carbon atom fatty acid, oxidation of unsaturated fatty acids, biosynthesis of fatty acids including desaturation, metabolism of phospholipids, cholesterol and alcohol	
Unit-IV	**Regulation of metabolism & Cell Communication**	**15 Lectures**
	Regulation of metabolism • Concept of homeostasis. • Regulation of metabolic flux by genetic mechanisms: Control of enzyme synthesis,constitutive and inducible enzymes; induction and repression of enzymes (lac operon and trp operon); regulatory proteins- Helix turn Helix, Zinc Fingers, Leucine Zippers. **Regulation of metabolism by extracellular signals:** nutrient supply, nutrient transport, endocrine control, neural control.	
	Cellsignalling • Hormones and their receptors	

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

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Course Code: RPSZOO103

Course Title: Genetics-I and Developmental Biology

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed Syllabus

RPSZOO103	Paper: III Genetics-I and Developmental Biology	Credits 4
Unit-I	**Genetics Chromosome theory of inheritance and Mendelism –I**	**15 Lectures**
	MITOSIS- Interphase and cell cycle, genetic control of cell cycle, stages of mitosis. • Meiosis: An overview of meiosis, the first meiotic division, the second meiotic division, comparison of spermatogenesis and oogenesis in animal cells. • non-disjunction and its implications	
	Organization of genetic material: • Structure of chromosomes • Chromosome number, shape and types • Structural features of eukaryotic chromosomes (chromatids, centromeres and telomeres; significance of telomeres; telomeres and cancer) • Heterochromatin and euchromatin • *In situ* hybridization • Giant chromosomes: lamp brush and polytene chromosomes	

	and salivary gland chromosome • Human chromosomes • Chromosome banding • Variations in chromosome structure and chromosome number	
	Principles of Mendelian Genetics: • Mendel's first law- segregation of allele • Mendel's second law- independent assortment • Monohybrid and dihybrid crosses • Molecular basis of dominance (genotype, phenotype, dominance, alleles) • The cellular basis of segregation and independent assortment	
	Genetics of cancer: • Relationship of cell cycle to cancer • Oncogenes • Tumour suppressor genes • Mutator genes • Chemicals and radiations as carcinogens.	
Unit-II	**Genetics- Extension of Mendelian genetics and non-Mendelian inheritance –I**	**15 Lectures**
	Alleles and phenotypes: • Incomplete or partial dominance and co-dominance • Epistasis – Dominant and Recessive • Complementation analysis • Multiple alleles • Lethal alleles (recessive and dominant lethal alleles) • Penetrance and expressivity	
	Quantitative inheritance: • Traits controlled by many loci • Location of polygenes • Heritability: measurement of heritability	
	Linkage, crossing over and gene mapping: • Chromosomal theory of linkage • Mechanism and types of crossing over • Mapping in prokaryotes and bacterial viruses • Gene mapping in eukaryotes (three point cross)	
	Genetic mapping in humans-	

	• Physical chromosome mapping: deletion mapping, somatic cell hybridization mapping, mapping by *in situ* hybridization; correspondence of genetic and physical maps. • Practical application of chromosome mapping- tracking the inheritance of an allele with coupled DNA markers.	
Unit-III	**Evolution –I**	**15 Lectures**
	Concept of evolution & theories of organic evolution (Lamarckism, Darwinism, De Vries mutation theory, Neo-Darwinism)	
	Evolution of horse	
	Human evolution	
	Evolution of Elephant	
	Human Migration and dispersal	
	Molecular Evolution	
	Molecular clock	
	Circadian Rhythm	
	Population and Evolutionary genetics: • Gene pool • Calculating allelic frequencies	
	The Hardy-Weinberg equilibrium and mating systems (non-random mating, assortative mating, inbreeding, dis-assortative matings)	
Unit -IV	**Developmental Biology**	**15 Lectures**
	Basic concepts of Developmental Biology • cell fate, competence, • commitment, • trans- dedifferentiation, • Cell specification, • Potency, • induction, • determination and differentiation; • morphogenetic gradients; • cell fate and cell lineages; • Apoptosis • Stem cells	

	• genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development.	
	Cell aggregation and differentiation in *Dictyostelium*	
	Morphogenesis and cell adhesion- Differential cell affinity, cadherins and cell adhesion.	
	Axis formation and pattern formation: Drosophila and *Xenopus*	
	Organogenesis	
	Vulva formation in *Caenorhabditis elegans*	
	Regeneration as a replay of development stages	
	New theories of Aging	
RPSZOOP103	**PRACTICAL** **Genetics-I and Developmental Biology**	**Credits 2**
1.	Culturing of *Drosphila.*	
2.	Culturing of *Caenorhabditis elegans*	
3.	Temporary squash preparation of onion/garlic root tip cells to study stages of mitosis.	
4.	Temporary squash preparation of testis of cockroach/ Tradescantia pollen to study stages of meiosis	
5.	Demonstration of inter-chromosomal connections in the cells of Tradescantia buds.	
6.	Temporary preparation of polytene chromosomes from salivary gland cells of Chironomus larva	
7.	Study of chromosome structures in human karyotype.	
8.	Observation of morphogenetic movements in chick embryo.	
9.	Effect of drug Ephedra / *Mucuna Prurines* on heart rate of 72 hours of chick embryo in vitro condition.	

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Course Code: RPSZOO104

Course Title: Applied Zoology-I

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed Syllabus

RPSZOO104	**Paper: IV** **Applied Biology**	**Credits 4**
Unit-I	**Instrumentation- Microtomy, microscopy, centrifugation-I**	**15 Lectures**
	Microtomy: Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, staining-differential and specific.	
	Cryopreservation	
	Principles and applications of microscopy: Light microscopy, phase contrast microscopy, fluorescence microscopy, polarization microscopy, confocal scanning microscopy, transmission electron microscopy, specimen preparation for electron microscopy, scanning electron microscopy.	
	Principles and applications of centrifugation: Basic principles of centrifugation, Low speed and high speed centrifuges, ultracentrifuge, application of centrifugation-preparative techniques, analytical measurements; care of centrifuges and rotors.	

Unit -II	**Biostatistics and computer application**	**15 Lectures**
	Arithmetic mean, mode, median, range, variance, standard deviation and standard error, coefficient of variation.	
	Testing of hypothesis: Statement for testing the hypothesis, statistical validation using student's "t" test, 'z' test, chi square test, simple and multiple correlation, regression analysis, ANOVA, Meaning of level of significance.	
	Computer applications: MS word, EXCEL, Power point, SPSS uses	
Unit- III	**Good Laboratory Practices and Research Methodology- I**	**15 Lectures**
	Safety in laboratories, Use, Care and Maintenance of common laboratory equipments: Microscope, pH meter, colorimeter/ spectrophotometer, analytical balance, centrifuge, electrophoresis apparatus, glassware; general safety measures; personal protection; chemical hazards; spillage and waste disposal; first aid.	
	Research methodology: Meaning of research; objective of research; motivation in research; types of research; research approaches; significance of research; research methods versus methodology; Research and scientific methods; Importance of knowing how research is done; Research process; Criteria for good research.	
	Research problem and research design: Selecting research problem; necessity of defining a problem; techniques involved in defining the problem; meaning of research design; need for research design; important concepts related to research design; different research designs; basic principles of experimental design; important experimental designs.	
Unit- IV	**Intellectual Property Rights**	**15 Lectures**
	Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs;	
	International framework for the protection of IP;	
	IP as a factor in R&D; IPs of relevance to biotechnology and few case studies;	
	Introduction to history of GATT, WTO, WIPO and TRIPS;	

	Concept of 'prior art': invention in context of "prior art"; Patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation	
RSZOOP104	**PRACTICAL** **Applied Zoology-I**	**Credits** **2**
1.	Identification of pictograms, symbols and signs of safety in laboratory practice.	
2.	Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining	
3.	Determination of pKa of weak acid.	
4.	Colorimeter: Selection of best filter.	
5.	Colorimeter: Determination of unknown concentration of solute	
6.	Biostatistics problems- Z-Test. T-Test, Chi Square.	
7.	Data analysis using MS Excel/ SPSS	
8.	Writing a Review Research Paper.	

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2. Principles and Techniques of Practical Biochemistry. Wilson and Walker, Cambridge Univ. Press.
3. Biological Science; 3rd Ed. D.J.Taylor, N.P.O.Green, G.W.Stou, Cambridge Univ. Press
4. Cell and Molecular Biology- Concepts and Experiments, Gerald Karp. John Wiley & Co.
5. Introductory Practical Biochemistry; S.K.Swahney, Randhir Sing. Narosa Publ.
6. An Introduction to Practical Biochemistry; 3rd Ed. David Plummer. Tata McGraw Hill
7. Practical Research Planning and Design; 2nd Ed. Paul D. Leedy. Macmillan Publ.
8. Elementary Practical Organic Chemistry Part I: Small Scale Preparations. 2nd Ed. Arthur I. Vogel. CBS Publ. and Distributors.
9. Research Methodology. Methods and Techniques; C.R.Kothari. Wiley Eastern Ltd. Mumbai.

10. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
11. Biotechnology and Patent laws:patenting living beings (2008) Sreenivasulu, N.S. and Raju C.B. Manupatra Publishers
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20. Samuel, M.L., 1991.Statistics for Life Sciences, Dellen Publishing Co, San Francisco.
21. Arthur M. Lesk, 2002. Introduction to Bioinformatics, Oxford University Press, New York
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Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

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

Paper Pattern:

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

Practical Examination Pattern:

C) External Examination: 50 Marks

Overall Examination & Marks Distribution Pattern

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

Semester-I

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

Semester II
Academic year 2020-2021

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

Course Code: RPSZOO201

Course Title: Animal Systematics and Ethology- II

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed syllabus

RPSZOO201	**Paper: I** **Animal Systematics and Ethology – II**	**Credits 4**
Unit I	**Phylogeny, Systematics of non-chordates and assorted topic-II**	**15 Lectures**
	Platyhelminthes and Nemethelminthes	
	Acanthocephala	
	Annelida	
	Sipunculoidea	
	Arthropoda	
	Onychophora - Peripatus, A connecting link between Annelida and Arthropoda.	
Unit II	**Phylogeny of Protochordates, Agnatha and assorted topics-II**	**15 Lectures**
	Urochordata and its similarities with other subphyla.	
	Cephalochordata and its similarities with other subphyla	
	Vertebrate ancestry and origin of Vertebrates.	
	Changes leading to first vertebrates	
	Salient features and phylogeny of Ostracoderms.	
	Affinities of Cyclostomes-	

	• resemblance with Cephalochordates • differences from fishes • vertebrate characters specialized characters	
Unit-III	**Phylogeny, Systematics of Chordates and Assorted topics- II**	**15 Lectures**
	Warm blooded reptiles. Archaeopteryx- a connecting link between Reptiles and Aves.	
	Salient features of class Aves and classification up to subclass.	
	Origin of flight (theory of cursorial & arboreal origin).	
	Birds as glorified reptiles.	
	Egg laying mammals- connecting link between reptiles and mammals.	
	Classification of mammals up to orders.	
	Dentition in mammals.	
	Walking gait (Plantigrade, Digitigrade, and Unguligrade)	
Unit- IV	**Animal behavior-II**	**15 Lectures**
	Development of behaviour: Significance of animal behaviour, influence of environment, hormones and genes. Cognition, neural control of behaviour, adaptiveness of behaviour.	
	Learning and memory: Innate behaviour (orientation, kineses, taxes, motivation, tropism, reflex and nest building), learned behaviour (sensitization and habituation, associative learning, imprinting, latent and insight learning, reasoning, instrumental conditioning, trial-and-error, discrimination, biased and language learning), neural mechanism of learning. Memory- nature, types and anatomy of memory, and memory storage.	
	Evolution and Genetics of behaviour: Genes and behavioral evolution, Hamilton's rule, kin selection, altruism, cost and benefits of social life, sex and sexual selection, phylogeny of behaviour, genetic control of behaviour (single and multiple gene effect). Genetics of burrow shape in Oldfield mouse and Deer mouse.	
	Social behaviour: Types of social groups, advantages of grouping, origin and roots to sociality, social organization- insects (honey bees, termites) and primates. Cost and benefits of	

	sociality, and evolution of eusocial behavior.	
RPSZOOP201	**PRACTICAL** **Animal Systematics and Ethology – II**	**Credits 2**
1.	Study of animal type*: *Periplanata americana:* Morphology, digestive system, nervous system, reproductive system and life history. Mountings of- cornea, salivary glands, gonapophyses, spermatheca	
2.	Study of systematics and major features of: i. Helminthes (Planaria, Liverfluke, Tapeworm, Ascaris, Trichinella) ii. Annelida (Nereis, Earthworm, Leech); iii. Sipunculoidea: (Sipunculus), iv. Arthropoda (Lobster, Balanus, Crab, Lepas, Scorpion, Spider, Limulus, Centipede, Millipede, Beetle) v. Urochordata (Simple Ascidian, Salpa/ Doliolum); vi. Cephalochordata (Amphioxus).	
3.	Study of Larval forms: Larvae of Helminthes- Miracidium, Sporocyst, Redia, Cercaria, Metacercaria; Trochophore, Crustacean larvae, Ascidian tadpole.	
4.	Study of nervous system of prawn.	
5.	Organoleptic test for fishes.	
6.	Study of social behavior of ants.	
7.	To study the repellent activity of lemon extract against the cockroach (*Periplaneta americana*).	

