Mangalore University

Department of Applied Zoology

M.Sc. Zoology
Choice Based Credit System
(CBCS)

SYLLABUS

2016

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PREAMBLE

In an attempt to make the post graduate courses competitive and on par withthe global standards, University Grants Commission had directed implementation of Choice-Based Credit System. The syllabi of various courses are being updated by Mangalore University. In keeping with the current style and developments in Animal Sciences the course content is being modified. To provide an opportunity to the student to opt for various courses customised for his/her inclination,choice is provided through soft-core courses and open elective courses. A solid grounding in a subject is provided through hard-core courses which are mandatory. There will thus, be a component of hard-core, soft-core and open-elective courses. Open-elective courses are to be opted during 2nd and 3rd Semester.

The present syllabus designed by the Board of studies spans over IV semesters. It will have a total of 88 credits, of which 50 credits (57%) form the hard-core, 32 credits (36%) form the soft-core and open electives account for 6 credits. The scheme of examinations and internal assessment is also provided. The calculation of credits and CGPA will be as per the guidelines of the University

Chairman
Board of Studies

M.Sc. ZOOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER PATTERN

Scheme of Examinations and Evaluation;

One credit of a course shall normally be evaluated for 30-35 marks in the final assessment (internal assessment + final examination). Thus a 5 credit course shall normally carry 150 marks and a 4 credit course shall normally carry 100 marks.

The theory and practical component of a course shall be evaluated as below;

3 hours of theory (3 credits)	**Marks**
Internal assessment	30
Final examination	70

4 hours Practical (2 credits)

Internal assessment	15
Final examination	35
Total	150

Thus a course with 3 hours of lectures (3 credits) and 4 hours of practical/laboratory (2 credits) shall carry 150 marks in the final assessment.

Soft core (practical) – 2hrs (1 credit), 2 practical are clubbed for 2 credits
Internal assessment: 15 (7.5 marks for each of the course clubbed)
Final examination : 35 (17.5 marks for each of the course clubbed)

Internal assessment shall be as below:

Theory

a. 2 objective tests for a total of 20 marks
b. 1 theory test for a total of 70 marks
c. The marks obtained shall be reduced to 30
d. Assignment/Seminar may be given in lieu of an objective test as decided by the departmental council.

Practical/laboratory

a. Continuous assessment or a practical test ordinarily during 14th week for 10 marks.
b. Records to be valued for 5 marks. The total maximum shall be 15 marks.

Project work(field/ laboratory work)

Project work carries 5 credits (field/laboratory).Internal assessment shall be based on

		Marks
a)	one objective test in the field of study	10
b)	one viva voce	35
		Total 45

Final examination shall carry 105 marks and the dissertation shall be sent for central valuation. A dissertation/project report shall be evaluated by 2 examiners one external and one internal from out of the panel of examiners preparedby the B.O.S. and approved by the University.

Pattern of Question Paper

Theory

One question (question I) with five subdivisions (a-e) representing all units with each subdivision carrying 2 marks. Five questions (question II to VI) of 12 mark each. One question from each unit of the syllabus. A question may have not more than 3 subdivisions (Example. II a, b, c) all carrying equal marks.

Q I. a-e : Short questions one from each unit. 5 x 2 = 10

QII to QVI : Each question for 12 marks (One question of 12 marks or Two questions of 6 marks each or three questions of 4 marks each) representing unit 1 to 5 with internal choice.

Practical

The final practical examination for 35 marks may have one or two major (10 to 12 marks) and one or two minor (5 – 8 marks) questions with 5 marks for viva voce. The final pattern can be arrived at by the departmental council.

List of Hard core, Soft-core and Open Elective courses

Semester	Code Number	Hard core courses
I	ZOH 401	Animal Taxonomy and Evolution
I	ZOH 402	Biological Chemistry
II	ZOH 451	Comparative Physiology
II	ZOH 452	Toxicology and Cancer Biology
II	ZOH 453	Animal Cell Biotechnology
III	ZOH 501	Genetics and Quantitative Biology
III	ZOH 502	Nutrition and Metabolism
III	ZOH 503	Neurobiology and Behaviour
IV	ZOH 551	Biology of Immune System
IV	ZOP 552	Project work
		Soft core courses
I	ZOS 403	Comparative Anatomy
I	ZOS 404	Tools and Techniques in Biology
I	ZOS 405	Entomology
II	ZOS 454	Adaptation Biology
II	ZOS 455	Molecular Cell Biology
II	ZOS 456	Developmental Biology
III	ZOS 504	Fisheries and Aquatic Biology
III	ZOS 505	Animal Breeding
III	ZOS 506	Environmental Biology
IV	ZOS 553	Wildlife Conservation and Management
IV	ZOS 554	Statistics and Bioinformatics
IV	ZOS 555	Radiation Biology
		Open Elective courses
II	ZOE 457	Parasites and diseases
III	ZOE 507	Vermitechnology

Overview and Schematic Syllabus

I Semester

Course Code	Hard/Soft core courses	Lecture Hrs/Week	PracticalsHrs/Week	Credit	Max Marks
ZOH401	Animal Taxonomy and Evolution	3	-	3	100
ZOH402	Biological Chemistry	3	-	3	100
ZOS403	Comparative Anatomy	3	-	3	100
ZOS404	Tools and Techniques in Biology	3	-	3	100
ZOS405	Entomology	3	-	3	100
ZOP 406	Animal Taxonomy and Evolution	-	4	2	50
ZOP 407	Biological Chemistry	-	4	2	50
ZOP 408	Comparative Anatomy and Tools & Techniques in Biology	-	2+2	1+1	50
ZOP 409	Tools & Techniques in Biology and Entomology	-	2+2	1+1	50
ZOP 410	Entomology and Comparative Anatomy	-	2+2	1+1	50
				18	550

Any two of the soft core courses to be opted/offered. The practical examinations for soft core courses to be clubbed to one practical examination of 50 marks

II Semester

Course Code	Hard/Soft/Open elective courses	Lecture Hrs/Week	Practicals Hrs/Week	Credit	Max marks
ZOH451	ComparativePhysiology	3	-	3	100
ZOH452	Toxicology and Cancer Biology	3	-	3	100
ZOH453	Animal Cell Biotechnology	3	-	3	100
ZOS454	Adaptation Biology	3	-	3	100
ZOS455	Molecular Cell Biology	3	-	3	100
ZOS456	Developmental Biology	3	-	3	100
ZOE457	Parasites and diseases	3	-	3	100
ZOP 458	ComparativePhysiology	-	4	2	50
ZOP 459	Toxicology and Cancer Biology	-	4	2	50
ZOP 460	Animal Cell Biotechnology	-	4	2	50
ZOP 461	Adaptation Biology and Molecular Cell Biology	-	2+2	1+1	50
ZOP 462	Molecular Cell Biology and Developmental Biology	-	2+2	1+1	50
ZOP 463	Developmental Biology and Adaptation Biology	-	2+2	1+1	50
				26	800

Any two of the soft core courses to be opted/offered. The practical examination for soft core courses to be clubbed to one practical examination of 50 marks.

III Semester

Course Code	Hard/Soft/Open elective courses	Lecture Hrs/Week	Practicals Hrs/Week	Credit	Max Marks
ZOH501	Genetics and Quantitative Biology	3	-	3	100
ZOH502	Nutrition and Metabolism	3	-	3	100
ZOH503	Neurobiology and Behavior	3	-	3	100
ZOS504	Fisheries and Aquatic Biology	3	-	3	100
ZOS505	Animal Breeding	3	-	3	100
ZOS506	Environmental Biology	3	-	3	100
ZOE507	Vermitechnology	3	-	3	100
ZOP 508	Genetics and Quantitative Biology	-	4	2	50
ZOP 509	Nutrition and Metabolism	-	4	2	50
ZOP 510	Neurobiology and Behavior	-	4	2	50
ZOP 511	Fisheries & Aquatic Biology and Animal Breeding	-	2+2	1+1	50
ZOP 512	Animal Breeding and Environmental Biology	-	2+2	1+1	50
ZOP 513	Environmental Biology and Fisheries & Aquatic Biology	-	2+2	1+1	50
				26	800

Any two of the soft core courses to be opted/offered.The practical examination for soft core courses to be clubbed to one practical examination of 50 marks.

IV Semester

Course Code	Hard/Soft/Open elective courses	Lecture Hrs/Week	Practicals Hrs/Week	Credit	Max marks
ZOH551	Biology of Immune System	3	-	3	100
ZOP552	Project work		8(Field\ labwork)	5	150
ZOS553	Wildlife Conservation and Management	3	-	3	100
ZOS554	Statistics and Bioinformatics	3	-	3	100
ZOS555	Radiation Biology	3	-	3	100
ZOP 556	Biology of Immune System	-	4	2	50
ZOP 557	Wildlife Conservation & Management and Statistics & Bioinformatics	-	2+2	1+1	50
ZOP 558	Statistics & Bioinformatics and Radiation Biology	-	2+2	1+1	50
ZOP 559	Radiation Biology and Wildlife Conservation & Management	-	2+2	1+1	50
				18	550

Any two of the soft core courses to be opted/offered. The practical examination for soft core courses to be clubbed to one practical examination of 50 marks.

Grand Total of Maximum Marks 2700

Credits distribution

	Credits	Percentage (%)
Total	88	-
Hard core	50	57
Soft core	32	36
Open elective	06	07

LEARNING OBJECTIVES:

1. To foster pristine ambience to the students with plethora of opportunities to gain mastery in distinct facets of Zoology.
2. To enrich proficiency in animal studies and handling, breeding and conservation of animals.
3. To cultivate professional integrity and righteousness through mentoring by connoisseur of subject experts
4. To adept skills required for teaching and research in animal sciences.

LEARNING OUTCOME:

1. With Master's Degree in Zoology you will learn how animals are grouped, their anatomy, physiology, nutrition, metabolism and adaptations. You will acquire an understanding of genetics and its importance in breeding of animals. You will also gain insight into toxic substances their effects, cell and molecular biology, cancer and its epidemiology, radiation and its effects and applications in biological systems. You will acquire competence with Wildlife conservation and management, Fisheries and aquatic biology and animal tissue culture and biotechnology.
2. To nurture oral and written skills to communicate effectively with scientific fraternity.
3. Retrieve explore and exploit information, to pen scientific articles and present courses.
4. Well-designed syllabus facilitates students to excel in various competitive exams.

PROGRAMME OUTCOME:

Students on completion of M. Sc. Zoology will acquire the knowledge of:

1. Different branches of animal sciences such as Animal systematics, evolution and anatomy, cell and molecular biology, modifications and adaptations of animals to different environments.
2. They will practice ethical, responsible, professional handling of animals and will be well trained in Animal physiology, immunology, neurobiology, nutrition and metabolism.
3. Applied aspects like toxicology, cancer biology, animal cell biotechnology,
4. Genetics and animal breeding, Aquatic and fishery biology, Aspects of wildlife conservation and management, vermitechnology.
5. Comply with all applicable regulations and requirements regarding biological effects of radiation and applications of radiation.