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4. J.Z. Young : The Life of Vertebrates, ELBS-Oxford Univ. Press.
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Course Code: RPSZOO202

Course Title: Biochemistry and Metabolism- II

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed syllabus

RPSZOO202	Paper-II Biochemistry and Metabolism- II	Credits 4
Unit –I	**Biomolecules- a structural and functional approach-II**	**15 Lectures**
	Proteins as polymers of amino acids • Amino acids: structure, classification based on structure, • polarity, nutritional requirement and metabolic fate; • properties of amino acids; • derivatives of amino acids, non-transcribed amino acids as protein constituents, • D-amino acids.	
	Organization of protein structure: • Primary structure and peptide bond, • secondary, tertiary and quaternary structure; • conjugate proteins- haemoglobin, cytochromes, myoglobin; bonds involved in protein organization. Properties of proteins: classification, denaturation and protein folding.	

	Biological functions of proteins. Biologically important peptides: glutathione, octa-, nona-, and deca-peptides.	
	Ramachandran plot.	
Unit – II	**Enzymes and Enzyme kinetics**	**15 Lectures**
	Mechanism of enzyme catalysis.	
	Enzyme kinetics: • Michaelis Menton equation; • Lineweaver-Burk plot; • significance of Vmax and Km(including non-competitive, Uncompetitive and competitive inhibitions); • factors affecting enzyme activity; • enzyme activation and inhibition. • Regulatory enzymes: covalently modulated, allosteric regulation, Isoenzymes (LDH, CK, ALP, ADH)	
	Non-protein enzymes- Ribozymes, Ribonucleas & Peptidyl transferase.	
Unit – III	**Metabolic pathways and Integration of metabolism**	**15 Lectures**
	Protein Metabolism: • Metabolism of amino acids: Amino acid pool, transamination; • oxidative and non- oxidative deamination; • metabolism of branched chain amino acids; • fate of carbon skeleton of amino acids.	
	Metabolism of ammonia: Urea cycle.	
	Metabolism of nucleic acids: • Synthesis of ribonucleotides- a brief idea of *de novo* pathway and salvation pathway. • Conversion of ribonucleotides to deoxyribonucleotides. • Degradation of nucleotides	
	Integration of Metabolism, Energy demand and supply;	
	Integration of major metabolic pathways of energy metabolism;	
	Intermediary metabolism;	
	Organ specialization and metabolic integration.	
	Metabolism in starvation	

Unit –IV	**Regulation of metabolism and inborn errors of metabolism**	**15 Lectures**
	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 • Teratogens and their effects • Sensitive period of teratogen • Specificity of teratogen • Thalidomide syndrome • Teratocarcinoma and Teratoma • Environmental teratogens • Evaluation of teratogenicity of chemicals	
RPSZOOP202	**PRACTICAL** **Biochemistry and Metabolism- II**	**Credits 2**
1.	Determination of total cholesterol and HDL cholesterol from serum.	
2.	Colorimetric estimation of protein by Peterson-Lowry method	
3.	Detection of conformation of BSA by viscosity measurement and effect of varying concentration of urea on viscosity of BSA	
4.	Determination of creatinine in serum.	
5.	Determination of urea in serum.	
6.	SDH specific activity	
7.	Enzyme kinetics - pH variation & Temperature-fungal amylase.	
8.	SDS PAGE of milk protein or blood plasma.	
9.	Isolation of polysaccharides from egg shell.	

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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

Course Code: RPSZOO203

Course Title: Molecular Biology and Genetics–II

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed Syllabus

RPSZOO203	Paper-III Molecular Biology and Genetics–II	Credits 4
Unit –I	**Molecular Biology- I**	**15 Lectures**
	DNA replication, repair and recombination • Unit of replication, • enzymes involved, • replication origin and replication fork, • fidelity of replication, • extra chromosomal replicons, • DNA damage and repair mechanisms, • homologous and site-specific recombination	
	Protein synthesis and processing	
	Ribosome • formation of initiation complex • initiation factors and their regulation	
Unit –II	**Molecular Biology- II**	**15 Lectures**

	RNA synthesis and processing • transcription factors and machinery, • formation of initiation complex, • transcription activator and repressor, • RNA polymerases, • capping, elongation, and termination, • RNA processing, • RNA editing, splicing, and polyadenylation, • structure and function of different types of RNA, RNA transport	
	Protein synthesis and processing • elongation and elongation factors • termination • genetic code • Post translational modifications	
Unit –III	**Genetic basis of syndromes and disorders**	**15 Lectures**
	Monogenic diseases • Autosomal dominant -Huntington diaease • Autosomal recessive -Cystic fibrosis • Genetic disorders of Haemopoietic systems (Sickle cell anemia) • X linked disorders • Genetic disorders of eye colour blindness • Muscle genetic disorders (Duchenne Muscular Dystrophy, *Myasthenia gravis*) • Genome imprinting syndromes (Prader-Willi & Angelman syndromes • Chromosomal disorders -aneuploidy, structural variations • Mitochondrial disorders • Multifactorial disorders – diabetes (detailed study), Obesity • Polygeneic congenital heart diseases • Cognitive disabilities (Schizophrenia) • Neurogenetic disorders (Parkinson disease • Genetics of reproduction	
Unit –IV	**Evolution-II**	**15 Lectures**
	Additive gene action and continuous variation	

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

REFERENCES:

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

6. T. Subramanian : Developmental Biology; Narosa Publ.
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19. A.P. Jha : Genes and Evolution; MacMillon India.

Course Code: RPSZOO204

Course Title: Applied Biology- II

Academic year 2020-21

COURSE OUTCOMES:

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

Detailed Syllabus

RPSZOO204	Paper-IV Applied Zoology-II	Credits 4
Unit –I	**Instrumentation-Principles and application of chromatography - II**	**15 Lectures**
	Planar chromatography (Paper and Thin layer): Preparation of stationary support, solvent, detection and measurement of components, applications.	
	Column chromatography: Packing and operation of column, loading the column, eluting the column, collection of elluent, detection of elluent, application.	
	Ion exchange chromatography: Ion exchange resins, selection of ion-exchanger, choice of buffers, preparation and use of ion-exchangers, storage of resins.	
	Gel chromatography: Theory of gel filtration; physical characteristics of gel chromatography, chemical properties of gel, selection of gel, gel preparation and storage, operation of	

	gel column, application	
	Affinity chromatography: Chromatography media, immobilized ligands, attachment of ligands to the matrix, experimental procedures and application.	
Unit –II	**Instrumentation-Principles and application of chromatography and Electrophoresis- III**	**15 Lectures**
	• Gas chromatography • Gas chromatography (GC): Instrumentation, selection of operating conditions, analysis of data and application. • HPLC. • Electrophoresis • Theory of electrophoresis • Horizontal agarose gel electrophoresis • Vertical polyacrylamide gel electrophoresis • Pulse field electrophoresis • Capillary electrophoresis • Isoelectric focusing of proteins • Two dimensional electrophoresis.	
Unit –III	**Good Laboratory Practices and Research Methodology- II**	**15 Lectures**
	Interpretation and report writing: Meaning of interpretation; technique of interpretation; precautions in interpretation; significance of report writing; layout of research report; types of reports; Presentation of research work- oral, poster and writing research paper; Precautions for writing research report.	
	Review of related literature: Understanding the role of review; how to begin a search for related literature- Library reference, recording and indexing, classification of references, internet sites for biological references; downloading the information through internet; requests for reprints through e-mail and post; classification and filing of reprints.	
	Writing research proposal: Characteristics of a proposal; content and organization of a proposal; weakness in proposal seeking funding.	
Unit –IV	**Bioinformatics**	**15 Lectures**

	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	
RPSZOOP204	**PRACTICAL** **Applied Zoology-II**	**Credits** **2**
1.	Identification of lipids in a given sample by TLC.	
2.	Separation of pigments from leaves or flowers by adsorption column chromatography.	
3.	Separation and identification of amino acids by 2D paper chromatography	
4.	Study of genetic diseases using OMIM database	
5.	Tools for gene and motif finding	
6.	Visualization of biological pathway- KEGG Pathway, Plant Reactome.	
7.	BLAST and its variants: Phi and Psi blast	
8.	Visualization of protein structure – Rasmol and PyMol	
9.	Protein structure prediction: Homology modelling based structure prediction tool-SWISS model	
10.	Submission of Poster and presenting/ Attending the Local/State/ National/International Seminars/workshops/ Conferences.	

REFERENCES:-

1. Modern Experimental Biochemistry; 3rd Ed. Rodney Boyer, Pearson Education.

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

Modality of Assessment

Theory Examination Pattern:

B) Internal Assessment- 40%- 40 Marks

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

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

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

Paper Pattern:

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

Practical Examination Pattern:

D) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

Overall Examination & Marks Distribution Pattern

Semester-II

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

Resolution No.: AC/I(19-20).2.RPS11

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for: Semester III & IV

Program: M.Sc

Program Code: Zoology (RPSZOO)

Specialization- Animal Physiology

(Credit Based Semester and Grading System
for the academic year 2020–2021)

ANIMAL PHYSIOLOGY

Course	Unit	TITLE	Credits
RPSZOO301		**Basics of Industrial and Environmental Biotechnology - I**	4
	I	The implications of recombinant DNA technology of commercial products and microbial synthesis	
	II	Large scale culture & production from recombinantmicroorganisms&genetically engineered animal cells	
	III	Medical Biotechnology	
	IV	Environmental Biotechnology I	
RPSZOO302		**Genetic Engineering Techniques and Its Applications**	4
	I	Genome management and analysis	
	II	Manipulation of gene expression in prokaryotes	
	III	Bioinformatics	
	IV	Animal biotechnology and Human therapies	
RPSZOP303		**Comprehensive Physiology-I**	4
	I	Level of response and Nutritional Physiology	
	II	Dynamics of physiological fluids	
	III	Physiological of mobility & Continuityof Life	
	IV	Neuroendocrine regulation, sensory & effecter physiology	
RPSZOP304		**Environmental and Applied physiology-I**	4
	I	Stress, Water and pressure as environmental Factors	
	II	Oxygen and Temperature as environmental Factors	
	III	Environmental Radiation, physiology of Biological Timing	
	IV	Physiological Tools for clinical diagnostics	
		Practical	
RPSZOOP301		Basics of Industrial and Environmental Biotechnology – I	2
RPSZOOP302		Genetic Engineering Techniques and Its Applications	2
RPSZOPP303		Comprehensive Physiology-I	2
RPSZOPP304		Project	2
Grand Total			**24**

Course Code: RPSZOO301

Course Title: Basics of Industrial and Environmental Biotechnology -I

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and analyse the concepts of recombinant DNA technology, GMOs, antibiotic resistant genes.
CO 2	Evaluate and comprehend the methods of Large-scale culture production and maintenance.
CO 3	Compare and contrast between different methods of fermentation and their benefits.
CO 4	Identify and differentiate between different types of vaccines and their applications.

Detailed Syllabus

RPSZOO301	Basics Of Industrial & Environmental Biotechnology -I	Credits 4
Unit-I	**The implications of recombinant DNA technology of commercial products and microbial synthesis**	**15 Lectures**
	The implications of recombinant DNA technology • General account on applications of biotechnology • Commercialization of biotechnology & biotech companies • Prospects of novel food technology • Economics of microbial biotechnology • Areas of significant public concern: Antibiotic resistance marker gene, transferof allergies, pollen transfer from GM plants, social, moral & ethical issuesassociated with GMOs.	
	Amino acids & their commercial use – production strain, process of L-glutamate, L-aspartate, L-phenylalanine, L-tryptophan.	

Unit-II	**Large scale culture & production from recombinant microorganisms & genetically engineered animal cells**	**15 Lectures**
	Large scale culture & production from recombinant microorganisms: • Batch fermentation • Fed batch fermentation • Continuous fermentation • Maximizing the efficiency of fermentation process • Harvesting, disrupting & downstream processing	
	Large scale culture & production from genetically engineered animal cell cultures: • Design of bioreactors for large scale animal cell culture- Batch, Fed batch • Mammalian cell lines & their characteristics • Media for the cultivation of mammalian cells • Commercial products produced with mammalian cell culture.	
Unit-III	**Medical Biotechnology**	**15 Lectures**
	Sub-unit vaccines • Sub-unit Vaccine production against viruses- Herpes simplex, Bovine foot &mouth disease virus • Peptide vaccines-synthetic drugs (engineered proteins) • Genetic immunization-DNA vaccines, Antisense DNA, Therapeutic ribozymes • Live recombinant vaccines • Attenuated vaccines against Cholera, Salmonella sp. • Vector vaccines-Vaccine directed against viruses-Rabies virus G-protein, Hepatitis B surface antigen • Anti-idiotypic vaccine for cancer treatment. • Multivalent subunit vaccine. • Microbiome.	
	Monoclonal antibodies (mAbs) &therapeutic applications: • mAbs for prevention of rejection of transplanted organs • Treatment of bacterial blood infection • Human and Hybridmonoclonal antibodies • HIV therapeutic agents and Anti tumor antibodies	

Unit -IV	**Environmental Biotechnology I**	**15 Lectures**
	Biomass utilization • Microorganisms in lignocellulose degradation • Isolation of prokaryotic & eukaryotic cellulase gene • Manipulation of cellulase gene • Production of single cell proteins by using biomass as raw material. • Commercial production of fructose and alcohol from biomass • Improvements of fructose and alcohol production • Fuel ethanol from biomass. • Biogas utilization	
	Bioremediation of aerobic compounds • Characteristics of xenobiotics in the environment • Characteristics of aerobic microorganisms for degradation of organic pollutants **Genetic engineering of biodegradative pathways-** • Manipulation by transfer of plasmid, manipulation by gene alteration • Degradation of xenobiotic compounds-petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organic compounds (aliphatic & aromatic)	
RPSZOOP301	**PRACTICAL** **Basics of Industrial & Environmental Biotechnology I**	**Credits 2**
1.	Demonstration of aseptic technique: Work place for aseptic handling, packing glassware (flasks, test tubes, pipettes, petri dish) for sterilization, aseptic transfer of liquids (pipetting from flask to test tube)	
2.	Preparation of LB agar plate, slant, butt & demonstration of streaking technique using bacterial culture to obtain isolated colonies	
3.	Isolation of bacterial culture on differential media (Mac Conkeys agar).	
4.	To estimate the number of bacteria in the given culture by Nephelometry	

REFERENCES:

1. Johan E. Smith, Biotechnology, 3rd Edition, Cambridge Univ. Press
2. Colin Rateledge and Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge Univ. Press
3. Susan R. Barnum, Biotechnology – An Introduction, Vikas Publishing House
4. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.
5. Alexander N. Glazer and Hiroshi Nikaido, Microbial Biotechnology – Fundamentals of applied microbiology, W. H. Freeman and Co, New York
6. InduShekar Thakur, Environmental Biotechnology – Basic concepts and applications, I. K. International Pvt. Ltd, Mumbai, New Delhi
7. John A. Thomas (Ed.), Biotechnology and safety assessments, 2nd Edition, Taylor and Francis
8. S. S. Purohit, Biotechnology – Fundamentals and applications, 3rd Edition, Agrobios, India
9. Patent Facility Centre (PTC) Technology information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, New Delhi

Course Code: RPSZOO302

Course Title: Genetic Engineering Techniques and Its Applications

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the basic concepts of Genetic engineering, vectors, genomics, and proteomics.
CO 2	Compare and contrast between different types of cloning vectors, electrophoresis techniques and their applications.
CO 3	Evaluate and comprehend concepts of gene expression in prokaryotes and bioinformatics.
CO 4	Develop skills and demonstrate different techniques of aseptic transfer.
CO 5	Isolate and identify different bacterial colonies.

Detailed Syllabus

RPSZOO302	Genetic Engineering Techniques And Its Applications	Credits 4
Unit-I	**Genome management and analysis**	**15 Lectures**
	The Basic tools of genetic engineering • Chemical Synthesis of DNA-Oligonucleotide synthesis by Phosphoramidite method, Synthesis of genes • DNA Sequencing -- Maxam-Gilbert method, Sanger's • dideoxynucleotide method, By using bacteriophage M13, By Primer walking, Next generation sequencing . • PCR and its types (RT- PCR, nested and multiplex)	
	Cloning Vectors • General purpose plasmid vectors (pUC19, pBR322) (Bacterial Vectors) • Bacteriophage and cosmid vectors • Yeast artificial chromosomes (YACs)	
	Analysis of genome/proteome • DNA fingerprinting/physical mapping/pulsed field gel	

	electrophoresis • Analysis of the proteome– 2D PAGE & Mass spectroscopy. • Analysis of mRNA transcripts– DNA Microarray.	
Unit -II	**Manipulation of gene expression in prokaryotes**	**15 Lectures**
	Promoters of gene expression in prokaryotes • Prokaryotic gene expression • Isolation of functional promoters • Promoter selection with E.coli plasmid pBR316 • Promoter selection with plasmid pKO1 • Gene expression from strong and regulatable promoters	
	Expression of cloned genes in prokaryotes • Increasing protein production and secretion • Inclusion bodies and fusion proteins • Unidirectional tandem gene arrays • Translation expression vectors • Increasing protein stability	
Unit -III	**Bioinformatics**	**15 Lectures**
	Uses and application of computers in biological sciences DNA profiling: cDNA and EST's (expressed sequence tags) Basic research with DNA microarrays and its application in healthcare. Biomedical genome research and pharmaco genomics Random amplified polymorphic DNA (RAPD) Human genomic variation-SNP's (single nucleotide polymorphisms,SNP's and disease; QTL (quantitative trait loci) and its relation to SNP's Satellite DNA and its types	
Unit -IV	**Animal biotechnology and Human therapies**	**15 Lectures**
	Animal Biotechnology • Transgenic animals and their applications: Mice as model system for human diseases and as test case model, Cows, pigs, sheep, goats as biopharmaceuticals, Transgenic insects and birds. • Recombinant DNA technology to prevent animal diseases • Conservation biology-Embryo transfer.	

	• Regulation of transgenic animals and patenting genetically engineered animals. • Knockout mice (Cre- loxP system)	
	Human therapies • Tissue engineering: Skin, liver, pancreas • Xenotransplantation • Antibody engineering • Cell adhesion based therapies: Integrins, Inflammation, Cancer and metastasis • Targeted gene replacement for correcting a mutated gene • Site directed mutagenesis	
RPSZOOP302	**PRACTICAL** **Genetic Engineering Techniques And Its Applications**	**Credits 2**
1.	Determination of Air microflora	
2.	Determinations of viable cell counts in the given culture of bacteria by dilution, spreading and pour plate technique.	
3.	Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis	

REFERENCES:

1. R. S. Crespi; Patents – a basic guide to patenting biotechnology, Cambridge Univ. Press
2. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers
3. Martin Fransman, GerdJunne, AnnemiekeRoobeek (Ed), The Biotechnology revolution?, Blackwell Scientific Publishers
4. Terence Cartwright, Animal Cells as Bioreactors, Cambridge Univ. Press
5. A. Rosevear, John F. Kennedy, Joaquim M. S. Cabral, Immobilized enzymes and cells, Adam Hilger Publishers, Bristol and Philadelphia
6. Micheal P. Tombs and Stepan E. Harding, An Introduction to polysaccharide biotechnology
7. T. A. Brown, Gene Cloning – An Introduction, 3rd Edition, Nelson Thornes
8. Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Publishers
9. U. Satyanarayan, Biotechnology, 2007 Reprint, Uppala Author Publisher Interlink

SPECIALIZATION- ANIMAL PHYSIOLOGY

Course Code:RPSZOP303

Course Title: Comprehensive Physiology-I

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and comprehend the concepts of nutritional physiology, its regulations and neural physiology.
CO 2	Compare and contrast between the different transport systems across the cell membranes.
CO 3	Differentiate and analyse the different physiologies of heart and circulatory systems amongst invertebrates and vertebrates.
CO 4	Understand and analyse the physiology of motility, biochemistry of contractile proteins, and physiology of skeletal muscle fibre.

Detailed Syllabus

RPSZOP303	Comprehensive Physiology-I	Credits 4
Unit-I	**Levels of response and Nutritional Physiology**	**15 Lectures**
	Levels of Physiological response- Molecular, Membrane, Organ and Organism. A brief idea of physiological response at molecularlevel	
	Membranephysiology- Functionalconsequencesofmolecularcompositionand arrangement.	
	Transport across cell membrane-Diffusion, active transport, pump; uniports, symports and antiport, co-transport by symporters and anitporters.	
	Physiology of Food Capture and Processing	
	Nutritive Patterns: Origin of nutritive types.	
	Feeding patterns:	

	a)Large particle feeding b)Surface nutrient absorption	
	Digestion: a)Bulk movement and peristalsis b)Comparative biochemistry of digestion c) Neural and hormonal regulation of secretion of digestive enzymes.	
	Regulation of nutritional intake: a)Hunger drive, Glucostatic and Hepatostatic theories of hunger drive b) Adaptation of gut to metabolic rate and diet. c) Balanced diet: A human perspective	
Unit-II	**Dynamics of physiological fluids-circulation**	**15 Lectures**
	Circulation of body fluids: a) Circulating fluids-Cytoplasm, Hydrolymph, hemolymph, lymph and Blood b) Circulatory mechanisms and Fluid compartments, movement of body fluids by somatic muscles. Hemolymph and open systems	
	Pressure and flow in vertebrate circulatory system. Physiological types of hearts with special reference to arthropods, annelids, mollusca, tunicates and vertebrates.	
	Pacemakers and specialized conducting fibers.	
	Selective distribution of blood flow.	
	Cardiac Physiology: Neuro hormonal regulation of cardiac amplitude and frequency. Effects of exercise on cardiac vascular physiology - A human perspective	
Unit- III	**Physiology of motility**	**15 Lectures**
	Physiology of movement and locomotion: Biochemistry of contractile proteins.	
	Physiology of non-muscular contractile elements: Axoplasmic movement, Chromosome involvement	
	Physiology of skeletal muscle fibre: • Actomyosin complex • Source of energy for muscle contraction • Sliding filament theory • Excitation of contraction and mechanism of regulation of	

	contraction by calcium • Mechanism of relaxation **Comparative physiology of invertebrate muscle:** • Polyneural innervation in anthropod muscle • Insect non-oscillatory postural muscle • Resonant flight and tymbal muscle in insects • Catch muscle and delayed relaxation	
Unit-IV	**Neurotransmission Physiology**	**15 Lectures**
	Physiology of neuronal system: Excitable membranes: • Membranes potential • Ions as current carriers - Protons, calcium, potassium, structure of cation-permeable channels and chloride channels	
	Synaptic transmission: • Electrical transmission • Chemical transmitters- Neuropeptide, FMRF-amide family, Gastrin, CCK family, Hypothalamic pituitary factors	
	Integrative Neurophysiology: Neurons, Inter neurons, neural Circuits, Networks, Primitive Nervous Systems, Nerve nets, Central pattern Generators in Invertebrates, Chordate Nervous System, Central Nervous System processing	
	Memory and Learning	
RPSZOPP303	**PRACTICAL** **Comprehensive Physiology-I**	**Credits 2**
1.	Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin, Lipase etc. in different animals (Cockroach).	
2.	Study of effect on activity of any enzyme of various factors like pH, Temperature, Activator, Inhibitor.	
3.	Determination of Km of a given enzyme.	
4.	Total RBC, WBC and Different WBC count- A comparative study of fish, goat and human.	
5.	Routine human blood tests like RBC, WBC, DWBC, Hb content, blood sugar. Prepare a report as required by a pathological laboratory (goat blood).	
6.	Observation of decreasing PO2 of water on the respiratory rate of a fish.	
7.	Effect of decreasing PO2 of water on Lactic acid in the muscle.	
8.	Estimation of salt loss and gain in an aquatic animal when it	

	is transferred to a salt- free medium and to natural medium.	
9.	Preparation of glycerinated muscle fibre and study of its properties.	
10.	Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.	

REFERENCES:

1. A. G. Giese: "Zoology III Cell Physiology" (3rd Ed) Saunders, Toppan
2. Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
3. Darnell, Loddish, Baktimore: "Molecular Cell Biology" Scientific American Books.
4. C. A. Keil, E. Neil & E.N. Joeb (1982): "Samson Wright, Applied Physiology" Oxford Univ. Press.
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7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology" "Comparative Animal Physiology", 4th Ed. Wileg – Liss Publ.
9. C. Ladd Prosser Ed. (1991): "Environmental & Metabolic Animal Physiology" "Comparative Animal Physiology" 4th Ed. Wileg – Liss Publ.
10. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.
11. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
12. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
13. P. W. Hochachka & G. M. Somero (1973): "Strategies of Biochemical Adaptation".

Course Code: RPSZOP304

Course Title: Environmental and Applied Physiology -I

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and comprehend the concepts of water, oxygen and solar radiation as environmental factors affecting physiology of animals.
CO 2	Compare and contrast between the different adaptations of invertebrates and vertebrates during oxygen deplete conditions and correlate it with their evolution.
CO 3	Evaluate and analyse the effect of radiation at cellular and molecular levels in animals and understand the phenomenon of radioprotection.
CO 4	Interpret the correlation of enzymes with different cancers.
CO 5	Develop employable skills related to testing various parameters of blood.