***PROGRAMME SPECIFIC OUTCOMES*:**

Students of M Sc. Zoology will acquire the skills and ability to:

1. Teach zoology at UG/PG level and biology at pre degree level.
2. Do research in basic and applied aspects of animal sciences.
3. Take up positions as lab technician/ forensic experts in toxicology / drug testing laboratories.
4. Take up a profession in animal breeding programmes/museum curator/zookeeper/Wildlife biologist/Scientist post in different laboratories and in industries.

I Semester

ZOH401: ANIMAL TAXONOMY AND EVOLUTION

Teaching Hours 10/Unit

COURSE OUTCOMES

1. Taxonomy course uses the lessons specifically designed to achieve student understanding of biosystematics and to move quickly beyond the knowledge level to high-level thinking.
2. Through this course, aspirants are trained to utilize different taxonomic tools like identification keys to identify different groups of organisms.
3. To know and understand the seven levels of classification and apply this knowledge to classify animals from the Kingdom to Species level.
4. They learn to evaluate biodiversity indices through usage of software.
5. They obtain an academic speciality besides evolutionary trends, species and characteristics, significance of evolution
6. This course inculcates in students, skills required for an animal taxonomist.

UNIT I

Definition and basic concepts of biosystematics taxonomy and classification. History of Classification – Linnaeus to new systematic. Higher order taxonomy – Aristotle to Whittaker's five kingdom and Carl Woese's six kingdom and three domains. Trends in biosystematics: Chemotaxonomy, Cytotaxonomy and Molecular taxonomy. Hierarchy of categories- Taxonomic ranks.

UNITII

Dimensions of speciation and taxonomic characters. Taxonomic procedures: Taxonomic collections, preservation, curetting, process of identification. Taxonomic keys, different types of keys, their merits and demerits. International code of Zoological Nomenclature (ICZN):Operative principles, interpretation and application of important rules. Major classes of taxonomy (Phenetics, Cladistics and Phylogenetics).

UNIT III

Evaluation of biodiversity indices. Evaluation of Shannon - Weiner Index, Simpson's index. Evaluation of Dominance Index. Similarity and Dissimilarity Index. Data collection methods, GPS, GIS and mapping

UNIT IV

Concepts of evolution and theories of organic evolution. Neo Darwinism and population genetics: Hardy-Weinberg law of genetic equilibrium. Detailed account of destabilizing forces: Natural selection, Mutation, Genetic Drift, Migration, Meiotic Drive. Trends in Evolution. Molecular Evolution- Gene evolution, Evolution of gene families, Assessment of molecular variation

UNITV

Species concepts: different types. Modes of speciation (Allopatric, Peripatric, Parapatric and Sympatric speciation). Origin and mechanisms of reproductive isolation. Patterns of speciation: gradualism and punctuated equilibrium. Major trends in the origin of higher categories. Micro and macro evolution. Molecular population genetics- Pattern of changes in nucleotide and amino acid sequence. Ecological significance of molecular variations (genetic polymorphism).Origin and Evolution of Economically important microbes and animals.

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ZOP 406: ANIMAL TAXONOMY AND EVOLUTION- LABORATORY.
4 Hours /Week

COURSE OUTCOME

1. Students are encouraged to do fieldwork to collect various samples and follow the identification keys to classify the animals.
2. Pupil are trained to use different devises required for sampling.
3. These practices are done at an individual level so that students will be confident enough to go to fields and taxonomically categorize the animals into different groups and also to explore new species.

Experiments

1. Construction of dichotomous key
2. Construction of Cladogram
3. Identification of major adult insects
4. Identification of major groups of Formicidae
5. Identification of major Elasmobranchs
6. Identification of major groups of Aquatic insects
7. Methods to collect and preserve insects-demonstration
8. Mouth partsof insects-adaptive radiation
9. TLC for venom of different organisms.
10. Assessment of the taxonomic diversity in a given habitat.

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ZOH402: BIOLOGICAL CHEMISTRY

Teaching Hours 10/Unit

COURSE OUTCOME

1. The course introduces the students to different biomolecules their structure and classification.
2. Students are trained to understand the importance and biological synthesis of different biomolecules like proteins, lipids and carbohydrates.
3. Enzymes their kinetics, regulation, classification, inhibition clinical importance is studied.
4. Chemistry of nucleic acids their synthesis and breakdown are also dealt.
5. Metabolic pathways their importance, regulation and disorders associated with it are discussed.
6. On completion of the course student will have an overview of the biomolecules their importance, structure synthesis and breakdown and associated metabolic disorders.

UNIT I

Carbohydrates-Classification, structure and properties.
Monosaccharaides – Glucose, Fructose and Galactose.
Disaccharides – Maltose, Lactose, Sucrose, Cellobiose and Trehalose
Polysaccharides – Glycogen, Starch, Cellulose and Inulin.
Heteropolysaccharides – Hyaluronic acid, chitin, heparin, chondroitin and keratin sulphate.
Physiologically important carbohydrates.

UNIT II

Lipids-Classification, structure and properties of fatty acids, triglycerides.
Oxidation of fatty acids – β oxidation, regulation and disorders.
Palmitate biosynthesis and its regulation.
Bile salts and bile pigments. Ketone bodies and their importance.
Prostaglandins and their significance.

UNIT III

Amino acids- classification, chemical nature and properties. Classification of proteins, physical-chemical properties, structure- primary, secondary, tertiary and quaternary. Methods for determining amino acid sequences – N-terminal, C- terminal and amino acid analysis of proteins. Protein synthesis and its inhibitors; Metabolism of aromatic amino acids. Laboratory synthesis of peptides. Protein Targeting and Degradation Protein folding - Diseases of protein mis-folding, Introduction to proteomics.

UNITIV

Classification of enzymes. Enzyme Kinetics, Factors affecting enzyme catalysed reactions. Enzyme inhibition. Allosteric regulations of enzyme activity Co-enzymes, metalloenzymes, iso-enzymes and Multienzyme complexes, Ribozymes. Clinical applications of enzymes. Blood clotting proteins, Plasma proteins and their importance

UNITV

Nucleic acids – Classification and chemistry.
Nucleosides, nucleotides, nucleoside analogs and polynucleotides.
Biosynthesis and break down of purines and pyrimidines.
Salvage pathway. Disorders of nucleic acid metabolism.

REFERENCES

1. Conn,E.E., Stumpf P.F.,Bruening G. and Dooi R. H (1995) Outlines of Biochemistry, John Wiley and Sons, Singapore.
2. Daniel, L.J. (1987) Laboratory Experiments in Biochemistry, Academic Press, New York.
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ZOP407: BIOLOGICAL CHEMISTRY- LABORATORY.
4 Hours /Week

COURSE OUTCOME

1. Students are trained to detect, analyze and quantify various biomolecules like carbohydrates, proteins and lipids. They are also trained in chromatography and colorimetric estimations.
2. As practical training is carried out at the individual level, skills developed by students help them to take up the clinical laboratory jobs.

Experiments

1. Color reactions of monosaccharaides and disaccharides.
2. Color reactions of polysaccharides.
3. Color reactions of proteins.
4. Precipitation reactions of proteins.
5. Identification of an unknown protein.
6. Estimation of blood glucose.
7. Estimation of cholesterol.
8. Course chromatography for sugars.
9. Estimation of total serum proteins by biuret method
10. Determination of urine creatinine by Jaffe's method.
11. Estimation of blood urea by diacetylmonoxime method.
12. Determination of DNA content.
13. Estimation of RNA content.
14. Course chromatography for amino acids

ZOS403: COMPARATIVE ANATOMY

Teaching Hours 10/Unit

COURSE OUTCOME

1. Comparative anatomy explores and establishes the correspondences between body parts of organisms from different species.
2. It builds the concepts of the living structures and helps to propose homology hypotheses between different organs.
3. Students are guided to understand the anatomy of different organ systems of organisms including invertebrates.
4. Contents of this course highlights the importance of anatomical structures to assess comparative study from lower to higher vertebrates.
5. It is the study of both the functional adaptation, which plays the main role, and the phylogeny.
6. Learners focus on methods and different tools used in anatomical studies.

UNIT I

Historical perspective and general concepts of Comparative Anatomy, Anaplasy, Homoplasy. Body plan of animals-evolutionary perspectives. Body plan of protochordates –their affinities with invertebrates and chordates, Origin of vertebrates – major life forms, Methods and tools used to study animal body

UNITII

Excretory organs- Organs of excretion among invertebrates; Gross anatomy development and evolution of kidneys. Structure of the nephron in relation to excretion and osmoregulation. Respiratory structures - General structure and types of internal gills; External gills; Lungs and gas bladder of fishes; Evolution of lungs from amphibians to mammals. Respiratory structures among invertebrates. Reproductive system of vertebrates

UNITIII

Circulation - Heart of vertebrates-evolutionary modifications; Evolution of major aortic and venous channels of vertebrates. Organization of the vascular system in invertebrates. Digestive tract- General organization and microscopic structure of the gut of vertebrates. Adaptive features of the digestive tract of vertebrates- evolutionary perspectives; General organization of the digestive tract of invertebrates.

UNIT IV

Integument- Gross anatomy of Integument of vertebrates and their derivatives. Skeleton - Components of the head skeleton; Principal types of jaw suspensions; Cranial kinesis; General structure of vertebrae; evolution of paired appendages, pectoral and pelvic girdles of vertebrates ; Ribs and sternum of fishes and tetrapods. Muscles- Gross structure of muscles; muscles of primary swimmers. Axial, Hypobranchial, Appendicular and Branchial muscles of tetrapods.

UNITV

Nervous system- General organization of the nervous system in animals; Comparative account of brain and evolution of telencephalon; Cranial nerves of vertebrates. Sense organs- Eye, ear, olfactory organs, Lateral line. Nervous system and electroreceptors of vertebrates. Photoreceptors and chemoreceptors of insects.

REFERENCES

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2. Cleveland, H.P., Roberts, Larry S. (Jr) and Larson A. (1995) Integrated Principles of Zoology. 9th edition, WBC Brown publishers.
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10. William, K.P.(1998) Life- The Science of Biology, 5th edition, Sinauer Associates Inc.

ZOP408: COMPARATIVE ANATOMY –LABORATORY
2 Hours/Week

COURSE OUTCOME

1. Comparative anatomy uses diverse techniques: classical dissection, examination of anatomical specimens.
2. They are made to expertise in preparing the samples for various histological studies and their comparative analysis.
3. This training provides insights into evolutionary changes of different organs within the animal kingdom and their significance.

Experiments

1. Wings and leg modifications in insects.
2. Dissection-study of external and internal features of cockroach.
3. Temporary mounts of cockroach-(a) gizzard (b) trachea (c) cross striations and nuclei of muscle fibre.
4. Microscopic anatomy of –artery, vein, lung, kidney, liver, oesophagus, stomach, intestine, testis and ovary of frog.
5. Study of embryological slides –chick.
6. Dissection-study of external and internal features of mouse.
7. Fixation of tissue and preparation of paraffin block
8. Preparation of paraffin slides and staining of paraffin sections.
9. Types of beaks and feet in birds.
10. Types of feathers in birds.