Detailed Syllabus

RPSZOP304	Environmental and Applied Physiology -I	Credits 4
Unit- I	**Stress, Water as an environmental factor**	**15 Lectures**
	Environmental Stress, Homeostasis and strategies of biochemical adaptations: Basic concept of environmental stress • Plastic and elastic strain • Stress resistance, stress avoidance and stress tolerance	
	Homeostasis and biochemical adaptation: • External and internal environment • Multiple control system • Strategies of biochemical adaptations	
	Water and Solute problem: • Preservation of intracellular solvent capacity • Strategies and degrees of ionic regulation • ATPase the model regulatory enzyme	

	Key role of GDH reaction	
	Salt glands in animal kingdom	
Unit- II	**Oxygen as environmental factor.**	**15 Lectures**
	Oxygen as an environmental factor: Oxygen and Origin of life. Oxygen dependencies in living organism. Anoxia adaptations in invertebrates. Adaptations of vertebrates during prolonged diving. Oxygen debt in vertebrate muscle.	
Unit –III	**Environmental Radiation.**	**15 Lectures**
	Radiation as an environmental parameter.	
	The solar spectrum.	
	Biomolecules involved in perception and trapping of solar radiations: Chlorophyll, Bacterio-rhodospin, Rhodospin and Vitamin A. Adaptations of animals to absence of solar radiations.	
	Effects of Ionizing radiations at the cellular and molecular level.	
	Phenomenon of radioprotection.	
	Effects of Ionization radiations at cellular and molecular level. Phenomenon of radioprotection.	
Unit –IV	**Enzymes and Body Fluids as Clinical Diagnostic Tools.**	**15 Lectures**
	Enzymes as diagnostic tools : • Plasma specific and non-plasma specific enzymes • Diagnostic importance of LDH • Enzyme in diagnosis of myocardial infarction • Enzymes in Liver diseases and toxicity • Enzymes in muscle disease • Enzymes in cancer	
	Physiological fluids as diagnostic tools: • Routine Blood tests, plasma composition- changes in disease • Serum: Urea-N, Creatinine, Uric acid, proteins, bicarbonates, Na+ K+ Cl- • Glucose tolerance test, glycosylated Haemoglobin • Lymph and cerebro-spinal-fluid: Changes in composition in disease	

	• Urine composition/ constituents as a diagnostic tool-Routine Urine tests, Urea-N, Creatinine, Uric acid, tests for proteinurea, albuminurea, Glucosurea, chyluria (for filariasis)	
RPSZOPP304	**PROJECT**	**Credits 2**
• Each student will choose a different topic related to the syllabus. • Students will submit their Project proposal having Introduction, Review of Literature, Materials and Methods, Expected outcomes and References.		

REFERENCES:

1. J. G. Philips (1975): "Environmental Physiology"Blackwell Scientific Publ.
2. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
3. Harold Harper: "Review of Physiology Chemistry" 4th Ed. Maruzen Asian Ed. Lang Medical Publ.
4. Richard Dawkins (1989): "Selfish Gene" Cambridge Univ. Press.
5. Leycock & Wise –"Essential Endocrinology" 2nd Ed. ELBS. Oxford Univ. Press.
6. Introduction from Rac Silver & Karvey Feder: "Hormones & Reproduction Behaviour" Scientific Americal (Readings from) W. H. Freeman & Co.
7. Marie A. Moisio & Elmer W. Moisio: "Understanding Laboratory & Diagnostic Tests" (1998) Delmar Publishers.
8. Sujit K. Chaudhuri: "Concise Medical Physiology" 2nd Ed. (1993) New Central Book, Agency (P) Ltd., Calcutta
9. Thomas G. M. Schalkhammer (Ed.) Indian Reprint 2004: "Analytical Biotechnology – Methods & Tools in Biosciences and Medicine Rajkamal Electric Press, Delhi
10. Praful B. Godkar (1994) Textbook of Medical Laboratory Technology Bhalani Publishing House, Bombay
11. Biswajit Mohanty & Sharbari Basu (2006): "Fundamentals of Practical Clinical Biochemistry" B. I. Publications (Pvt.) Ltd., New Delhi
12. G. P. Talwar & S. K. Gupta (Ed.) (1993): A Handbook of Practical and Clinical Immunology Vol. 2 Second Edition CBS Publishers & Distributors, New Delhi.

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

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

Paper Pattern:

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

Practical Examination Pattern:

C) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

D) Modality for Project

Topic / Title	02
Literature survey	08
Objectives and purpose	06
Material and Method	08
Work plan with timeline	10
Expected outcome	08
Viva voce based on proposal	08
Total- 50 Marks	

Overall Examination & Marks Distribution Pattern

Semester-III

Course	RPSZOO301		RPSZOO302		RPSZOP303		RPSZOP304		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical's	50		50		50		50		200

SEMESTER-IV
ANIMAL PHYSIOLOGY

Course	Unit	Title	Credits
RPSZOO401	**Basics of Industrial &Environmental Biotechnology-II**		
	I	Microbial synthesis of commercial products	4
	II	Large scale culture & production for industrial biotechnology	
	III	Agricultural Biotechnology	
	IV	Environmental Biotechnology II	
RPSZOO402	**Genome Management, Manipulation, Regulations And Patents In Biotechnology**		
	I	Genome management	4
	II	Manipulation of gene expression in eukaryotes	
	III	The human genome project	
	IV	Regulations and patents in biotechnology	
RPSZOP403	**Comprehensive Physiology-II**		
	I	Level of response and Nutritional Physiology	4
	II	Dynamics of physiological fluids	
	III	Physiological of mobility & Continuity ofLife	
	IV	Neuroendocrine regulation, sensory & effecter physiology	
RPSZOP404	**Environmental and Applied physiology-II**		
	I	Stress, Water and pressure as environmental factors	4
	II	Oxygen and Temperature as environmental Factors	
	III	Environmental Radiation, physiology of Biological Timing	
	IV	Physiological Tools for clinical diagnostics	
		PRACTICAL	
RPSZOOP401		Basics Of Industrial & Environmental Biotechnology II	2
RPSZOOP402		Genome Management, Manipulation, Regulations And Patents In Biotechnology	2
RPSZOPP403		Comprehensive Physiology-II	2
RPSZOPP404		Project	2
Grand Total			**24**

SEMESTER-IV

Course Code: RPSZOO401

Course Title: Basics of Industrial & Environmental Biotechnology II

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Comprehend and understand the concepts of microbial synthesis of organic acids, polysaccharides, antibiotics, and their applications.
CO 2	Compare and contrast between different methods of immobilization.
CO 3	Evaluate and analyse the different techniques used in agricultural biotechnology.
CO 4	Compare and contrast between different types of bioreactors of bio-absorption and methods of bioleaching.
CO 5	Develop skills and demonstrate the technique of immobilization of cells

Detailed Syllabus

RPSZOO401	Basics Of Industrial & Environmental Biotechnology II	Credits 4
Unit-I	**Microbial synthesis of commercial products**	**15 Lectures**
	Microbial synthesis of commercial products • Organic acids & their commercial applications – Citric acid, gluconic acid,lactic acid, Acetic acid. • Antibiotics – Cloning antibiotic biosynthetic gene by complementation & otherAminoglycosides & their uses **Polysaccharides:** Bacterial polysaccharides: General properties & their commercial applications- • Dextran, Xanthan, Alginate. • Genetic engineering for the large scale production of Xanthan gum & it's modification • Marine polysaccharides: General properties & their	

	commercial application-Agar &agarose, Chitosan • Polyesters: Polyhydroxyalkanoates (PHA)-Biosynthesis of PHA, Biopol-commercial biodegradable plastic	
Unit-II	**Large scale culture & production for industrial biotechnology**	**15 Lectures**
	Biotransformations • Selection of biocatalyst-screening & use of novel existing biocatalyst • Genetic modification of existing biocatalyst (Indigo biosynthesis) • Biocatalyst immobilization- • Methods of immobilization- Cross linking, supported immobilization,adsorption & ionic binding, covalent coupling, lattice entrapment • Immobilized soluble enzymes & suspended cells • Immobilization of multi-enzyme systems & cells • Immobilized enzyme reactors- Batch reactors, continuous reactors **Analytical enzymes-** • Enzymes in diagnostic assays: Test strip systems & Biosensor Electrochemical & optical type.	
Unit -III	**Agricultural Biotechnology**	**15 Lectures**
	Agricultural Biotechnology: • Nitrogen fixation • Nitogenase-Component of nitrogenase; Genetic engineering of nitrogenasecluster • Hydrogenase-Hydrogen metabolism • Genetic engineering of hydrogenase gene • Nodulation-Competition among nodulation organisms, genetic engineering of nodulation gene • Microbial insecticides-Toxins of Bacillus thuringiensis, mode of action & use of thuringiensis toxins, thuringiensis toxin gene isolation, genetic engineering of Bacillus thuringiensisstrains& cloning of thuringiotoxin gene.	

	• Developing insect resistant, virus resistant & herbicide resistant plant • Algal products: Fuels from algae, marine natural products & their medical potential-anticancer, antiviral compounds, anti bacterial agents.	
Unit-IV	**Environmental Biotechnology II**	**15 Lectures**
	Bioabsorption of metals (Recovery from effluents) • Bioabsorption by fungi, algae, moss & bacteria • Mechanism of bacterial metal resistance & genetic engineering for specificProteins. • Bioreactors for bioabsorption-packed bed, fluidized bed, rotating disc, single blanket, sequential reactors • Phytoremediation &its use in biotechnology	
	Bioleaching of metals • Biochemical mechanism of bioleaching • Extraction from mixtures • Types of bioleaching • Methods for bioleaching-Tank & heap bioleaching • Microorganisms used for bioleching	
RPZOOP401	**PRACTICAL** **Basics Of Industrial & Environmental Biotechnology- II**	**Credits 2**
1.	Immobilize Yeast cells in calcium alginate & prepare a bioreactor column to demonstrate Invertase activity in the bioreactor column.	
2.	Antibiotic sensitivity test.	
3.	To plot a growth curve for the microorganisms provided.	
4.	To determine the portability of given water sample by MPN method.	

REFERENCES:

1. Johan E. Smith, Biotechnology, 3rd Edition, Cambridge Univ. Press
2. Colin Rateledge and Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge Univ. Press
3. Susan R. Barnum, Biotechnology – An Introduction, Vikas Publishing House
4. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.

5. Alexander N. Glazer and Hiroshi Nikaido, Microbial Biotechnology – Fundamentals of applied microbiology, W. H. Freeman and Co, New York
6. Indu Shekar Thakur, Environmental Biotechnology – Basic concepts and applications, I. K. International Pvt. Ltd, Mumbai, New Delhi
7. John A. Thomas (Ed.), Biotechnology and safety assessments, 2nd Edition, Taylor and Francis
8. S. S. Purohit, Biotechnology – Fundamentals and applications, 3rd Edition, Agrobios, India
9. Patent Facility Centre (PTC) Technology information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, New Delhi

Course Code: RPSZOO402

Course Title: Genome Management, Manipulation, Regulations and Patents in Biotechnology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Evaluate and analyse different tools used for genetic engineering.
CO 2	Compare and contrast between different tools for gene transfer techniques and cloning vectors.
CO 3	Understand and comprehend the concept of manipulation of gene expression in eukaryotes.
CO 4	Understand the human genome project, its applications and interpret genetic linkage maps.
CO 5	Construct genetic linkage maps and physical maps and integrate them.
CO 6	Understand and comprehend the rules and regulations involved in patent application in the broad field of biotechnology.

Detailed Syllabus

RPSZOO402	**Genome Management, Manipulation, Regulations and Patents In Biotechnology**	**Credits 4**
Unit-I	**Genome management**	**15 Lectures**
	The Basic tools of genetic engineering • Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation, liposome, ligand mediated, gene gun or biolistic approach, viral mediated • Selection and screening of recombinants • Nucleic acid probes and hybridization, Southern blotting and Northern blotting. • Immunological assays for identification of gene product, Western blot, Flow cytometry.	
	Cloning Vectors • Retrovirus and SV40 vectors • Special purpose vectors- Expression vectors, Secretion vectors, Shuttle or bi-functional vectors, single stranded phage and phagemids.	
Unit-II	**Manipulation of gene expression in eukaryotes**	**15 Lectures**
	• Eukaryotic gene expression • Introduction of DNA into fungi-yeast and filamentous fungi (fungal transformation) • Heterologous proteins production in yeasts • Heterologous proteins production in filamentous fungi • Cultured insect cells expression systems Baculovirus transfer vector • Mammalian cell expression systems- Human Papova BK virus shuttle vector	
Unit-III	**The human genome project**	**15 Lectures**

	• The human genome, scope and goals of the project • Genetic linkage maps, chromosome walking, restriction mapping. • Polymorphic DNA markers(RFLP, AFLP, VNTR) • Restriction fragment length polymorphism (RFLP) and its uses • RNAi and is application to treat human disease. • Physical maps, Sequence tagged sites • Integrating genetic linkage and physical maps • Mapping human diseases • Positional cloning: Getting closer to a disease causing gene (Cystic fibrosis) • Testing for exons • Limitations of positional cloning. FISH	
Unit-IV	**Regulations and patents in biotechnology**	**15 Lectures**
	Regulating recombinant DNA technology • Regulatory requirements – safety of genetically engineered foods Chymosin, tryptophan, bovine somatotropin • Regulation environmental release of genetically engineered organism (GEO). Ice minus Pseudomonas syringae • Regulatory agencies and laws for product regulation • Risk assessment: How much risk? • Open field tests of GEO • Development of policy for Human gene therapy	
	Patenting biotechnology inventions • What constitutes the patent? • The patent process • The conditions to be satisfied for an invention to be patentable :Novelty, Inventiveness, Usefulness • Patenting in different countries, types of inventions that are not patentable in India • What is Paris convention? Principal features of Paris convention • Patenting multicellular organisms • Patenting and fundamental research	

RPZOOP402	**PRACTICAL** **Genome Management, Manipulation, Regulations And Patents In Biotechnology**	**Credits 2**
1.	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.	
2.	Demonstrate the western blotting technique for the given sample of protein.	
3.	Demonstrate the effect of medium on growth curves of given microorganism, using two different media (minimal &enriched).	