ZOS404: TOOLS AND TECHNIQUES IN BIOLOGY

Teaching Hours 10/Unit

COURSE OUTCOME

1. Here students are taught to deal with different tools and techniques applicable in biological research including various types of microscopes, centrifuges, electrophoresis, chromatography etc.
2. The theory session mainly focuses on understanding the principles and working mechanisms of different instruments.
3. Learning of microbiological techniques,media preparation and sterilization.
4. Fermentationmethods to study product yield.
5. To get acquainted with Cytological and histological techniques
6. Develop skills of advanced instrumentation.
7.

UNITI

Microscopy, principle & applications. Light microscope and phase contrast microscope, Fluorescence microscope, Electron microscope, Confocal microscopy. General principle and applications of Colorimeter, Spectrophotometer, Ultra centrifuge, Flame photometer, Beer and Lamberts law. Microbiological techniques, Media preparation and sterilization, Inoculation and growth monitoring, Microbial assays - Microbial identification (cytological staining methods for bacterial and fungal strains).Use of fermenters.

UNITII

Computer aided techniques for data presentation data analysis and statistical techniques. Cryotechniques: Cryopreservation of cells, tissues, organs and organisms. Cryosurgery, Cryotomy, Freeze fracture and freeze drying. Separation techniques. Chromatography, principle type and applicants, Electrophoresis, Principles, types and applications PAGE and agarose gel electrophoresis. Organelle separation by centrifugation.

UNIT III

Radioisotope and their biological applications. Sample preparation for radioactive counting of biological samples and Autoradiography. Immunological techniques: Immunodiffusion (Single & Double) and immunoelectrophoresis. Techniques immunodetection: Immunocyto / histochemistry, immunoblotting, immunodetection, immunofluorescence. Surgical techniques: Organ ablation (eg. Ovariectomy, adrenalectomy), Perfusion techniques, Stereotaxy, Indwelling catheters, Biosensors.

UNITIV

Histological techniques: Principles of tissue fixation, Microtomy, Staining, Mounting and Histochemistry. Cell culture techniques: Design and functioning of tissue culture laboratory, Culture media, essential components and Preparation. Cell viability testing.

UNIT V

Cytological techniques: mitotic and meiotic chromosome preparations from insects and vertebrates. Chromosome banding techniques (G-C-Q-R. banding), Flow cytometry. Molecular cytological techniques- In situ hybridization (radio labelled and non-radio labelled methods), FISH, Restriction banding. Molecular biology techniques: Southern hybridization, Northern hybridization, DNA Sequencing- Polymerase chain reaction (PCR)

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ZOP409: TOOLS AND TECHNIQUES IN BIOLOGY- LABORATORY

2 Hours/Week

COURSE OUTCOME

1. In the practical course, they are trained to handle the majority of devices available in the institute.
2. This training of handling devices used in biological research labs gives them the confidence to work in different research labs in the future.

Experiments

1. To familiarize in the use of pH meter and Colorimeter.
2. One-dimensional Ascending & Descending course chromatography of Amino acids & sugars.
3. Two-dimensional Ascending & Descending Course chromatography of Amino acids.
4. One-dimensional Ascending & Descending TLC of Amino acids & sugars.
5. Fractionation of Sugars from fruit juice using TLC.
6. Microscopy and Microphotography.
7. Column Chromatography for proteins, pigments and aminoacids.
8. Course Electrophoresis of amino acids.
9. course Electrophoresis of proteins.
10. Agar Gel Electrophoresis of proteins.
11. Polyacrylamide Gel Electrophoresis (PAGE).
12. SDS- Polyacrylamide Gel Electrophoresis (PAGE).
13. To perform image analysis using CCD camera of Microscopic dynamic Images.

ZOS405: ENTOMOLOGY

Teaching Hours 10/Unit

COURSE OUTCOME

1. Students are trained in the basics of insect classifications and preservation of collected samples in the laboratory condition for future studies.
2. The behavioural paradigm, insect physiology and biological applications of various insects are studied in detail.
3. Plant-insect interactions are discussed to understand the biological significance of insects in controlling pests and pollination.
4. Nutritional requirements of different insects are discussed and this will help the students to establish own insect culture at home or fields.
5. The training helps the students to apply for different competitive exams and get selected.
6. Taxonomical training in identification and classification of insects helps students get job opportunities as entomologists or in related fields.

UNITI

Historical review of insect classifications. Basic of insect classification. Phylogeny of the Arthropoda and the Hexapoda. Hexapoda Orders: Protura, Diplura, Collembola, Archeognatha, Zygentoma, Odonata, Ephemeroptera Orders: Orthoptera; Dictyoptera; (Mantodea, Blattodea, Isoptera), Phasmida; Dermaptera, Psocoptera. Mallophaga; Siphunculata; Hemiptera (Homoptera. Heteroptera); Thysanoptera. Orders: Coleoptera; Strepsiptera; Neuroptera; Hymenoptera. Orders: Trichoptera; Lepidoptera; Siphonaptera; Diptera

UNITII

Scope of insect ecology. Ecosystem approach to insect ecology' ecosystem, levels, their structure and functions (herbivore, entomophagy, haemophagy). Population Ecology: Population dynamics: size, fluctuation, models' Biogeography, Community ecology: species interaction, community structure 'Successional' changes, diversity versus stability.

UNITIII

Fundamentals of Insect ethology and its application: Pattern of behaviour' periodicity and clocks. Functional aspects of behaviour: displacement' orientation' communication, reproduction, host selection, defence. Polymorphic phases (swarms, outbreaks, and migration). Locusts in making, and adaptive behaviour. Population ethology; behavioural genetics and evolution. Chromo-ecological and protective behaviour.

UNITIV

Insect behaviour as control measure in plant protection. Biological control: definition; history. Biological control agents: parasites and parasitoids, predators, and competitors. Mass

production and distribution. Advantages and disadvantage of biological control. Integrated Pest Management (IPM): Definition; importance; tools; basic principles and evolutionary trends. Ecological basis of IPM. Legislative methods.

UNITV

Insect growth, life cycle, stages of development, metamorphosis (histolysis, histogenesis), types of metamorphosis, moulting, hormones controlling moulting. Nutritional requirements of insects. Digestion of special food stuffs (wool, collagen, keratin, pollen, silk. wax). Fat body. Heart and circulation; physical and chemical properties of haemolymph. Haemocytes. Physiological response of insect to heat.

REFERENCES

1. Arnett, R. (2000) American Insects: A Handbook of the Insects of America North of Mexico, 2nd edition, CRC Press.
2. Chapman, R. F. (1998) The Insects: Structure and Function, 4th edition [paperback] Cambridge University Press.
3. Daly,H. V., Doyen J. T. and Purcell A. H. (1998) Introduction to Insect Biology and Diversity, 2nd edition, Oxford University Press. .
4. Gullan, P. J. and Cranston P.(2010) The Insects: An Outline of Entomology, 4th edition, Wiley-Blackwell Press.
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6. Resh, V. H. (2009) Encyclopedia of Insects, 2nd edition, Elsevier Science.
7. Triplehon, C.A and Johnson N.F (2005) Borror and Delong's Introduction to the study of Insects, 7th edition, Thomson Brooks/Col, U K.

ZOP410: ENTOMOLOGY-LABORATORY
2 hours/week

COURSE OUTCOME

1. They are trained in collection, classification and preservations of different insect sample for long term studies.

2. Practical sessions are devoted for training the students in understanding the advantages and disadvantages of insects in pest control and different policies of pest management.

Experiments

1. Mounting and Taxonomy: Dry mounting and slide mounting. Sting apparatus, hypopharyngeal gland and pollen basket of honey bees. Insect taxonomy, use of taxonomic features, classification of ants.
2. Productive insects: *Bombyx mori* (Mulberry) adults, cocoons, *Exoristas orbelensis* (Uzi fly parasite). *Apis cerana* (Hive bee) and *A. mellifera* (European bee) adults, pollen, bee wax, queen cell. *Galleria mellonella* (greater wax moth)
3. Pests of stored products: *Sitophils oryzae* (Rice weevil), *Callosobruchus maculates, C. chinensis* (Pulse beetles), *Corcyra cephalonica* (Rice moth).
4. Major pests of crops (slide preparation/ permanent slides/ museum specimens): Rice: *Nilaparva talugens* (Brown planthopper); sugarcane: *Chilo* spp. (Shoot & stem borers); *coconut*: *Oryctus rhinoceros* (Rhinoceros beetle), *Rhynchophorus ferrugineus* (Red palm weevil); *mango*: *Sternochetus mangiferae* (Mango Seed Weevil); *coffee*: *Xylotrechus quadripes* (Coffee white stem borer), *Hypothene mushampei* (Coffee berry borer); *cotton*: *Helicover paarmigera* (American Bollworm), *Spodoptera litura* (Tobacco caterpillar); *vegetables*: *Henosepila chnavigintiocto punctate* (Spotted leaf beetle), *Leucinodes orbonalis* (Brinjal shoot & fruit borer), *Diaphania indica* (Cucumber defoliator); *p*olyphagous pests: White grubs (root grubs), *Holotrichia* sp. and *Leucopholis* sp., *Aleurodicus dispersus* (Spiralling whitefly), mealybugs.
5. Vectors and parasites: *Anopheles, Culex,* and *Aedes* adult mosquitoes. Parasites: *Leishmania* sp., *Plasmodium* spp. and *Wuchereria* spp.
6. Parasitoids, predators and biopesticides: Biocontrol agents- *Cryptolaemus montrouzieri* (Ladybird beetle), *Leptomastix dactylopii* (parasitoid wasp), *Trichogramma* spp. (egg parasitoid). Indigenous natural enemies: Predators- *Spalgisepius* (Apefly) and *Chrysoper lacarnea* (Lacewing), Parasitoids- Hymenopteran parasitoids, biopesticides.
7. Insect traps: Pheromone traps- Funnel, Sleeve, Del-Ta, Wota, Fligh, Cross-vane, and bucket traps, Volatile traps- Bottle trap and Multiple plastic cup trap, pheromone dispensers (polythene vials, polythene sachet, rubber septa) and light traps.
8. Rearing techniques of pests

II Semester

ZOH451: COMPARATIVE ANIMAL PHYSIOLOGY

Teaching Hours 10/unit

COURSE OUTCOME

1. The teaching session is involved in making students to understand different physiological systems and their functional role in human and other animals.
2. Students are also taught about various disorders due to functional and cellular defect in different physiological pathways.
3. Importance of hormones and their functions.
4. The reproductive physiology of both invertebrates and vertebrates are discussed.
5. The complete gastrointestinal physiology is dealt in great details to make students aware of molecular and physiological aspects of gut functions and its abnormality.
6. The studies on respiratory, reproductive and osmoregulation physiology are discussed.