REFERENCES:

1. R. S. Crespi; Patents – a basic guide to patenting biotechnology, Cambridge Univ. Press
2. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers
3. Martin Fransman, GerdJunne, AnnemiekeRoobeek (Ed), The Biotechnology revolution?, Blackwell Scientific Publishers
4. Terence Cartwright, Animal Cells as Bioreactors, Cambridge Univ. Press
5. A. Rosevear, John F. Kennedy, Joaquim M. S. Cabral, Immobilized enzymes and cells, Adam Hilger Publishers, Bristol and Philadelphia
6. Micheal P. Tombs and Stepan E. Harding, An Introduction to polysaccharide biotechnology
7. T. A. Brown, Gene Cloning – An Introduction, 3rd Edition, Nelson Thornes
8. Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Publishers
9. U. Satyanarayan, Biotechnology, 2007 Reprint, Uppala Author Publisher Interlink

SPECIALIZATION – ANIMAL PHYSIOLOGY

Course Code: RPZOP403

Course Title: Comprehensive Physiology-II

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the physiology of respiration & nitrogen metabolism.
CO 2	Detailed learning in excretion physiology and studying the excretory systems present in various animals.
CO 3	Explore the new technologies used for human interventions.
CO 4	Understand the physiology of hormones in detail.

Detailed syllabus

RPZOP403	**Comprehensive Physiology-II**	**Credits 4**
Unit–I	**Physiology of Respiration and Nitrogen Metabolism**	**15 Lectures**
	Respiration: Transition from water to land- Vertebrates and invertebrates. O2 consumption, RQ and modifying agents: Activity, Temperature, Salinity, Photoperiod, Development, Hibernation, Animal size and metabolism.	
	Respiratory functions of blood: Respiratory pigments, respiratory acidosis and alkalosis, Alkali reserve Control and co-ordination of respiration	
	Nitrogen Metabolism: Amino-N Metabolism, Nucleic acid metabolism, Nitrogenous waste products.	
	Ammonia toxicity and detoxification pathways- Ammonotely, Ureotely, Purinotely, uricotely, Storage excretion.	
	Patterns of detoxification pathways in eggs and during metamorphosis, Phylogenetic patterns.	

Unit–II	**Dynamics of physiological fluids-composition**	**15 Lectures**
	Dynamics of fluid composition: Body fluid composition- water, solute and Intracellular regulation.	
	Cutaneous evaporation, Respiratory evaporation, Integrated functioning for nitrogen excretion and osmoregulation Contractile vacuole, Coelomoducts, Flame cells, Green gland, Malpighian Tubules, Invertebrate Nephredia and Vertebrate Nephron	
	Comparative physiology of vertebrate kidney	
	Kidney stones and kidney transplants - a human perspective	
	Transfusion, Blood Replacement- A human perspective.	
	Haemodialysis and peritoneal dialysis- A human perspective.	
Unit–III	**Physiology of Continuity of Life**	**15 Lectures**
	Physiology of Reproduction: Selfish gene, evolution of gametes, maternalDNA Endocrine regulation of reproduction in invertebrates, Molluscs, Crustaceans,Insects	
	Comparative account of vertebrate gonadotropins, gonadalsteroids.	
	Interaction of steroid hormones and nervoustissue.	
	Human intervention in Reproduction Contraceptives, MTP, Treatment of Infertility	
	Assisted Reproduction Techniques- IFV, GIFT, ICSI, ZIFT, DI, AID	
Unit–IV	**Endocrine regulation, sensory & effecter physiology**	**15 Lectures**
	Physiology of Endocrine Regulation: Specificity, Membrane bound receptor system, Cytosolic receptor system, Invertebrate Endocrine System, Lower invertebrates, Annelids, Molluscs, Crustaceans, Insects **Regulated supply of hormones**: Feedback: Direct and Indirect Hypothalamo-Hypophysicalaxis, Pineal-Pituitarygland,Thyroidand Adrenalgland,G-E-P(Gastro-entero-pancreatic) cells, Renal hormones Cardiac hormones, Prostaglandins.	
	Sensory and Effecter physiology SensoryPhysiology-	

	StructuralandFunctionalClassification,Modality Intensity, Sensory coding	
	Various receptors-Chemoreception, Mechanoreception,Electroreception, Thermoreception, Photoreception.	
	Physiological effectors:Cnidoblasts,BioluminescentsystemsChromatophores, electric organs.	
RPSZOPP403	**PRACTICAL** **Comprehensive Physiology-II**	**Credits 2**
1.	Determination of Urea, Creatinine in blood -Human/goat	
2.	Determination of serum content of uric acid, cholesterol – Human/goat	
3.	Effect of injection of insulin/ glucagon on the blood sugar and liver glycogen in rat/ mouse	
4.	Routine urine tests and preparation of report as per pathological laboratory.	
5.	Performance of Ouchterlony technique to demonstrate immune diffusion	
6.	Demonstration of single radical immune diffusion of antibody and antigen	
7.	Influence of sub lethal (50-60ppm) ammonia (as liquor ammonia/ ammonium hydroxide/ ammonium chloride) on a suitable fish exposed to ammonia stress for 3/7/15 days with reference to the following parameters: a. Level of excretory ammonia b. Level of activity of hepatic and brain glutamate dehydrogenase c. Level of amino acid content of muscle, gill, brain and liver	
8.	A survey based project to study physiological diagnostic tools with the help of local pathological laboratory/ hospital.	
9.	Effect of administration of carbon tetra chloride in rat/mice with reference to following parameters a. Total lipid and free fatty acid content of liver b. Free fatty acid content of plasma c. Level of activity of the following enzymes: AspAT, AlaAT, AICP, ACP, LDH, SDH and ATPase	

REFERENCES:

1. A. G. Giese: "Cell Physiology" (3rd Ed) Saunders, Toppan
2. Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
3. Darnell, Loddish, Baktimore: "Molecular Cell Biology" Scientific American Books.
4. C. A. Keil, E. Neil & E.N. Joeb (1982): "Samson Wright, Applied Physiology" Oxford Univ. Press.
5. R. Eckert & D. Randall (1982): "Animal Physiology: 2nd Ed." W. H. Freeman & Co.
6. W. A. Hoar (1982): "General & Comparative Animal Physiology 3rd Ed." Prentice Hall Inc.
7. C. L. Prosser (1973): "Comparative Animal Physiology" W. B. Saunders.
8. C. Ladd Prosser Ed. (1991): "Neural & Integrative Animal Physiology" "Comparative Animal Physiology", 4th Ed.Wileg – Liss Publ.
10. C. Ladd Prosser Ed. (1991): "Environmental & Metabolic Animal Physiology" "Comparative Animal Physiology" 4th Ed. Wileg – Liss Publ.
11. Withers, P.C. (1983): "Comparative Animal Physiology" International Ed. Saunders College Publishing.

Course Code: RPSZOP404

Course Title: Environmental and Applied physiology-II

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enumerate the pressure as environmental factor and study its effect at cellular level.
CO 2	Understand and gain the knowledge about temperature as an environmental factor and study its importance.
CO 3	Learn in detail about the biological rhythms and Photoperiodism.
CO 4	Understand the antibodies and organ function test as clinical diagnostic tool.

Detailed Syllabus

RPSZOP404	**Environmental and Applied physiology-II**	**Credits: 4**
Unit- I	**Pressure as an environmental factor**	**15 Lectures**
	Pressure as an environmental factor : • Fundamental effects of pressure on biological system	

	• Rate of enzyme action with respect to pressure • Effect of pressure on weak bonds and the consequences for higher orders of Protein structure. • Effectsofpressureoncellularprocessesviz.transcription,translationandgeneregulation • Strategiesofenzymeadaptationstopressureinmarineorganisms: FDPaseandPK	
Unit-II	**Temperature as environmental factor**	**15 Lectures**
	Temperature Regulation/ Response to temperature fluctuations: • Thermal limits ofsurvival • TemperatureandStructuraleffectswithresponsetoBiologicalmoleculesand biological membranes. • Temperature and rate effects: TemperaturedependentE~Saffinity,Lipoprotein enzymes. • Thermal resistance of dormant and active cells. • Ectothermy and endothermy. • Endothermy in invertebrates. • BiochemicaladaptationsofEctothermy:Antifreezesubstances, Heatshockproteins.	
Unit- III	**Radiation and Physiology of Biological Rhythms**	**15 Lectures**
	Physiology of Biological Rhythms and timings: • Temporal organization of the cells • Circadian Rhythms. Synchronization of circadian rhythms • Dormancy in fresh water and terrestrial animals • Preparatory phases, Induction of dormancy, Arousal from dormancy Entrainment and dormancy Diapause in insects-Induction, Factors affecting and termination of Diapause, Diapause and endocrine functions Photoperiodism Biological clocks	
Unit- IV	**Physiological Tools for clinical diagnostics**	**15 Lectures**
	Antibodies as diagnostic tools: • RIA- of GnRH, Gonadotropins, T3, T4, TSH, HCG, Insulin • ELISA-for detection of HCG , diagnosis of Amoebiasis,	

	Typhoid, HIV **Monoclonal antibodies as diagnostic tools:** • Detection of HCG, Diagnostic of STD, Streptococcal throat infections, Herpes and Cancer **Organ Function Tests as diagnostic tools**: • Liver function tests and toxicity tests • Pancreatic function tests • Gastric function tests • Kidney function tests.	
RPSZOPP404	**PROJECT**	**Credits 2**
• Research project will be executed; results tabulated & analyzed using appropriate statistical tools. • The research project will be submitted in the form of dissertation at the time of practical examination.		

REFERENCES:

1. K. Schmidt – Niel (1983): "Animal Physiology: Adaptation & Environmental" 3rd Ed. Cambridge Univ. Press.
2. R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
3. P. W. Hochachka & G. M. Somero (1973): "Strategies of Biochemical Adaptation".
4. J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
5. J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
6. Harold Harper: "Review of Physiology Chemistry" 4th Ed. Maruzen Asian Ed. Lang Medical Publ.
7. Richard Dawkins (1989): "Selfish Gene" Cambridge Univ. Press.
8. Leycock & Wise –"Essential Endocrinology" 2nd Ed. ELBS. Oxford Univ. Press.
9. . Introduction from Rac Silver & Karvey Feder: "Hormones & Reproduction Behaviour" Scientific Americal (Readings from) W. H. Freeman & Co.
10. . Marie A. Moisio & Elmer W. Moisio: "Understanding Laboratory & Diagnostic Tests" (1998) Delmar Publishers

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

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

Paper Pattern:

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

Practical Examination Pattern:

C) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

D) Modality for Project

Abstract	04
Materials and methods	04
Procedure followed	04
Observation	04
Interpretation of results	06
Conclusion and discussion	08
Bibliography	04
Viva voce base on the project	08
Power point presentation	08
Total- 50 Marks	

Overall Examination & Marks Distribution Pattern
Semester- IV

Course	RPSZOO401		RPSZOO402		RPSZOP403		RPSZOP404		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical's	50		50		50		50		200

Resolution No.: AC/I(19-20).2.RPS11

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for: Semester III & IV

Program: M.Sc-II

Program Code: Zoology (RPSZOO)

Specialization- Oceanography

(Credit Based Semester and Grading System
for the academic year 2020–2021)

SEMESTER- III

OCEANOGRAPHY

Course	Unit	TITLE	Credits
RPSZOO301	**Basics Of Industrial & Environmental Biotechnology-I**		
	I	The implications of recombinant DNA technology of commercial products and microbial synthesis	4
	II	Large scale culture & production from recombinant microorganisms&genetically engineered animal cells	
	III	Medical Biotechnology	
	IV	Environmental Biotechnology I	
RPSZOO302	**Genetic Engineering Techniques And Its Applications**		
	I	Genome management and analysis	4
	II	Manipulation of gene expression in prokaryotes	
	III	Bioinformatics	
	IV	Animal biotechnology and Human therapies	
RPSZOG303	**General, Physical, Chemical And Biological Oceanography**		
	I	General Oceanography	4
	II	Physical Oceanography	
	III	Chemical Oceanography	
	IV	Biological Oceanography	
RPSZOG304	**Planktology, Fish, Fishery Science, Immunology Of Fish And Aquaculture**		
	I	Planktology	4
	II	Fish And Fisheries Science	
	III	Immunology of Fish	
	IV	Aquaculture	
		PRACTICAL	
RPSZOOP301		Basics Of Industrial & Environmental Biotechnology-I	2
RPSZOOP302		Genetic Engineering Techniques And Its Applications	2
RPSZOGP303		General, Physical, Chemical And Biological Oceanography	2
RPSZOGP304		Project	2
Grand Total			**24**

Course Code: RPSZOO301

Course Title: Basics of Industrial and Environmental Biotechnology -I

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand and analyse the concepts of recombinant DNA technology, GMOs, antibiotic resistant genes.
CO 2	Identify different commercially useful amino acids.
CO 3	Evaluate and comprehend the methods of Large-scale culture production and maintenance.
CO 4	Compare and contrast between different methods of fermentation and their benefits.
CO 5	Identify and differentiate between different types of vaccines and their applications.