UNITI

Digestion - Digestive Enzymes
Digestion and absorption of carbohydrates, proteins and lipids
Regulatory mechanisms of digestion
Gastro-intestinal motility
Gastro-intestinal disorders

UNITII

Respiration- Comparative study of aquatic and terrestrial respiration
Respiration in insects and birds
Transport of O_2 and CO_2
Role of Blood as a buffer
Haemodynamics

UNITIII

Osmoregulation- Ionic and water balance in tissues
Osmoregulation in aquatic, amphibious and terrestrial animals
Patterns of N2 excretion
Urine formation in a nephron
Regulation of renal function

UNITIV

Hormones - Principles of Endocrinology
Mechanisms of water- and lipid soluble hormone action
Hormonal regulation of fuel metabolism
Estrous cycle and its hormonal basis
Endocrine regulation of insect metamorphosis

UNITV

Reproductive Physiology-

Spermatogenesis and oogenesis in mammals

Molecular mechanisms of fertilization in mammals.

Oral contraceptives and their hormonal basis.

Insect reproductive systems

Hormonal regulation of reproduction in insects

REFERENCES

1. Berne, R.M. and Levy M.N (1990) Principles of Physiology, C.V. Mosby Company, St. Louis.
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13. Shepherd, G.M. (1994) Neurobiology, 3rd edition, Oxford University Press, USA.
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ZOP458: COMPARATIVE PHYSIOLOGY- LABORATORY
4Hours/Week

COURSE OUTCOME

1. In the practical session, they are trained in measuring physiological parameters like pH, blood glucose, glycogen, starch, respiration quotient, urine metabolites etc.
2. Different enzyme assays are carried out in the practical sessions to teach the biological importance and functional mechanism of different enzymes and hormones.

Experiments

1. Determination of glucose by glucose oxidase method
2. Detection of excretory products in urine
3. Active uptake of indigo carmine by Malpighian tubules
4. Starvation and liver glycogen levels
5. Determination of Respiratory quotient
6. Reproductive systems of insects
7. Collection of insect eggs and study of their development
8. Neuroendocrine cells of insects.
9. Ascorbic acid and its metabolites in urine
10. Hydrolysis of starch
11. Enzyme action on lipids (lipase)
12. Diagnosis of *H. Pylori*.

ZOH452: TOXICOLOGY AND CANCER BIOLOGY

Teaching Hours 10/Unit

COURSE OUTCOME

1. Course focuses on different toxins of animal and also of microbial origin.
2. Understanding the mode of action of chemicals, toxins and fundamentals of toxicological assays.
3. Students are trained in forensic toxicological techniques. They are made aware of drug abuse and its ill effects..
4. They get basic knowledge on mutations, genotoxicity, carcinogens and carcinogenesis.
5. Advanced cancer treatment modalities are discussed.
6. Course helps students to get into various toxicological labs as drug inspectors, quality controllers and even as oncologists.

UNITI

Introduction- Definitions, What toxicologist study? Major subdivisions of toxicology. Dose-response relationships and their importance, basic components of tests generating dose-response data, Frequency response and cumulative response. Factors influencing toxicity- Route of administration, host factors-species, strain, age and sex, Biological factors- Accumulation and storage of chemicals in the organism. Biotransformation reactions. Role and mechanisms of xenobiotic metabolizing enzymes.

UNITII

Toxicological testing methods-Acute and chronic toxicity tests, $LD_{50,}$ LC_{50} and $ED_{50.}$Teratogenicity testing. Reproductive toxicology– Effect of xenobiotics on male and female reproductive organs/cells in mammals. Organ/tissues specific toxicity. Toxicity of metals (Lead, Mercury, Arsenic, Cadmium). Pesticide toxicity- Acute and Chronic effects of organophosphate, Organo-chlorine and Carbamate insecticides, Toxicity of pyrethroids. Bio-magnification. Natural toxins- Import microbial, plant and animal toxins. Treatment of toxicity- Antidotal therapy.

UNITIII

Foundations of Forensic Toxicology- classification of poisons, sign and symptoms of common poisons, antidotes, collection of samples. Drugs: Drugs of abuse, classification and identification. Narco analysis and brain mapping. Explosives: Classification, composition and characteristics of explosives, pyrotechinques, IEDs, explosion process and affects, types of hazards, effect of blast waves on structure Courtroom Testimony, Investigation of Toxicity-Related Death/Injury, Documentation Practices, Considerations for Forensic Toxicological Analysis, Drug Concentrations and Distribution.

UNIT IV

Mutagenesis and genetic toxicology- Test systems of genotoxicity testing, Genotoxicty testing in mammals –Bone marrow chromosomal aberration, Micronucleus test, sperm abnormality assay, comet assay. Occupational and environmental exposure -Endosulphan tragedy. What is cancer?, classification of human cancers, Growth characteristics of cancer cells, tumor angiogenesis. Tumor staging. Causes of cancers-chemical carcinogenesis; Steps involved in chemical carcinogenesis. Radiation carcinogenesis-ionizing radiation, UV radiation.

UNITV

Oncogenes-Functional class of oncogenes (proto-oncogenes), Mechanisms of carcinogenic transformations by oncogenes. Viral oncogenes. Tumor suppressor genes- mechanisms of tumor suppressor in cancer induction (P53). Patient – tumor interactions- Pain, nutritional effects, hematological effects, fever and infection hormonal effects, neurological and dermatological effects. Tumor immunology-mechanisms of immune response to cancer, natural killer cells, 'Danger theory'.

REFERENCES

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2. Becker,F .F. (Ed) (1975) Cancer, Vol.1-3, Plenum Press, New York.
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ZOP459: TOXICOLOGY AND CANCER BIOLOGY- LABORATORY
4 Hours/Week

COURSE OUTCOME

1. They are trained in toxicological testing methods.

2. They develop skills to screen the food adulteration and detection of toxicants.
3. Aspirants are made to understand the process of tumorigenicity and staging.

Experiments

1. Determination of LC50
2. Determination of LD50
3. Detection of Organo-phosphates by Chromatographic methods.
4. Estimation of Catalase activity.
5. Effect of heavy metals on enzyme activity.
6. Transplantalteratogenesis.
7. Detection of mercury chloride by enzyme inhibition technique.
8. Detection of adulterants in food samples.
9. Analysis of presence of toxicants like pesticides etc. from samples
10. Visit to Forensic Science laboratory and preparation of report.
11. Study of life history of insects of Forensic importance.
12. Experiments to study the genotoxicity of chemicals in mouse.
13. Transplantation and induction of mouse ascites tumour and studies on the characteristic of tumour cells.
14. Induction of solid tumour in mice and study the chromosomal aberrations in cancer.
15. Histological observation of different types of cancers (Permanent slides).

ZOH453: ANIMAL CELL BIOTECHNOLOGY

Teaching Hours 10/Unit

COURSE OUTCOME

1. This course aims at inculcating the principles and skills of animal cell culture in students.
2. They are introduced basics of cell culture, cell lines primary cultures, types of cultures etc., media, maintenance of cultures types of cultures etc.
3. Different cell culture techniques including preparation of media, maintenance of cultures, sub-culturing, maintenance of records applications of cell culture are dealt in detail.
4. Culturing of embryonic and stem cells, Hybridoma technology and monoclonal antibodies their applications, commercial applications of cell culture are also discussed.
5. Course also introduces students to genetic engineering, plasmids, Cloning, methods of gene introduction to cells and animals, transgenic animals and genetically modified animals.
6. Students groomed in animal cell biotechnology course can be entrepreneur in cell culture based industry or can get into cell culture based research or can get employed in cell culture based industries.

UNITI

Introduction, Historical perspective, advantages and limitations of animal tissue culture. Major differences in vitro .Types of tissue culture. Biology of cultured cells- Culture environment, cell adhesion, cell proliferation, differentiation, Initiation of culture, cell senescence, continuous cell lines. Design and layout of laboratory,-Construction, sterile handling area, incubation, culture room, service bench, Preparation, wash up, maintenance of sterile condition. Equipment- Essential, beneficial and useful equipments, consumable items. Culture medium- Physico-chemical properties, complete media, serum, serum free media, balanced salt solutions, selection of medium and serum. Preparation and sterilization- Apparatus, Reagents and media, storage, Contamination- Source and types of contamination

UNITII

Primary culture- types of primary culture, Isolation of tissues – mouse and chick embryos, human biopsy material, Explant culture, primary cell culture, disaggregation- enzymatic, mechanical. Suspension culture. Cell lines: Definition, Evolution of cell lines, continuous cell lines, cell line designation, maintenance, subculture, maintenance records. Cell line banking, cryopreservation, cell viability assays. Lymphocyte culture technique and its applications

UNITIII

Culture and maintenance of human and mouse embryonic stem cells. Stem cells in gene therapies, stem cell based therapies for autoimmune diseases. Hybridoma technology – Cell hybrids, Production and application of monoclonal antibodies. Use of animal cells as

replacement for whole animal in toxicity testing. Commercial application of animal tissue culture – Uses of animal cells in vaccine production

UNITIV

Genetic engineering-General introduction and concept, Transduction and transfection, C-DNA, Recombinant DNA techniques, Restriction enzymes, Salient features of cloning vectors, Different types of cloning vectors, Plasmids, Cosmids, Phagemids, Shuttle vectors, Viral vector. Outline of gene cloning, gene cloning procedures, C-DNA cloning, Gene libraries, Chromosome Walking and jumping, Recombinant selection and screening- genetic methods, immunochemical methods, South-western screening, nucleic acid hybridization, product recovery.

UNITV

Methods to introduce genes into animal cells, electroporation, viral vectors, retroviruses, lipofection, calcium phosphate co precipitation. Transferring genes into animal oocytes, Eggs and embryos – Transgenic animals. Use of transgenic technology in research, knock-out mice. Production of human disease equivalents in the mouse, Novel therapies for human diseases. Transgenic technology in the improvement of farm animals, transgenesis in animal cloning. Genetically modified (GM) plants and foods.

REFERENCES

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ZOP460: ANIMAL CELL BIOTECHNOLOGY- LABORATORY
4 Hours/week

COURSE OUTCOME

1. Students are trained in different aspects of cell culture like sterilization, media preparation, culturing, maintain cells cultures and their applications.
2. They are also learn recombinant DNA techniques, restriction enzymes, blotting techniques etc.

Experiments

1. Introduction to general requirements of animal tissue culture laboratory.
2. Cleaning, washing, Preparation and sterilization methods for tissue culture work.
3. Preparation of media, serum, BSS, PBS, trypsin etc.,
4. Trypan blue dye exclusion test for cell viability
5. Lymphocyte culture techniques, Preparation of human metaphase chromosomes.
6. Growth and maintenance of tumour cell lines.
7. Cell proliferation test using MTT assay
8. Separation of peripheral blood mononuclear cells (PBMCs) - Histopaque method.
9. Mouse macrophage and lymphocyte culture
10. Primary explant culture of mouse pup/adult/ chick embryo organs
11. Mouse bone marrow/hemopoetic cell cultures
12. Contamination of cultures
13. Study of restriction sites in λ DNA – Demonstration
14. Western blot technique -Demonstration.

ZOS454: ADAPTATION BIOLOGY

Teaching Hours 10/week

COURSE OUTCOME

1. To learn biological rhythms in animals including humans.
2. This course introduces the pupil to different physiological adaptations and acclimatization of an organism to various environments.
3. To enlighten students on animal responses to light and temperature.
4. Students are made to understand the importance of chronobiology and Chrono medicine.
5. Importance of hibernation, aestivation and insect diapause.
6. Aspirants are made to appreciate the maternal, foetal and neonatal physiology.