Detailed Syllabus

RPSZOO301	Basics Of Industrial & Environmental Biotechnology -I	Credits 4
Unit- I	**The implications of recombinant DNA technology of commercial products and microbial synthesis**	**15 Lectures**
	The implications of recombinant DNA technology • General account on applications of biotechnology • Commercialization of biotechnology & biotech companies • Prospects of novel food technology • Economics of microbial biotechnology • Areas of significant public concern: Antibiotic resistance marker gene, transfer of allergies, pollen transfer from GM plants, social, moral & ethical issues associated with GMOs.	
	Amino acids & their commercial use – production strain, process of L-glutamate, L-aspartate, L-phenylalanine, L-tryptophan.	

Unit-II	**Large scale culture & production from recombinant microorganisms & genetically engineered animal cells**	**15 Lectures**
	Large scale culture & production from recombinant microorganisms: • Batch fermentation • Fed batch fermentation • Continuous fermentation • Maximizing the efficiency of fermentation process • Harvesting, disrupting & downstream processing	
	Large scale culture & production from genetically engineered animal cell cultures: • Design of bioreactors for large scale animal cell culture- Batch, Fed batch • Mammalian cell lines & their characteristics • Media for the cultivation of mammalian cells • Commercial products produced with mammalian cell culture.	
Unit-III	**Medical Biotechnology**	**15 Lectures**
	Sub-unit vaccines • Sub-unit Vaccine production against viruses- Herpes simplex, Bovine foot &mouth disease virus • Peptide vaccines-synthetic drugs (engineered proteins) • Genetic immunization-DNA vaccines, Antisense DNA, Therapeutic ribozymes • Live recombinant vaccines • Attenuated vaccines against Cholera, Salmonella sp. • Vector vaccines-Vaccine directed against viruses-Rabies virus G-protein, Hepatitis B surface antigen • Anti-idiotypic vaccine for cancer treatment. • Multivalent subunit vaccine. • Microbiome. **Monoclonal antibodies (mAbs) & therapeutic applications**: • mAbs for prevention of rejection of transplanted organs • Treatment of bacterial blood infection • Human and Hybrid monoclonal antibodies • HIV therapeutic agents and Anti tumor antibodies	

Unit-IV	**Environmental Biotechnology I**	**15 Lectures**
	Biomass utilization • Microorganisms in lignocellulose degradation • Isolation of prokaryotic & eukaryotic cellulase gene • Manipulation of cellulase gene • Production of single cell proteins by using biomass as raw material • Commercial production of fructose and alcohol from biomass • Improvements of fructose and alcohol production • Fuel ethanol from biomass. • Biogas utilization	
	Bioremediation of aerobic compounds • Characteristics of xenobiotics in the environment • Characteristics of aerobic microorganisms for degradation of organic pollutants • Genetic engineering of biodegradative pathways- • Manipulation by transfer of plasmid, manipulation by gene alteration • Degradation of xenobiotic compounds-petroleum products, n-alkanes, alkenes, cycloaliphatic compounds, aromatic hydrocarbons, polyaromatic hydrocarbons, chlorinated organic compounds (aliphatic & aromatic)	
RPSZOOP301	**PRACTICAL** **Basics of Industrial & Environmental Biotechnology-I**	**Credits 2**
1.	Demonstration of aseptic technique: Work place for aseptic handling, packing glassware (flasks, test tubes, pipettes, petri dish) for sterilization, aseptic transfer of liquids (pipetting from flask to test tube)	
2.	Preparation of LB agar plate, slant, butt & demonstration of streaking technique using bacterial culture to obtain isolated colonies	
3.	Isolation of bacterial culture on differential media (Mac Conkeys agar).	
4.	To estimate the number of bacteria in the given culture by Nephelometry	

REFERENCES:

1. Johan E. Smith, Biotechnology, 3rd Edition, Cambridge Univ. Press
2. Colin Rateledge and Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge Univ. Press
3. Susan R. Barnum, Biotechnology – An Introduction, Vikas Publishing House
4. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.
5. Alexander N. Glazer and Hiroshi Nikaido, Microbial Biotechnology – Fundamentals of applied microbiology, W. H. Freeman and Co, New York
6. InduShekar Thakur, Environmental Biotechnology – Basic concepts and applications, I. K. International Pvt. Ltd, Mumbai, New Delhi
7. John A. Thomas (Ed.), Biotechnology and safety assessments, 2nd Edition, Taylor and Francis
8. S. S. Purohit, Biotechnology – Fundamentals and applications, 3rd Edition, Agrobios, India
9. Patent Facility Centre (PTC) Technology information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, New Delhi

Course Code: RPSZOO302

Course Title: Genetic Engineering Techniques and Its Applications

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the basic concepts of Genetic engineering, vectors, genomics, and proteomics.
CO 2	Compare and contrast between different types of cloning vectors, electrophoresis techniques and their applications.
CO 3	Evaluate and comprehend concepts of gene expression in prokaryotes and bioinformatics.
CO 4	Develop skills and demonstrate different techniques of aseptic transfer.
CO 5	Isolate and identify different bacterial colonies on agar plates.

Detailed Syllabus

RPSZOO302	Genetic Engineering Techniques And Its Applications	Credits 4
Unit-I	**Genome management and analysis**	**15 Lectures**
	The Basic tools of genetic engineering • Chemical Synthesis of DNA-Oligonucleotide synthesis by Phosphoramidite method, Synthesis of genes • DNA Sequencing -- Maxam-Gilbert method, Sanger's • dideoxynucleotide method, By using bacteriophage M13, By Primer walking, Next generation sequencing • PCR and its types (RT- PCR, nested and multiplex)	
	Cloning Vectors • General purpose plasmid vectors (pUC19, pBR322) (Bacterial Vectors) • Bacteriophage and cosmid vectors • Yeast artificial chromosomes (YACs)	
	Analysis of genome/proteome	

	• DNA fingerprinting/physical mapping/pulsed field gel electrophoresis • Analysis of the proteome– 2D PAGE & Mass spectroscopy. • Analysis of mRNA transcripts– DNA Microarray.	
Unit -II	**Manipulation of gene expression in prokaryotes**	**15 Lecture**
	Promoters of gene expression in prokaryotes • Prokaryotic gene expression • Isolation of functional promoters • Promoter selection with E.coli plasmid pBR316 • Promoter selection with plasmid pKO1 • Gene expression from strong and regulatable promoters	
	Expression of cloned genes in prokaryotes • Increasing protein production and secretion • Inclusion bodies and fusion proteins • Unidirectional tandem gene arrays • Translation expression vectors • Increasing protein stability	
Unit -III	**Bioinformatics**	**15 Lectures**
	Uses and application of computers in biological sciences DNA profiling: cDNA and EST's (expressed sequence tags) Basic research with DNA microarrays and its application in healthcare. Biomedical genome research and pharmaco genomics Random amplified polymorphic DNA (RAPD) Human genomic variation-SNP's (single nucleotide polymorphisms, SNP's and disease; QTL (quantitative trait loci) and its relation to SNP's Satellite DNA and its types	
Unit -IV	**Animal biotechnology and Human therapies**	**15 Lectures**
	Animal Biotechnology • Transgenic animals and their applications: Mice as model system for human diseases and as test case model, Cows, pigs, sheep, goats as biopharmaceuticals, Transgenic insects and birds.	

	• Recombinant DNA technology to prevent animal diseases • Conservation biology-Embryo transfer • Regulation of transgenic animals and patenting genetically engineered animals • Knockout mice (Cre- loxP system)	
	Human therapies • Tissue engineering: Skin, liver, pancreas • Xeno transplantation • Antibody engineering • Cell adhesion based therapies: Integrins, Inflammation, Cancer and metastasis • Targeted gene replacement for correcting a mutated gene • Site directed mutagenesis	
RPSZOOP302	**PRACTICAL** **Genetic Engineering Techniques And Its Applications**	**Credits 2**
1.	Determination of Air microflora	
2.	Determinations of viable cell counts in the given culture of bacteria by dilution, spreading and pour plate technique.	
3.	Using mini-prep method isolate plasmid DNA from the given strain of bacteria & show the purity of the isolate by performing agarose gel electrophoresis	

REFERENCES:

1. R. S. Crespi; Patents – a basic guide to patenting biotechnology, Cambridge Univ. Press
2. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers
3. Martin Fransman, GerdJunne, AnnemiekeRoobeek (Ed), The Biotechnology revolution?, Blackwell Scientific Publishers
4. Terence Cartwright, Animal Cells as Bioreactors, Cambridge Univ. Press
5. A. Rosevear, John F. Kennedy, Joaquim M. S. Cabral, Immobilized enzymes and cells, Adam Hilger Publishers, Bristol and Philadelphia
6. Micheal P. Tombs and Stepan E. Harding, An Introduction to polysaccharide biotechnology
7. T. A. Brown, Gene Cloning – An Introduction, 3rd Edition, Nelson Thornes

8. Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Publishers
9. U. Satyanarayan, Biotechnology, 2007 Reprint, Uppala Author Publisher Interlink

SPECIALIZATION- OCEANOGRAPHY

Course Code: RPSZOG303

Course Title: General, Physical, Chemical and Biological Oceanography

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Explain the theory of plate tectonics and correlate it to the formation of the major features of the sea-floor.
CO 2	Demonstrate how the oceans are connected to and drive major Earth ocean processes, such as atmospheric and oceanic circulation, climate and weather being helpful to students in the field of research.
CO 3	Understand the different parameters of Sea supporting life under water.
CO 4	Interpret the relationship of Salinity, Temperature and Density.
CO 5	Enumerate the factors affecting on marine life.

Detailed Syllabus

RPSZOG303	General, Physical, Chemical and Biological Oceanography	Credits 4
Unit–I	**General oceanography**	**15 Lectures**
	Terminology of submarine topography Continental shelf, continental slope, submarine canyons, submarine mountain ranges, Guyots and trenches with special reference to the Indian Ocean and adjacent seas.	
	A general knowledge of typical oceanographic research vessel and its equipments, oceanographic labs and stations of the world	

	and India**.**	
	General properties of sea water: Salinity, Chlorinity, Temperature, Light, Density, Pressure, Salinity-Temperature-Density Relationship (STD).	
Unit–II	**Physical oceanography**	**15 Lectures**
	Vertical circulation: wind induced circulation, Thermohaline circulation and upwelling of water**.**	
	Waves: Characteristics of waves, deep water and shallow water waves, transitionalwaves, wind generated waves, internal waves and Tsunami	
	Tides: Tides generating forces, equilibrium theory of tides, dynamic theory of tides,tides as a source of power.	
	Currents: Types of currents, major currents of the world, Coriolis effect and El Nino effect.	
	Oceanographic circulation: Ekman spiral, geotropic current, westward intensification with dynamic topography.	
Unit–III	**Chemical oceanography**	**15 Lectures**
	Composition of sea water- constancy of its composition and factors affecting the composition, major and minor constituents, trace elements and their biological role.	
	Dissolved gases in the sea water and their role in the environment, CO2system, dissolved O2 and oxygen profile, hydrogen sulphide.	
	Nutrients in the ocean, their cycles and factors influencing their distribution a) Nitrogen b) Phosphorus c) Silicon.	
Unit–IV	**Biological oceanography**	**15 Lectures**
	Division of marine environment. • Marine biotic diversity: Plankton, Nekton, Benthos- brief account, Implications of species richness, measuring diversity, quadrients of species diversity, models explaining diversity gradient. • Intertidal organisms and their zonation. • Changing shore lines and erosion.	