UNITI

Introduction- Definition, types of adaptation. Physical and behavioral. Environmental variables. Environmental conditions of aquatic, terrestrial and xeric habitats. Light condition-eclosion in insects. Biological rhythms including circadian rhythms, Milestones in clock research, Chronobiology in 21st century, Evolution of biological timing system, Clocks, genes and evolution, Adaptive functional significance of biological clocks, Phase shift, Phase response curves (PRC) and phase transition curves (PTC);

UNITII

Photoreception and photo-transduction, The physiological clock and measurement of day length; Role of photic and non-photic cues in seasonality; Reversal of roles of principal and supplementary cues, The relevance of biological clocks for human welfare - Clock function (dysfunction), Inter tidal animals and their adaptations. Concepts of homeostasis, acclimation and acclimatization. Basic mechanisms of biochemical adaptation. Adaptation during physical exercise.

UNITIII

Diversity and complexity of the clock system- Melatonin, depleted Oxygen availability and its effects. Anhydrobiosis and hibernation. Adaptation to deep sea living and diving. Physiology of insect diapauses. Circadian pacemaker system in vertebrates with particular reference to rodents; Suprachiasmatic nucleus (SCN) as the main vertebrate clock; concept of core and shell.

UNITIV

Temperature relations, Adaptations to temperature variations, molecular mechanisms of adaptations. Endothermy and Ectothermy. Extremophiles varieties and their adaptations. Mechanisms of body temperature regulation, Fever. Heat shock proteins. Human health and diseases - Chronopharmacology, Cronomedicine, Chronotherapy.

UNITV

Alterations and adaptations in maternal physiology during pregnancy. Material and fetal prolactin. Placenta: Endocrine functions, Transport mechanisms, Fetal physiology, growth and metabolism, Neonatal physiology. Lactation and Lactogenesis

REFERENCES

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ZOP461: ADAPTATION BIOLOGY-LABORATORY

2 Hours/Week

COURSE OUTCOME

1. Experiments are designed to train how animals show behavioural changes and adaptations based on varied environmental conditions.
2. Students are well trained to conduct circadian rhythms using various animal models.

Experiments

1. Assay of circadian rhythms using animal model systems.
2. Assay of circadian activity rhythms in human.
3. Effect of physical exercise on haematological parameters and cardiac activity.
4. Experiments demonstrating the photoperiodic clock
5. Regulation of eclosion rhythm in *Drosophila*.
6. Excretion of chloride as a function of salinity in fish.
7. Seasonal and daily variations in salinity, temperature and tides.
8. Haemolymph ions during aestivation in molluscs (*Pila*)
9. Effect of temperature on physiological functions.
10. Study of parasitic adaptations.
11. LDH isozymes in foetal tissues.
12. Food consumption and assimilation by pregnant and normal mice.

ZOS455: MOLECULAR CELL BIOLOGY

Teaching Hours 10/Unit

COURSE OUTCOME

1. Structural organization of the cell and functioning of different cell organelles are taught.
2. Types of cell divisions in organisms and their scientific relevance is to be studied.
3. Student will gain an understanding of chemical and molecular processes that occur in and between cells.
4. In molecular biology, aspirant learns about how molecules interact within the cell to promote proper growth, division, and development.
5. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis.
6. At the end of this course students should be excited about basic science and its applications and gain higher level thinking skills that is necessary for scientists.

UNIT I

Introduction: Historical highlights, Cell theory, Organization of prokaryotic and eukaryotic cells. DNA as a data storage medium, C-value paradox, Evidences for DNA as genetic material transformation experiment. Structure of DNA and RNA, Replication of DNA in prokaryotes and eukaryotes. Transcription in prokaryotes and eukaryotes, RNA processing, Spliceosomes. Translation in prokaryotes and eukaryotes.

UNITII

Molecular composition and models of membrane architecture – Davson – Danielli model, Fluid mosaic model, cell-cell adhesion, Cell Junctions. Transport across cell membrane – Diffusion and Active transport. Cell-cell signalling – cell surface receptors, second messenger system signalling from plasma membrane to nucleus, signal transduction.

UNITIII

Structural organization of nucleus and nucleolus. Morphology and functional elements of eukaryotic chromosomes-Centromere, nuclear organizers, Telomere, heterochromatin and Euchromatin. Molecular organization of chromatin, Nucleosome model. Structure and functions of Endoplasmic Reticulum and Golgi Complex.

UNIT IV

Cell-cycle and Cell division: Phases of cell-cycle, Cyclins and Cyclin dependent kinases. Regulation of Cdk-cyclin activity. Molecular aspects of cell division, Meiotic division and genetic recombination. Mitotic poisons. Biology of ageing, Apoptosis – definition, mechanism and significance.

UNITV

Microscopy – Bright and dark field microscopy, Phase contrast, Confocal, Two photon, Scanning &Electron microscopy. Staining techniques for the localization of proteins and carbohydrates. Southern, Northern and Western blot techniques, DNA finger printing, Fluorescent InSitu Hybridization (FISH). Polymerase Chain Reaction and DNA sequencing

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ZOP 462: MOLECULAR CELL BIOLOGY- LABORATORY
2 Hours/Week

COURSE OUTCOME

1. To be skilled in protocols of cell divisions-mitosis and meiosis in different organisms.
2. To perform different molecular techniques that are primarily used in biological research.
3. The main methods included are the isolation of RNA/DNA, DNA amplification and studies to understand the different types of cell division.

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Experiments

1. Microscopy and Micrometry.
2. Mitosis in plants.
3. Mitosis in insects / Meiosis in insects.
4. Mitotic chromosomes from bone marrow of mouse.
5. Sperm shape abnormality assay in mice.
6. Isolation of RNA from yeast./Isolation of DNA from liver/spleen. and determination of purity of DNA.
7. Restriction digestion of DNA/DNA electrophoresis.
8. DNA Sequence Reading from autoradiogram.
9. Problems-Transcription, Translation, Restriction Digestion, Gene cloning.

ZOS456: DEVELOPMENTAL BIOLOGY

Teaching Hours 10/Unit

COURSE OUTCOME

1. Course is designed with an intension of exploring levels of growth in organisms.
2. It highlights the processes of gametogenesis and histogenesis.
3. Detailed study on body plans of tetrapods and their evolution.
4. Student learn physiology of regeneration in invertebrates and vertebrates.
5. Study on early development of protochordates and chordates.
6. Emphasis on birth defects and role of various stem cells in growth. Different genes and molecular pathways controlling developmental process are discussed.

UNITI

Gametogenesis and early development-Physiological, chemical and molecular events during a) Oogenesis & b) Spermatogenesis c) Fertilization d) Cleavage e) Competence and induction f) Primary, secondary and abnormal inductions g) Mesoderm induction in amphibians h) Totipotency and nuclear transplantation experiments.

UNITII

Embryonic and body plan**-** Embryonic polarity – Drosophila and Ampihibia, b) Gastrulation in Amphibia and Mammal c) Epithelial morphogenesis, cytoskeleton components, microtubules, microfilaments and intermediate filaments. Teratology and its significance in histogenesis. d) Erythropoiesis, pancreogenesis and myogenesis

UNIT III

Regeneration**-**Physiological changes during regeneration in planarians and amphibians, Life cycles and Evolution of Developmental pattern a) The frog lifecycle, b) The life cycle of Zebra fish c) Developmental pattern of Metazoan, d) Multicellularity – Evolution of differentiation.

UNITIV

Early development-Early development of vertebrates- a) Fish b) Birds c) Mammals. Early development of Invertebrates- a) Seaurchin b) Snails c) Tunicates d) Nematodes

UNITV

Developmental defects: Birth Defects and Endocrine Disruptors. Ecological Developmental Biology: Biotic, Abiotic, and Symbiotic regulation of Development. Gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc. Pluripotent stem cells and its application in embryology studies.

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2. Beril, N.J. andKarpotata.G. (1972) Development, McGraw Hill Publications)
3. Browder L.W. Erickson Co-ordinator A and Jeffery N.R., Developmental Biology Saunders College publications.
4. Carlson, B.M. 1998 Pattern's foundations of Embryology (McGraw Hill publications: New York).
5. Danton,H.O'Day, (2012) Human Developmental Biology, eBookIt.com.
6. Gilbert, S.F. (2009) Developmental Biology, 6th Edition, Sinauer Associates- Publishers, USA.
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ZOP463: DEVELOPMENTAL BIOLOGY- LABORATORY
2 Hours/Week

COURSE OUTCOME

1. In the practical course, various animal models are considered for demonstrating the process of development.
2. Embryogenesis and pattern of gene expression in embryogenesis are also studied.

Experiments

1. Observation of slides of the early development of fish, frog, chick
2. Preparation of whole mount of chick blastoderm.
3. Morphogenetic movements of cells in-vitro during development of chick
4. Observations of sections of testis and ovary of fish, frog and rat.
5. Organogenesis in chick and pig – observation of sections
6. Demonstration of live observation of drosophila embryogenesis.
7. Study of life cycle of *Drosophila melanogaster*
8. Study of regeneration in *Hydra*
9. Influence of temperature and teratogens on animal development
10. Study of embryogenesis in *Drosophila* and pattern of gene expression in embryogenesis by *in situ* hybridization technique.

ZOE457: PARASITES AND DISEASES

Teaching Hours 10/Unit

COURSE OUTCOME

1. This course mainly deals with different parasites that are responsible for various human diseases and their epidemiology and to introduce the students to current knowledge on the morphological features and life cycles of principal human parasites.
2. Outstanding progress will be achieved to understand serious parasitic infections caused by obligate parasites, facultative and opportunistic parasites.
3. To learn methods for accurate diagnosis of parasites responsible for food poisoning.
4. To know disease transmission processes.
5. Methods of prevention and to control the spread of these parasites.
6. This course is offered as an open elective choice for students from other departments who are interested in understanding different parasite born human infections and its control.

UNIT I

General Introduction, different types of animal association- parasitism and types of parasites, primary and secondary hosts, transmission of parasitic infection. Parasitic zoonosis, epidemiology of parasitic zoonosis, transmission. Host- parasitic interactions – parasitic effects benefiting the parasites, parasitic effects benefiting the host.

UNIT II

Prasitic protozoans- Life cycle and Biology of (pathology and control measures also)
Mastigophora – *Trypanosoma, Leishmania, Giardia, Trichomonas*
Sarcodina- *Entamoeba, Iodamoeba*
Chilophora-*Balantidium,* Sporozoa- *Toxoplasma, Plasmodium,*

UNITIII

Helminth parasites -
Life cycle and Biology (pathology and control measures also).
Nematoda-*Ancylostoma, Ascaris, Enterobius, Wuchereria, Onchocerca, Loa, Trichuris.*
Trematoda- *Polystoma, Schistosoma, Echinostoma, Fasciola*
Cestoda- *Taenia, Echinococcus, Dipylidium.*

UNITIV

Morphology, life history and medical importance of disease transmitting vectors-
Diptera- Culicoides, *Aedes, Culex, Anopheles,* House fly.
Siphonoptera: *Xenopsylla, Ctenocephalides, Echidnophaga, Tunga*
Phthiraptera – *Pediculus, Pthirus*
Hemiptera _ *Cimex, Triatoma*
Malaria, Chikungunya, Dengue fever (Transmission cycle).

UNITV

Morphology, life history and importance of Acarines-
Ticks: *Argas, Rhipicephalus, Boophilus, Haemaphysalis*
Mites: *Sarcoptes, Leptotrombidium, Psoroptes, Demodex, Dermanyssus*
Myasis- Venomous, Utricating and allergic arthropods- control measures.
Vector status of Cockroach.

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2. Berger, S. A., MarrJ. (2006)Human Parasitic Diseases Sourcebook, Jones & Bartlett.
3. Chandler, A. C. (1944) Introduction to Parasitology, With Special Reference to the Parasites of Man, 7thedition,New York, Wiley.
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5. Farrar, J., Hotez P., Junghanss T., Kang G. Lalloo D. and White N. J. (2013) Manson's Tropical Diseases, 23rd edition. Elsevier publication.
6. Margo, W. M. S., PybusJ. And KocanA. A.(2008). Parasitic Diseases of Wild Mammals, 2ndedition, Iowa State University Press, Ames, Iowa, USA.

III Semester

ZOH501- GENETICS AND QUANTITATIVE BIOLOGY

Teaching Hours 10 /Unit

COURSE OUTCOME

1. The course is mainly focused on principles of classical genetics, environmental and genetic influences on expression of traits.
2. Both animal and human models are used to explain the phenomenon. Structural and functional components of genes are also studied.
3. Consequences of gene modifications and the possible mechanism of its repair, genetic control in the development of adult characters are also dealt.
4. Genetic disorders prevailing in human population, their chances of inheritance, genetic methods of screening and preventive measures are included.
5. Pupil are trained in various statistical tools commonly used are also included in understanding and interpreting the probable chances of genetic pattern of inheritance of human traits.
6. In the biological research fields, statistical analysis plays an essential role in concluding data and postulating different hypothesis. So Biostatistics is an essential subject for those who go for a research carrier.

UNIT I

Historical highlights - Development of the gene concept. Elements of heredity and variation. Mendelian Genetics - Mendelian principles; Mendelian inheritance and probability. Modified genetic ratios – Co-dominance – incomplete dominance – Lethal alleles, Interaction between different genes – Duplicate genes, Complementary genes, penetrance and expressivity, pleiotropy, Epistasis, Extra chromosomal inheritance. Sex determination – sex linked inheritance in Drosophila and man, sex limited and sex influenced traits. Multiple alleles – Genetics of Blood group inheritance.

UNIT II

Genetic code, molecular structure of gene, transposable elements, gene mutations and DNA repair. Regulation of gene expression in prokaryotes and eukaryotes, Operon concept, attenuation and anti-termination, Giant chromosomes, Environmental regulation of gene expression. Linkage, recombination and gene mapping: Linkage groups, complete and partial linkage. Construction of linkage maps in Drosophila,

Genetic basis of development in Drosophila- Genes involved in Drosophila development and their functional role.

UNIT III

Human karyotype; International System for Human cytogenetic Nomenclature (ISCN) , Chromosome aberrations- structural and numerical variations- Chromosomal syndromes; Human genome project; Genetic counselling ; Genetic Screening- Amniocentesis, Chorionic Villus Sampling, Cardiocentesis; Dermatoglyphics.

UNIT IV

Genome imprinting ; Genetics of behaviour- twins in genetic Studies; Pedigree analysis ; Inheritance of Autosomal and sex chromosomal traits ; Multi- factorial and polygenic Inheritance ; Population genetics-Hardy Weinberg law; Factors changing allelic frequencies – Mutation, Selection, Genetic drift, Migration. Meiotic drive.

UNIT V

Population and sample- Sampling techniques ; Organization of biological data –Tabular and Graphical Methods ; Analysis of data – Measures of central tendency(Mean, Median, Mode) Standard deviation ; Probability & Frequency distribution –Normal, Binomial and Poisson distributions ; Correlation and regression ; Chi-Square test; Test of significance , t –test, Analysis of Variance(ANOVA).

REFERENCES

1. Brown, T. A. (1998) Genetics a molecular approach, 3rd edition, Chapman & Hall Publishers, London.
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3. Connor, J. M. and Smith M. A. F. (1987) Essential Medical Genetics, 2nd edition, Black well scientific publications.
4. Fraser, C. F. and Nora J. J. (1986) Genetics of man, 2nd edition, Lea and Febiger publishers, Philadelphia.
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23. Zubay, G. (1987) Genetics, Benjamin Publishers, California.

ZOP 508: GENETICS AND QUANTITATIVE BIOLOGY – LABORATORY
4 Hours/Week

COURSE OUTCOME

1. Structure of specialized chromosome explain their significance in the expression of adult normal and mutant characters in drosophila. Drosophila crossing experiments using various mutants with normal flies helps in understanding the Mendelian principles of inheritance.
2. Preparation of Human Karyotype and chromosome banding to study the normal and abnormal chromosomes is included to understand the possible mode of inheritance of diseased traits in the family.
3. Pedigree analysis using human blood groups and dermatoglyphics (palmar/ finger print) pattern from different families of the region are included to study the variations and their possible genetic significance at the population level.

Experiments:

1. Preparation of culture media and maintenance of *Drosophila* – To Study the life cycle.
2. Morphological features of *Drosophila*
3. *Drosophila* mutants
4. Mounting of Genital plate and Sex comb
5. Study of Polytene chromosome of *Drosophila*.
6. Chromosome banding techniques and karyotyping.
7. Study the dermatoglyphics pattern and its significance.
8. Chromatographic separation of eye pigments in *Drosophila*
9. Study of Human blood group genetics and estimation of allelic frequencies
10. Experiments to demonstrate the pattern of inheritance of characters in *Drosophila* –
    a. Expt. 1: To demonstrate Mendel's law of segregation
    b. Expt. 2: To demonstrate Mendel's law of independent assortment
    c. Expt .3: To demonstrate Pattern of inheritance of X- linked genes
11. Genetic problems
12. Biostatistics problems

ZOH502- NUTRITION AND METABOLISM

Teaching Hours 10 /Unit

COURSE OUTCOME

1. Basic training includes types of nutrients and their importance.
2. Evaluation of nutrient quality and quantity of nutrients, their balancing in animal nutrition.
3. Concept of human nutrition with balanced nutrition and their importance with reference to health and in chronic diseases.
4. Students are groomed to understand different energy currencies, regulation of metabolic pathways.
5. They learn energy metabolism and related disorders. Importance of minerals and vitamins in nutrition.
6. Course initiates interested students to become an entrepreneur as a nutritionist and dietician.

UNIT I

Concepts of nutrition: Nutrients and nourishment, Basic concepts, Nutrients and their functions, The feed nutrients their classification. Nutrients analysis and energy concepts: Methods of analysis of nutrients and feed stuff and its merits and demerits, Van Soest analysis, Specialized analytical methods, total digestible nutrients, apparent and true digestibility, energy utilization. Feed and nutrient requirements in animals: Methods for determining utilization and requirements in animals, merits and demerits.

UNIT II

Applied animal nutrition: Principles of animal nutrition, Animal husbandry and nutrition requirements, Feeding standards and productivity, Factors affecting feed consumption

Feed preparation and processing: Hot and cold processing methods, feed processing for ruminants and non-ruminants, feed mixing, Chemical treatment, Cubed forges.

Diet formulation- Pearson square method and algebraic method.

Nutrition of dairy: Nutrient requirements in dairy cow and cyclic changes.

Nutrition of laboratory animals: Requirements of mice rat and rabbits.

Nutrition of wild animals: Concept of wildlife nutrition, dietary husbandry of herbivores, Underutilized sources of feed, feeding animal wastes.

UNIT III

Human nutrition: Nutritional basis of health, BMR, balanced nutrition, Nutrients and their importance, Dietary fibre, Antioxidants and phyto-chemicals.

Eating disorders: Anorexia nervosa, Binge eating disorder, Protein energy malnutrition, under- nutrition and over-nutrition

Nutrition and chronic diseases: Hypertension, Diabetes mellitus, Osteoporosis

Food safety: Food processing, Harmful substances in food, Food borne illness and genetically modified foods.

UNIT IV

Energy metabolism:Metabolic pathways and their regulation, Types of metabolic pathways, Regulation of pathways, Signal transduction and role of second messengers in regulation. High energy phosphate compounds. Overview of metabolism and the provision of metabolic fuels. Glycolysis and oxidation o pyruvate: Pathway, regulation and energetics of pathway. Citric acid cycle: Importance, pathway regulation and energetics, Glyoxylate cycle, amphibolic role. Respiratory Chain and oxidative phosphorylation: Respiratory chain, Chemiosmotic theory, ATP synthesis, inhibitors and uncouplers of respiratory chain, clinical aspects.

UNIT V

Carbohydrate, mineral and vitamin metabolism: Glycogen metabolism, Importance of glycogen, formation and breakdown of glycogen, Role of Glucagon and insulin in glycogen metabolism, Glycogen storage diseases. Gluconeogenesis: Glucose homeostasis, Precursors, pathway, regulation and energetics, Pentose phosphate pathway: importance, pathway, regulation and energetics, Role of NADPH

Water and minerals: Water the essential ingredient for life, Major minerals (Sodium, potassium, chloride, calcium, phosphorus and magnesium). Trace minerals (Zinc, iron, Selenium, Iodine, Copper, Manganese, Fluoride, Chromium, Molybdenum).

Vitamins: Water and fat soluble vitamins, functions, dietary recommendations, sources, and deficiency symptoms. Role of vitamins and minerals in intermediary metabolism.

REFERENCES

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9. Voet, D. and Voet J. G. (2005) Biochemistry 3rd edition, John Wiley and Sons, New York.

ZOP 509: NUTRITION AND METOBOLISM – LABORATORY
4 Hours/ week.

COURSE OUTCOME

1. Students are nurtured individually to measure the nutrient contents of different feeds used in the animal husbandry.
2. They are trained in enzyme assays and enzyme kinetics.
3. Students also learn different techniques like RIA, UB Test, Flourimetry, and flame photometry.