	Effect of physical factors on marine life • Light: photosynthesis, colouration, structural adaptations, bioluminescence. • Temperature: tolerance, geographical distribution, size, calciumprecipitation, metabolism, bipolarity, tropical submergence and periodicity. • Salinity: tolerance and distribution, size, buoyancy and osmoregulation. • Currents: role in nutrition, transportation and propogation. • Marine bacteria and their role.	
RPSZOGP303	**PRACTICAL** **General, Physical, Chemical and Biological Oceanography**	**Credits 2**
1.	Physical and chemical oceanography:(Uniform methods for all colleges to be followed Determination of physico-chemical parameters: i. Salinity (Argentometric and conductivity method) ii. Dissolved oxygen, iii. Carbon dioxide. iv. Nitrates-nitrites. v. Silicates. vi. Phosphate-phosphorus.	
2.	Textural features**:** Sediment analysis- size fraction (sand, silt, clay)	
3.	Identification of foraminiferans and radiolarians from sand.	
4.	Estimation of primary productivity by light and dark bottle**.**	
5.	Identification of intertidal organisms: • **Rocky shore**- Patella, Chiton, Fissurella, Mytilus species, *Pernaviridis*, Cardium, Balanus, Gorgonids, Littorina and Corals. • **Sandy shore**: Solen, Umbonium, Oliva, Pea crab, Fiddler crab, Molluscan shells, Starfish and Balanoglossus. • **Muddy shore**: Lingula, Chaetopterus, Arenicola, Tubiculus worm and Mud skipper. • Laboratory procedure for quantitative estimation of plankton	

	settling method, wet weight method, weight displacement method, counting method.	
6.	Identification of Zooplankton permanent slides Noctiluca, Obelia medusa, Zoea, Zoea porcelina, Copepods, Mysids, Echinoderm larvae, Nauplius, Sagitta, Doliolum, Salpa, Fish eggs and larvae, Jelly fish, Physalia, Porpita	
7.	Study of fecundity-maturation studies.	
8.	Plotting the frequency polygon by ova diameter measurement.	
9.	Identification and classification of Marine fishes List of Marine fishes **Elasmobranchs** **i.** Family- Carcharidae *Carcharias* sps. *Zygaena malleus* **ii.** Family- Rhinobatidae *Rhynchobatusdjeddensis* **iii.** Family- Trygonidae *Trygonuarnak* **Teleost** **iv.** Family- Percidae *Lutianusjohnii, Therapon*sps., *Pristipomamaculatum,Synagrisjaponicus, Gerresfilamentosus* **v.** Family- Squamipinnes *Scatophagusargus* **vi.** Family – Mullidae *Upenoidesvittatus* **vii.** Family- Polynemidae *Polynemustetradactylus* **viii.** Family- Sciaenidae *Pseudosciaenadiacanthus, Sciaena*sps. **ix.** Family- Trichuridae *Trichurussavala/ haumela* **x.** Family- Carangidae *Caranxrottleri, Chorinemustoloo* **xi.** Family- Stromatidae *Pampuschinensis, Pampus argenteus* **xii.** Family- Scombridae *Rastrelligerkanagurta, Cybiumguttatum* **xiii.** Family- Trachinidae *Sillagosihama* **xiv.** Family- Cottidae	

	Platycephalus punctatus **xv.** Family- Gobidae *Periophthalmus*sps.,*Boleophthalmus*sps. **xvi.** Family- Sphyraenidae *Sphyraenaacutippinis* **xvii.** Family- Mugillidae *Mugil*sps. **viii.** Family- Gadidae *Bregmaceros*sps. **xix.** Family- Pleuronectidae *Psettodeserumei, Cynoglossus elongatus* **xx.** Family- Siluridae *Arius dussumieri* **xxi.** Family- Scopelidae *Sauridatumbil, Harpodonnehereus* **xxii.** Family- Sombresocidae *Belone stongylurus, Hemiramphus*sps. **xxiii.**Family- Clupeidae *Pellonafeligera, Clupea longiceps* **xxiv.**Family- Chirocentridae *Chirocentrusdorab* **xxv.**Family- Muraenesox*Muraenesox*sps.	
10.	Cells and tissues of Immune system of fishes	

REFERENCES:

1. Svedrup et al., The Oceans.
2. N.B. Nair and D.H Thampi., Atextbook of marine ecology, T-M-H.
3. Harold Thurman, Introductory oceanography, Prentice Hall. London.
4. QasimS.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London. NavyaPrinters, Hyderabad.
5. Michael King, Fisheries Biology assessment and management, Fishing News Publishers, 1995.
6. R. GordobPirje, Oceanography.
7. Newell and Newell, Marine Plankton.
8. Jhingran, Fish and fisheries
9. P. Michal, Ecologival methods for field and laboratory investigations.
10. R.V. Tait, Marine zoology, Oxford press.
11. David Ross, Introduction to Oceanography.
12. Carl Schliper, Research method in marine biology.

13. B.F. Chapgar, Sea Shore life of India, SIDGWICK and JACKSON, London
14. D.V. Bal and K.V. Rao, Marine fisheries of India, T-M-H.
15. Russel and Young, The Seas

Course Code: RPSZOG304

Course Title: Planktology, fish, fishery science, immunology of fish and aquaculture

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Gain an overview of fishery science and aquaculture industry.
CO 2	Enumerate different adaptations of plankton and interrelate it with environmental conditions.
CO 3	Identify the role of the immunological system of fish, its components and various external factors that affect it.
CO 4	Compare and contrast between different fisheries and aquaculture systems.
CO 5	Understand and recall fish classification with the help Francis Day Volume.

Detailed Syllabus

RPSZOG304	Planktology, fish, fishery science, immunology of fish and aquaculture	Credits 4
Unit –I	**Planktology**	**15 Lectures**
	Classification of Plankton: Adaptation to planktonic life. Factors influencing the distribution and abundance, plankton bloom, patchiness, vertical distribution and red tide.	
	Diurnal migration of zooplankton.	
	Inter-relationship between phyto and zooplankton.	
Unit–II	**Fish and fisheries science**	**15 Lectures**

	• An overview of fish classification as per Francis Day and FAO. • Major commercial fisheries: Elasmobranchs (shark and ray) • Teleosts**:**Sciaenoids, Indian salmon, Seer fish, Mackerel, Sardine, Carangids, Tuna, Sole fish, Harpodon, Ribbon fish fisheries. • Crustacean fisheries**:** Prawns (penaeid and non penaeid), Shrimps, Lobster and Crab. • Molluscan fisheries**.** • Seaweeds	
	CRZ and fishing regulations	
Unit –III	**Immunology of fish**	**15 Lectures**
	Defense system: Specific and non-specific	
	Response to pathogens	
	Fish vaccinations	
	Ontogeny of fish immune system	
	Fish leucocytes	
Unit –IV	**Aquaculture**	**15 Lectures**
	History, scope and importance of aquaculture: Aquaculture practices in India. Cultivable organisms for aquaculture and criterion for their selection.	
	Different systems of aquaculture such as Pond Culture, Cage Culture, PenCulture, Running Water Aquaculture, Raft Culture,Aquaranching.	
	Aquaculture of Indian major carps and *MacrobrachiumRosenbergii*	
	Impact of aquaculture on environment.	
RPSZOGP304	**PROJECT**	**Credits 2**
• Each student will choose a different topic related to the syllabus. • Students will submit their Project Proposal Having Introduction, Review of Literature, Materials and Methods, Expected Outcomes & References.		

REFERENCES:

1. Kurian and Sebastian, Prawn and prawn fisheries of India.
2. M. Krishna Pillai. Introduction to Planktology, Himalaya Publishing
3. A.A. Fincham. Basic marine biology, British Museum Natural History.
4. Latha Shenoy. Course manual in fishing technology, CIFE, Versova, Mumbai.

5. Jefferey F. Raymond, Plankton and productivity, Vol. I and II.
6. J.S.Levington, Marine Biology, Function, biodiversity, ecology. Oxford University Press.
7. Wealth of India, Vol. IV, CSIR Publications.
8. S.P. Biswas, Manual of methods in fish biology, South Asian publishers private Ltd., New Delhi.
9. J.P. Rilcy and R, Chester, Introduction to marine chemistry, Academic Press, London and New Delhi.
10. American Public Health Association-2000.
11. J.V.R. Pillai, Aquaculture principles and plasia, Blackwell Scientific pub.
12. Das P. and JhingranA.C.G., Fish genetics in India.
13. Colin E. Purdon, Genetics and Fish breeding, Chapman and Hall.
14. Schroder J.J., Genetics and Mutagenesis of fish, Chapman and Hall.
15. P. Bensam. Development of marine fishery sciences in India, Daya publishing House.

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

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

Paper Pattern:

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

Practical Examination Pattern:

C) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45

Total	50

D) Modality for Project

Topic / Title	02
Literature survey	08
Objective and purpose	06
Material and Method	08
Work plan with timeline	10
Expected outcome	08
Viva voce based on proposal	08
Total- 50 Marks	

Overall Examination & Marks Distribution Pattern
Semester-III

Course	RPSZOO301		RPSZOO302		RPSZOG303		RPSZOG304		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical's	50		50		50		50		200

SEMESTER- IV

OCEANOGRAPHY

Course	Unit	TITLE	Credits
RPSZOO401	**Basics Of Industrial & Environmental Biotechnology II**		4
	I	Microbial synthesis of commercial products	
	II	Large scale culture & production for industrial biotechnology	
	III	Agricultural Biotechnology	
	IV	Environmental Biotechnology II	
RPSZOO402	**Genome Management, Manipulation, Regulations And Patents In Biotechnology**		4
	I	Genome management	
	II	Manipulation of gene expression in eukaryotes	
	III	The human genome project	
	IV	Regulations and patents in biotechnology	
RPSZOG403	**Oceanographic Instruments And Expeditions, Marine Ecology, Marine Pollution And Biological Resources**		4
	I	Oceanographic Instruments And Expeditions	
	II	Marine Ecology	
	III	Marine Pollution And Reclamation	
	IV	Biological Resources	
RPSZOG404	**Planktology, Fish, Fishery Science And Biology Of The Ocean**		4
	I	Planktology	
	II	Fish And Fisheries Science	
	III	Biotechnology In Fishery And Biometric Studies	
	IV	Biology Of The Ocean	
	PRACTICAL		
RPSZOOP401		Basics Of Industrial & Environmental Biotechnology II	2
RPSZOOP402		Genome Management, Manipulation, Regulations And Patents In Biotechnology	2
RPSZOGP403		Oceanographic Instruments And Expeditions, Marine Ecology, Marine Pollution And Biological Resources	2
RPSZOGP404		Project	2
Grand Total			**24**

SEMESTER-IV

Course Code: RPSZOO401

Course Title: Basics of Industrial & Environmental Biotechnology II

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Comprehend and understand the concepts of microbial synthesis of organic acids, polysaccharides, antibiotics, and their applications.
CO 2	Compare and contrast between different methods of immobilization.
CO 3	Evaluate and analyse the different techniques used in agricultural biotechnology.
CO 4	Compare and contrast between different types of bioreactors of bio-absorption and methods of bioleaching.
CO 5	Develop skills and demonstrate the technique of immobilization of cells

Detailed Syllabus

RPSZOO401	Basics Of Industrial & Environmental Biotechnology II	Credits 4
Unit-I	**Microbial synthesis of commercial products**	**15 Lectures**
	Microbial synthesis of commercial products. • Organic acids & their commercial applications – Citric acid, gluconic acid,lactic acid, Acetic acid. • Antibiotics – Cloning antibiotic biosynthetic gene by complementation & otherAminoglycosides & their use **Polysaccharides:** • Bacterial polysaccharides: General properties & their commercial applications- • Dextran, Xanthan, Alginate. • Genetic engineering for the large scale production of Xanthan gum & it's modification • Marine polysaccharides: General properties & their commercial application-Agar &agarose, Chitosan	

	• Polyesters: Polyhydroxyalkanoates (PHA)-Biosynthesis of PHA, Biopol-commercial biodegradable plastic.	
Unit -II	**Large scale culture & production for industrial biotechnology**	**15 Lectures**
	Biotransformations • Selection of biocatalyst-screening & use of novel existing biocatalyst • Genetic modification of existing biocatalyst (Indigo biosynthesis) **Biocatalyst immobilization-** • Methods of immobilization- Cross linking, supported immobilization,adsorption & ionic binding, covalent coupling, lattice entrapment • Immobilized soluble enzymes & suspended cells • Immobilization of multi-enzyme systems & cells • Immobilized enzyme reactors- Batch reactors, continuous reactors **Analytical enzymes-** • Enzymes in diagnostic assays: Test strip systems & Biosensor Electrochemical & optical type.	
Unit -III	**Agricultural Biotechnology**	**15 Lectures**
	Agricultural Biotechnology: • Nitrogen fixation • Nitogenase-Component of nitrogenase; Genetic engineering of nitrogenasecluster • Hydrogenase-Hydrogen metabolism • Genetic engineering of hydrogenase gene • Nodulation-Competition among nodulation organisms, genetic engineering of nodulation gene • Microbial insecticides-Toxins of Bacillus thuringiensis, mode of action & use of thuringiensis toxins, thuringiensis toxin gene isolation, genetic engineering of Bacillus thuringiensis strains& cloning of thuringiotoxin gene. • Developing insect resistant, virus resistant & herbicide resistant plant	

	• Algal products: Fuels from algae, marine natural products & their medical potential-anticancer, antiviral compounds, anti bacterial compounds.	
Unit- IV	**Environmental Biotechnology II**	**15 Lectures**
	Bioabsorption of metals (Recovery from effluents) • Bioabsorption by fungi, algae, moss & bacteria • Mechanism of bacterial metal resistance & genetic engineering for specific Proteins. • Bioreactors for bioabsorption-packed bed, fluidized bed, rotating disc, single blanket, sequential reactors • Phytoremediation & its use in biotechnology	
	Bioleaching of metals • Biochemical mechanism of bioleaching • Extraction from mixtures • Types of bioleaching • Methods for bioleaching-Tank & heap bioleaching • Microorganisms used for bioleching	
RPZOOP401	**PRACTICAL** **Basics Of Industrial & Environmental Biotechnology- II**	**Credits 2**
1.	Immobilize Yeast cells in calcium alginate & prepare a bioreactor column to demonstrate Invertase activity in the bioreactor column.	
2.	Antibiotic sensitivity test.	
3.	To plot a growth curve for the microorganisms provided.	
4.	To determine the portability of given water sample by MPN method.	