Experiments

1. Assay of phosphatases
2. Assay of transaminaases
3. Assay of dehydrogenases
4. Enzyme kinetics:
   a. Effect of substrate concentration, enzyme concentration and time
   b. Effect of temperature on enzyme activity
   c. Effect of pH on enzyme activity
   d. Effect of metal ions on enzyme activity

5. Proximate analysis of feed;
   a. Determination of moisture
   b. Crude protein determination
   c. Ether extract
   d. Crude fibre
   e. NFE and energy calculations

6. Estimation of phosphorus.
7. Estimation of ascorbic acid.
8. Urea breath test
9. Estimation of hormones by RIA
10. Flame photometry
11. Flourimetry

ZOH503- NEUROBIOLOGY AND BEHAVIOUR

Teaching Hours10 /Unit

COURSE OUTCOME

1. This course is focussed on understanding the structural complexity and functioning of the nervous system across the animal kingdom.
2. Complexity of nervous systems among different animal groups and its evolutionary significance with respect to its structural and functional organizations are discussed.
3. Students are taught different mechanisms of communication between animals of same/different species.
4. Levels of learning by animals and how this information is stored in the form of memory are highlighted.
5. Animal behavioural studies are also dealt to understand how the nervous system helps animals to face different psychological conditions caused due to stress, anxiety, depression, etc.
6. In addition, neurological controls of reproductive strategies played by different animal species to increase their populations are highlighted.

UNIT I

Cellular neurophysiology-
Organization of nervous systems
Ionic basis of resting membrane potential
Generation and conduction of action potential
Neural transmission and integration
Sensory transduction

UNIT II

Motor systems –
Excitation-Contraction coupling
Molecular basis of muscle contraction
Skeletal muscle mechanics and fibre types
Smooth muscle and cardiac muscle
Neuro-Muscular disorders

UNIT III

Learning and memory-
Instincts and Imprinting
Habituation, sensitization and Associative learning
Cognitive abilities and reasoning
Types of memory and learning
Molecular mechanisms of learning and memory

UNIT IV

Communication-

Chemical Ecology –Pheromones:Chemistry, types, and significance in insects and mammals.

Vomeronasal organ

Sound production and auditory communication in insects

Dance language' in honeybees

Speech production

UNIT V

Reproductive strategies-

Features of sexual reproduction

Parental investment of the sexes

Sexual selection

Mate choice, competition and aggression

Mating systems – polygamy, monogamy, polygyny.

REFERENCES

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6. Gadagkar R. (1997) Survival strategies, University Press
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10. Simmons P. and David Y. (1999) Nerve Cell and Animal Behaviour, 2nd edition. Cambridge University Press.

ZOP 510: NEUROBIOLOGY AND BEHAVIOUR - LABORATORY
4 Hours/week

COURSE OUTCOME

1. In the practical session, students are trained to label neurons using some of the new transgenic techniques like the Gal4-UAS system and one of the Nobel Prize winning tool: Golgi techniques.
2. They are trained in taking up ethnobiology studies.

Experiments

1. Methylene blue visualization of sensory neurons in Drosophila.
2. Differentiation of mechanoreceptors and chemoreceptors in Insects.
3. Golgi-staining technique.
4. Stimulus - contraction parametersin muscles – Kymographic studies.
5. Effect of Neurotransmitters/mimics on pacemaker neurons – cardiac pacemakers.
6. Habituation in earthworms/crab.
7. Olfactory discrimination in insects
8. Social insects – study of insect colonies.
9. Recording and analysis of insect (cricket) calls, bird calls.
10. T-Maze labyrinth, learning in mice.
11. Filial imprinting in chicks.
12. Sensitization in crabs.

ZOS504- FISHERIES AND AQUATIC BIOLOGY

Teaching Hours 10 /Unit

COURSE OUTCOME

1. Course introduces learners to fish diversity & distribution, classification of fishes their food & feeding habits and reproductive characteristics.
2. Fish culture practices types of fish culture, preservation and economics of fishery are discussed
3. Acquatic community, abiotic and biotic factors that influence fishery industry both in freshwater and marine environment are also highlighted
4. Types of planktons their classification and importance, productivity, seasonal variations and management of water bodies for acquaculture are focused.
5. Different types of aquatic pollution and their effects on fishery.
6. Student on completion of this course can become an entrepreneur in fishery/aquaculture based industry. He/she can also take up job in fishery based industry.

UNIT I

Fish diversity and body design: Distribution of freshwater fishes of India. Distribution of marine fishes of India.Classification of fishes with special reference to evolutionary trends and adaptations. Gas exchange and swimming– 1) Air breathing organs and gas bladder 2). Swimming modes (fin versus body trunk, swimming muscles and tail beat) Fish growth and reproduction: Growth curves, Length weight relationship, Length frequency analysis, Food and feeding habits (General account). Reproduction- The gonads, types of reproduction endocrine regulation of reproduction, Reproductive cycles, spawning, : fish egg and larvae, reproductive behavior, parental care.

UNIT II

Fish culture practice in India: Freshwater carps (Indian major and minor) and Lacustrine fish culture (ornamental). Mariculture – Finfish and shellfish culture. Setting up and maintenance of an aquarium.Hybridization and cryopreservation. Fish and shell fish diseases, prophylaxis and therapy. Fishery technology and economics-Fishing gears and crafts.Fishing industry in India (including preservation and processing). Fishery research Institutes in India. Fishery economics.Economic importance and nutritional value of fishes.

UNIT III

Aquatic environment**:** Classification of freshwater habitats: - Lotic and lentic ecosystems. Morphometry - lake and river. Physical factors (light and temperature). Chemical factors.Methods for measurement of salinity and chlorinity. BOD, COD, and oxygen and their importance Biological zonation ,Oceanography: - General features, waves, tides, current and upwelling. Physico-chemical properties of Estuary – Salinity and temperature. Inorganic nutrients; Phosphates, Silicate and Nitrate, their cycle N: P ration and its signification, wealth of the sea – minerals

UNIT IV

Aquatic community: - Plankton - Classification, distribution and migration, Phyton and Zooplankton- Method of collection of plankton and estimation of primary, secondary and tertiary productivity, factors affecting productivity, regional differences and seasonal variations. Phytoplankton and Zooplankton inter relations Benthos – Animal communities in lakes, stream and reservoir Management and conservation of aquatic habitats: Management of lakes - Eutrophication, control of nutrient and macrophyte biomass.

UNIT V

Aquatic Pollution: Major pollutants, sources, dynamics, transport paths and agents. Sewage, industrial and agricultural discharges, composition, disposal systems.Nutrients- detergents, heavy metals and pesticides composition and fate in the marine environment, biological concern, and toxicity and treatment methods. Thermal pollution:, thermal stratification, effects of thermal pollution and Management of heat. Radioactive pollution.Oil pollution - biological effects biodegradation.Bacteria and pollution.

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ZOP 511: FISHERIES AND AQUATIC BIOLOGY - LABORATORY
2 Hours/week

COURSE OUTCOME

1. Students get expertise in identification of fish and shell fishes and other aquatic organisms.

2. They are taught different types of fish culture, shellfish culture and live feed culture.

3. They are technically trained for fish breeding and hatchery technology, pond management, These skills help them in getting employment in fishery-based industry.

Experiments

1. Identification of fishes (Museum and local fishes)
2. Determination of length-weight analysis in fishes.
3. Determination of absolute and relative fecundity in fishes.
4. Determination of food and feeding habit of fishes. Gonado- somatic Index of fish.
5. Identification of important fish parasites (external and internal).
6. Demonstration of fish breeding techniques.
7. Field visit to fish ponds, fish landing center and Fish processing Unit.
8. Identification of fishing gears and fish byproducts. Qualitative and quantitative analyses of planktons.
9. Use of Limnological equipment's: Sacchi disc. Elman's grab, Water sampling bottle. Plankton net, Sedgwick after counting cell.
10. Determination of total alkalinity and dissolved organic matter.
11. Determination of total hardness, calcium and magnesium.

ZOS505- ANIMAL BREEDING

Teaching Hours 10 /unit

COURSE OUTCOME

1. Expertise on identification of various animal breeds such as cattle breeds, sheep. Goat, swine, horse and poultry breeds *etc.*
2. Trained in different animal husbandry practices and are made to know the animal husbandry issues to deal in scientific manner.
3. Students will be well equipped with the advanced and basic techniques on the breeding methods for different animals in the laboratory.
4. Different processes adopted by various scientific labs and animal breeding centres are dealt in detail.
5. Economic importance of various breeds and advantages are discussed.
6. Training in domestication and breeding of various animals builds in them confidence to be Entrepreneurs.

UNIT I

What is animal husbandry? Animal husbandry Practices in India. Issues in animal husbandry –Assessing risk, Animal welfare, environmental Issues, consumer issues, marketing issues. Diseases of domestic animal and preventive measures. Breeding research - Conservation of breeds. Status, opportunities and challenges in conservation of Animal Genetic Resources. IPR - issues pertaining to animal genetic resources/animal products or by-products.

UNIT II

Selection of animals for breeding-Methods of selection- selection criteria – Artificial selection, Long term artificial selection. Gametic selection, Zygotic selection, heterozygous advantage. Heritability and genetic improvements- Broad and Narrow -sense heritability. Selection differential, Generation interval, Genetic gain. Evaluation of breeding animals-desirable traits, Identification system. Performance record, Reproductive efficiency, production traits, Selection indices. Selection of superior breeding stock-Breeding value, aids to selection.

UNIT III

Breeding methods –Inbreeding Systematic inbreeding measurement of inbreeding, panmictic index, Advantages and disadvantages of inbreeding. Cross breeding line breeding –Hybrid vigor, advantages and disadvantages. Methods of breeding of farm animals-cattle, swine, poultry, horse. Requirements and methods of breeding small lab animals (Rats and mice).

UNIT IV

Definition of breed-Breeds of animals- Cattle breeds-Beef cattle, Dairy cattle, Dairy goats, Sheep, Swine, Poultry and Horse breeds. Practical breeding plans –Dairy cattle breeding-Beef cattle breeding –Sheep breeding- Pig breeding –Poultry breeding. Feeding and managing of Dairy animals, Feeding and managing of swine, sheep poultry and horse breeds.

UNIT V

Modern trends in animal breeding-artificial insemination: super ovulation-embryo transfer techniques. Animal cloning. Institutional animal ethics committee. Advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

REFERENCES

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ZOP 512: ANIMAL BREEDING - LABORATORY
2 Hours/week

COURSE OUTCOME

7. Students are trained to breed small laboratory animals and ornamental fishes.
8. Visit are made to different animal farms, poultry, dairy processing and feed production industry in and around Mangalore regions to have practical knowledge.
9. Various animal breeding techniques are taught and after the course some of them take up job opportunities in animal husbandry related industries.

Experiments

1. Mouse breeding experiments
2. Demonstration of fish breeding techniques
3. Estimation of genetic parameters – Diallel analysis - Triallel analysis -D2 analysis - Problems in Matrix.
4. Problems relating to gene and genotypic frequencies under different conditions.
5. Estimation of inbreeding in regular and irregular systems.
6. Estimation of effective population size.
7. Computation of quantitative genetic effects.
8. Estimation of variance components.
9. Field visit to Dairy farm and preparation of report.
10. Visit to Piggery and Poultry farm and preparation of report.

ZOS506- ENVIRONMENTAL BIOLOGY

Teaching Hours 10 /Unit

COURSE OUTCOME

1. The course provides a broad outline on 'Ecology and ecosystem functions' covering various aspects. They include, types of ecosystem, components of ecosystem, community and populations, factors regulating community origination, species interactions.
2. Concept of habitat, ecological niche ecological pyramids are dealt.
3. Community ecology, types of interactions and ecological succession
4. Emphasis is given on marine ecosystem including 'Exclusive Economic Zone (EEZ). Environmental pollutions on biological system.
5. Microbial influence on ecosystem, impact assessment and development of sustainable ecosystems are also included.