REFERENCES:

1. Johan E. Smith, Biotechnology, 3rd Edition, Cambridge Univ. Press
2. Colin Rateledge and Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge Univ. Press
3. Susan R. Barnum, Biotechnology – An Introduction, Vikas Publishing House
4. Bernard R. Glick and Jack J. Pasternack, Molecular Biotechnology – Principles and applications of recombinant DNA, ASM Press, Washington DC.

5. Alexander N. Glazer and Hiroshi Nikaido, Microbial Biotechnology – Fundamentals of applied microbiology, W. H. Freeman and Co, New York
6. Indu Shekar Thakur, Environmental Biotechnology – Basic concepts and applications, I. K. International Pvt. Ltd, Mumbai, New Delhi
7. John A. Thomas (Ed.), Biotechnology and safety assessments, 2nd Edition, Taylor and Francis
8. S. S. Purohit, Biotechnology – Fundamentals and applications, 3rd Edition, Agrobios, India
9. Patent Facility Centre (PTC) Technology information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, New Delhi

Course Code: RPSZOO402

Course Title: Genome Management, Manipulation, Regulations and Patents in Biotechnology

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Evaluate and analyse different tools used for genetic engineering.
CO 2	Compare and contrast between different tools for gene transfer techniques and cloning vectors.
CO 3	Understand and comprehend the concept of manipulation of gene expression in eukaryotes.
CO 4	Understand the human genome project, its applications and interpret genetic linkage maps.
CO 5	Construct genetic linkage maps and physical maps and integrate them.

Detailed Syllabus

RPSZOO402	**Genome Management, Manipulation, Regulations and Patents In Biotechnology**	**Credits 4**
Unit-I	**Genome management**	**15 Lectures**
	The Basic tools of genetic engineering • Gene transfer techniques: Protoplast fusion, calcium phosphate, precipitation, electroporation, liposome, ligand mediated, gene gun or biolistic approach, viral mediated • Selection and screening of recombinants • Nucleic acid probes and hybridization, Southern blotting and Northern blotting. • Immunological assays for identification of gene product, Western blot, Flow cytometry.	
	Cloning Vectors • Retrovirus and SV40 vectors • Special purpose vectors- Expression vectors, Secretion vectors, Shuttle or bi-functional vectors, single stranded phage and phagemids	
Unit -II	**Manipulation of gene expression in eukaryotes**	**15 Lectures**
	• Eukaryotic gene expression • Introduction of DNA into fungi-yeast and filamentous fungi (fungal transformation) • Heterologous proteins production in yeasts • Heterologous proteins production in filamentous fungi • Cultured insect cells expression systems Baculovirus transfer vector • Mammalian cell expression systems- Human Papova BK virus shuttle vector	
Unit-III	**The human genome project**	**15 Lectures**
	• The human genome, scope and goals of the project • Genetic linkage maps, chromosome walking, restriction mapping • Polymorphic DNA markers(RFLP, AFLP, VNTR) • Restriction fragment length polymorphism (RFLP) and its uses	

	• RNAi and its application to treat human disease. • Physical maps, Sequence tagged sites. • Integrating genetic linkage and physical maps • Mapping human diseases • Positional cloning: Getting closer to a disease causing gene (Cystic fibrosis) • Testing for exons.	
	• Limitations of positional cloning. FISH	
Unit-IV	**Regulations and patents in biotechnology**	**15 lectures**
	Regulating recombinant DNA technology • Regulatory requirements – safety of genetically engineered foods Chymosin, tryptophan, bovine somatotropin • Regulation environmental release of genetically engineered organism (GEO). Ice minus Pseudomonas syringae • Regulatory agencies and laws for product regulation • Risk assessment: How much risk? • Open field tests of GEO • Development of policy for Human gene therapy	
	Patenting biotechnology inventions • What constitutes the patent? • The patent process • The conditions to be satisfied for an invention to be patentable :Novelty, Inventiveness, Usefulness • Patenting in different countries, types of inventions that are not patentable in India • What is Paris convention? Principal features of Paris convention • Patenting multicellular organisms • Patenting and fundamental research	
RPSZOOP402	**PRACTICAL** **Genome Management, Manipulation, Regulations And Patents In Biotechnology**	**Credits 2**
1.	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.	

2.	Demonstrate the western blotting technique for the given sample of protein.	
3.	Demonstrate the effect of medium on growth curves of given microorganism, using two different media (minimal &enriched).	

REFERENCES:

1. R. S. Crespi; Patents – a basic guide to patenting biotechnology, Cambridge Univ. Press
2. R. E. Speir, J. B. Griffiths, W. Berthold (Ed), Animal Cell Technology – Products of today, prospects of tomorrow, Butterworth –Heinman Publishers
3. Martin Fransman, GerdJunne, AnnemiekeRoobeek (Ed), The Biotechnology revolution?, Blackwell Scientific Publishers
4. Terence Cartwright, Animal Cells as Bioreactors, Cambridge Univ. Press
5. A. Rosevear, John F. Kennedy, Joaquim M. S. Cabral, Immobilized enzymes and cells, Adam Hilger Publishers, Bristol and Philadelphia
6. Micheal P. Tombs and Stepan E. Harding, An Introduction to polysaccharide biotechnology
7. T. A. Brown, Gene Cloning – An Introduction, 3rd Edition, Nelson Thornes
8. Bob Old and S. B. Primrose, Principles of Gene Manipulation, 5th Edition, Wiley Blackwell Publishers
9. U. Satyanarayan, Biotechnology, 2007 Reprint, Uppala Author Publisher Interlink

SPECIALIZATION- OCEANOGRAPHY

Course Code: RPSZOG403

Course Title: Oceanographic instruments and expeditions, marine ecology, marine pollution and biological resources

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Identify and explain the various oceanographic instruments for the purpose of studying physic-chemical parameters of the sea, necessary for research purposes.
CO 2	Enumerate the various habitats of marine organisms and their variations.
CO 3	Analyze the repercussions of anthropogenic activities on the sea and resources obtained from the sea and economy they generate.
CO 4	Understand and evaluate the marine ecology and impact of pollution on it.

Detailed Syllabus

RPSZOG403	Oceanographic instruments and expeditions, marine ecology, marine pollution and biological resources	Credits 4
Unit-I	**Oceanographic instruments and expeditions**	**15 Lectures**
	Oceanographic instruments: Grab (Peterson and Van veen) for benthos collection, naturalist's dredge (Ekman Sanders deep sea anchor dredge), trawl, plankton nets and continuous plankton sampling system, Reversing Nansen bottles, Reversing thermometer, Salinometer, Secchi disc, Stempel's pipette and dilution jar, underwater photography, remote sensing and satellite imaging, SCUBA apparatus.	
	Oceanographic Expeditions: Challenger, Indian Ocean and Antarctic.	
	Law of sea**.**	
Unit–II	**Marine ecology**	**15**

		Lectures
	Coastal ecosystems, estuaries, Coral reefs and Bays	
	Salt marshes and salt pans	
	Mangroves	
	Marine eutrophication	
Unit –III	**Marine pollution and reclamation**	**15 Lectures**
	Impact of anthropogenic activities: Pollution- • Domestic sewage, industrial/heavy metals. Agricultural-fertilizers and pesticides. • Oil pollution. • Ocean dumping. • Radioactive and Thermal waste. Reclamation. Ocean Acidification Impacts of Global Warming	
Unit –IV	**Biological resources**	**15 Lectures**
	Resources from the sea: Mineral resources: • Continental margin. • Deep sea mud oozes and manganese nodules. • Oil, gas and sulphur deposits and role of ONGC. • Bioactive compounds from the sea. • Scientific and economical aspect of seabed exploration and mining.	
RPSZOGP403	**PRACTICAL** **Oceanographic instruments and expeditions, marine ecology, marine pollution and biological resources**	**Credits 2**
1.	**Oceanographic instruments**: i. Nansen reversing bottle. ii. Deep sea reversing thermometer. iii. Bathythermometer iv. Drift bottle v. Ekman's current meter vi. Secchi disc vii. Plankton nets: Standard net, Hensen net and Clarke Bumpus net	

	viii. Stemple pipette and counting slide ix. Nekton sampling device-trawls x. Benthic sampling devices-dredges, grabs and corers	
2.	**Detection of heavy metals**: i Zinc ii Lead iii Copper.	
3.	Food and feeding in fish.	
4.	Preparation of Zooplankton mountings.	
5.	**Biometric studies of fish/ prawn** i. Study of relationship between total length and standard length/head length/body depth length/body weight. ii. Calculate correlation (standard length and total length, head length and total length,body depth and total length). Calculate the index values for various relationships.	
6.	**Identification of fouling and boring organisms** Limnoriasps., Lepas, Balanus, Caprella, Teredo, Littorina, Crassostrea, Pellaria/ Sertularia	
7.	**Identification and classification of fresh water fishes** Rohu, Catla, Mrigal, Tilapia, Gourami and fresh water giant prawn (*Macrobrachiumrosenbergii*).	
8.	**Crustacean fishery** *Penaeus monodon, P. indicus, M.monoceros, P. stylifera, Solenoceraindica,Nematopaleomon, Acetes indicus*	
9.	**Molluscan fishery** *Meretrix, Pernaviridis, Katelysiasps., Crassostriasps., Xancuspyrum, Solenkempi,* Cuttle fish and gastropods.	

REFERENCES:

1. Svedrup et al., The Oceans.
2. N.B. Nair and D.H Thampi., Atextbook of marine ecology, T-M-H.
3. Harold Thurman, Introductory oceanography, Prentice Hall. London.
4. QasimS.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London. NavyaPrinters, Hyderabad.
5. Michael King, Fisheries Biology assessment and management, Fishing News Publishers, 1995.
6. R. GordobPirje, Oceanography.
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9. P. Michal, Ecologival methods for field and laboratory investigations.

10. R.V. Tait, Marine zoology, Oxford press.
11. David Ross, Introduction to Oceanography.
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Course Code: RPSZOG404

Course Title: Planktology, fish, fishery science and biology of the ocean

Academic year 2020-21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Enumerate the methods used in studies of planktons and learn about their relationship with other marine organisms.
CO 2	Interrelate the relationship between different plankton species and fisheries and understand the role of plankton as indicator species.
CO 3	Analyze the statistical methods widely used in research analysis and also the factors affecting the dynamics of a population.
CO 4	Identify the various endogenous rhythms in the oceans and discuss the types of reproduction and larvae found in marine organisms.
CO 5	Understand the techniques used in biometric studies of fishes.

Detailed syllabus

RPSZOG404	**Planktology, fish, fishery science and biology of the ocean**	**Credits 4**
Unit –I	**Planktology**	**15 Lectures**
	Marine algae and plankton in relation to fisheries**.**	
	Indicator species	
	Methods of collection, preservation and analysis of plankton.	
	Marine Bio-deterioration: Fouling and Boring organisms.	
Unit–II	**Fish and fisheries science**	**15 Lectures**
	Population Dynamics Abundance in population and fishery. Fishery catches and fluctuation. M.S.Y., Optimum Yield, Age Composition, Population Growth, Population Models.	
	Socio-economics of fishermen.	
Unit –III	**Biotechnology in fishery and biometric studies**	**15 Lectures**
	Statistical methods: Collection of data, Sampling methods, Presentation data, Measurement of centraltendency and dispersion, Frequency distribution, Analysis of variance and co-variance, Correlation regression, Theory of probability, Tests of significance, Chi-square test.	
	Measurement of fish: • Measurement of length and weight • Morphometric measurements • Merestic counts	
Unit – IV	**Biology of the ocean**	**15 Lectures**
	Endogenous rhythms : biological clocks, lunar periodicity and tidal rhythms.	
	Sense Organs: types of organs and their functions	
	General account of reproduction in marine organisms.	

	General account of different types of larvae in Crustacea, Mollusca, Echinodermata and Teleost	
RPSZOGP404	**PROJECT**	**Credits 2**
• Research project will be executed; results tabulated & analyzed using appropriate statistical tools. • The research project will be submitted in the form of dissertation at the time of practical examination.		

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Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

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

B) External Examination- 60%- 60 Marks

Semester End Theory Examination:

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

Paper Pattern:

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

Practical Examination Pattern:

C) External Examination: 50 Marks

Particulars	Marks
Journal	05
Experimental tasks/ Viva	45
Total	50

D) Modality for Project

Abstract	04
Material methods	04
Procedure followed	04
Observation	04
Interpretation of results	06
Conclusion and discussion	08
Bibliography	04
Viva voce base on the project	08
Power point presentation	08
Total- 50 Marks	

Overall Examination & Marks Distribution Pattern
Semester-IV

Course	RPSZOO401		RPSZOO402		RPSZOG403		RPSZOG404		Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External	
Theory	40	60	40	60	40	60	40	60	400
Practical's	50		50		50		50		200