6. The theoretical foundation will help the students to understand the impact of various environmental pollutions on ecosystems in general and biological resources in particular.

UNIT I

Ecosystems: Structure, function and types of ecosystem- terrestrial, fresh water, marine and estuarine. Abiotic and Biotic components, basic laws of energy flow, food chain, food web, ecological pyramids. Concept of habitat, niche and guild, concept of ecotone, edge effect and Concept of Gaia hypothesis.

UNIT II

Population ecology, population dynamics, stochastic and time lag models of population growth, population characteristics- mortality, fecundity, density, age distribution, population explosion. Community ecology- prey and predator relationships and various types of interactions. Ecological succession, its mechanism and its type. Ecological climax.

UNIT III

Biogeochemical cycles- carbon, nitrogen and phosphorus. Biomes- classification, biotic elements of biome and their characteristic in the biome. Microbial distribution in nature, interaction within microbial communities, with man and animals, dispersal of microorganisms in different environments.

UNIT IV

Marine ecosystem – Biological zones and its type, inter-tidal ecosystem: rocky - zonation pattern -physical and biological factors, sandy shores and protected sand flats – physical and biological factors, bio-geographical zones of India, faunal composition and adaptations. Exclusive Economic Zones (EEZ).

UNIT V

Environmental pollution, control and its effect on biological systems. Conservation management of natural resources. Environmental impact assessment. Sustainable development.

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ZOP 513: ENVIRONMENTAL BIOLOGY - LABORATORY
2 Hours/week

COURSE OUTCOME

1. The students will be trained on various methods of assessment of pollutions.

2. The impact of various pollutions on biotic community will be assessed through analysis of samples collected from different habitat (polluted / un polluted). The seasonal impact also will be assessed wherever possible.
3. It makes learnersto understand the importance of a healthy environment for the survival of different living organisms.

Experiments

1. Aspirants are exposed to nature and its components
2. Exploration of ecosystems to study life cycle of different organisms.
3. Calculation of biodiversity Index.
4. Vegetation studies by line, quadrate and belt transect methods.5.
5. Construction of ecological pyramids of different ecosystems.
6. Productivity of aquatic ecosystem by plankton study,
7. Study of wetland flora and fauna.
8. Field visit to aquatic, forest and other ecosystems for identification of biota.
9. Surveillance and quality of analysis of potable water.
10. Physico-chemical properties of polluted water.

ZOS507 – VERMITECHNOLOGY

Teaching Hours 10 /unit

COURSE OUTCOME

1. The course is structured at the basic level for the benefit of the students coming from different discipline having broad scope for employability.
2. In general soil earthworms, their characteristic features, occurrence, their influence on soil fertility and solid waste management are included.
3. Vermicomposting technology broadly followed at the global level and some Indigenous methods, role of microbes in increasing the soil fertility by the action of earthworms, their advantages and limitations dealt.
4. Role of microbes in worms and in decomposition is discussed.
5. Vermiculture products and their benefits in agriculture practice, economics of vermitechnology along with the practical difficulties are included.
6. Students will be trained on how to maintain a small vermicompost bin as a simple method for converting the Kitchen waste.

UNIT I

Introduction to Vermitechnology, definition and history, general characters of Annelida, the habitat of earthworm (soil), diversity of earthworms, collection of earthworms, preservation of earthworms. Interaction of earthworms with other organisms. Vermitechnology and waste management, role of earthworms on ecology, an eco-friendly approach to sustainable agriculture.

UNIT II

Vermiculture techniques, advantages of vermiculture, vermicomposting technology, methods of vermicomposting, large scale manufacture of vermicompost, worm casts, vermicompost, vermiwash, vermiwash production techniques, role of earthworms in soil fertility, use of vermicompost for crop production, use of vermicompost in land improvement and reclamation, potentiality of vermibiotechnology in India

UNIT III

Role of earthworms in waste management, solid wastes an option for resource recovery, expert system for hotel waste management, evaluation of nutritional status of vermicompost and growth response of some forest tree species to its application in a nursery, vermifilter, earthworm as farmer's friend, earthworms as bioreactors, organic farming, influence of chemical inputs on earthworm activity, vermiculture for waste reduction, economic importance of earthworms.

UNIT IV

Earthworms and microorganisms, The effects of earthworms on the number, biomass and activity of microorganisms. Importance of microorganisms as food for earthworms. Dispersal of microorganisms by earthworms. Role of intestinal microbes of earthworms on the

decomposition of organic wastes. Field sampling – Passive methods, counting of mass and biomass estimation.

UNIT V

Effect of vermicompost application on soil and plant growth, vermicompost as a organic manure a good substitute of fertilizers. Influence of pests and microbes on vermiculture, measures to control them. Marketing of vermicomposting products and financial support by governments and NGOs for vermiculture.

REFERENCES

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3. Dash, M. C. (2012) Charles Darwin's Plough Tool for Vermitechnology, I.K.. International Publishing House Pvt Ltd. New Delhi, India.

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IV Semester

ZOH551- BIOLOGY OF IMMUNE SYSTEM

Teaching Hours 10 /Unit

COURSE OUTCOME

1. It is an important course as students are trained to understand the basics of immunology .
2. Evolution of immune cells and organs in vertebrates and invertebrates is discussed.
3. To know about antigen, immunogen, epitopes and their properties.
4. Development of immune responses, organs and molecules involved in it are also dealt in detail.
5. Howour immune system fights different pathogens and evasive mechanisms developed by the microbes.
6. The discussion also includes autoimmunity and applied aspects like immunological basis of organ transplantation, development and applications of vaccines.

UNIT I

Overview of the immune system: Historical perspectives and important concepts.

Cells, organs and micro environments of immune system: Cells of immune system, Primary lymphoid organs, Secondary lymphoid organs, Tertiary lymphoid organs

Innate immunity: Components of innate immunity, Interactions between innate and adaptive immunity systems.The complement system: Major pathways of complement activation, diverse functions, Regulation of complement activation, Complement deficiencies and microbial evasion strategies.

UNIT II

Antigens and Immunogens: Immunogens and immunogenicity, Properties of immunogens, Epitopes and their characteristic properties, Adjuvants, Haptens.

Major histocompatibility complex: Structure and function of MHC molecules, General organization and Inheritance of the MHC, Role of MHC and Expression patterns,

MHC and immune responsiveness, MHC alleles and suceptiblity to diseases.

Processing and presentation of antigens: Endogenous and Exogenous pathway of antigen processing and presentation of antigens, Cross presentation of exogenous antigens, presentation of nonpeptide antigens.

UNIT III

Structure and function of antibodies: Structure of Antibodies, Antibody binding site, Antibody mediated effector functions, Antibody classes and biological activities, Antigenic determinants on antibodies, B-Cell receptor, Immunoglobulin super family and monoclonal antibodies, abzymes.

B – cell development: Development in bone marrow, Development of B-1 and marginal-zone B cells, B cell activation, Differentiation and Memory generation.

Receptor and signaling: Receptor ligand interactions, Common strategies used in many signaling pathways, Signal transduction in B cells.

UNIT IV

T – cell development : Early thymocyte development, T-cell activation differentiation and memory .T- cell receptor and co-receptor complex, accessory molecules and signaling.
Cell mediated effector responses , Experimental assessment of cell –mediated cytotoxicity.
T-cell responses to tumors, regulatory T-cell responses an memory, T-cell responses.
Immune cell behaviour- before antigen is introduced, during innate immune response, during adaptive immune response and in peripheral tissues.

UNIT V

Tolerance: Establishment and maintenance of tolerance; Immunosuppression and induction of immunosuppression.
Autoimmunity: autoimmune diseases, factors responsible for induction, mechanisms of induction and treatment.
Infectious diseases; Bacterial, Viral, Protozoan and Fungal infections and evasive mechanisms developed by microbes.
Vaccines: Active and passive immunization, Vaccine strategies, Types of vaccines advantages and challenges
Transplantation immunology: Types of transplants, Graft rejection, Tissue typing Immune tolerance to allografts, clinical transplantations.

REFERENCES

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ZOP 556: BIOLOGY OF IMMUNE SYSTEM- LABORATORY
4 Hours/Week

COURSE OUTCOME

1. In the practical session, students are trained to understand the basics of antigen-antibody reactions, electrophoresis, antibody development and other techniques routinely used in an immunobiology laboratory.
2. The technical training provided here helps students to develop skills in immunological techniques and their applications.

Experiments

1. Study of cells of immune system
2. Organs of immune system.
3. Agglutination reaction
4. Precipitation reaction
5. Quantitative precipitation assay.
6. Immunoelectrophoresis
7. Rocket immunoelectrophoresis
8. Countercurrent immunoelectrophoresis
9. Preparation of antisera
10. Precipitation of immunoglobulins by ammonium sulphate method.
11. Isolation and purification of immunoglobulin G
12. Enzyme Linked ImmnoSorbent Assay (ELISA)
13. Dot ELISA
14. Hapten conjugation method
15. Scale grafting in fish.

ZOP552 – PROJECT WORK

COURSE OUTCOME

1. Here students are given individual projects and they are supposed to perform the experiments/field works separately to complete their projects.
2. They are trained to go through literature survey before they start any project work. The subject of the projects may be the taxonomical description of different animal groups available in and around Mangalore University or laboratory work where they are trained to perform experiments using various animal models, molecular tools etc.
3. Project works are mainly focused for students to develop some scientific questions and solutions based on their experience.
4. In summary this session helps them have good scientific reading, design experiments and conclude scientific hypothesis based on their experimental data.
5. At the end of the semester, they are asked to present 10-15 minutes seminar and two examiners will evaluate their work.
6. Students are also encouraged to present their work in different national/state level conferences or workshops. Thus the project work develops in students the skill of planning, executing and presenting the research work.

ZOP552: PROJECT WORK
8 Hours(Field/ Laboratory Work)

ZOS553- WILDLIFE CONSERVATION AND MANAGEMENT

Teaching Hours 10 /Unit

COURSE OUTCOME

1. The course provides a broad outline on various aspects of 'Biodiversity conservation'
2. It includes, levels of understanding biodiversity in different ecological biomes, methods of population study and documentation.
3. Interaction of the species and their uniqueness, threats and conservations strategies, legal aspects on conservation of biodiversity, special projects and their current status are also included.
4. Threats to our environment and how it is possible to solve these issues scientifically.
5. Students will be visiting the *in-situ* and *ex-situ* conservation and management facilities to learn more about the effective steps taken by the conservation authority in saving the unique /rare/ threatened animals.
6. The theoretical foundation will help the biologist to take part in the effective wildlife conservation and management program with the advanced scientific methods.

UNIT I

Biodiversity concepts- Ecosystem diversity, Genetic diversity, Species diversity, Biodiversity from ecological, taxonomical and evolutionary prospective (Alpha, Beta and Gamma diversity); Biodiversity assessment- Inventorying and Monitoring biodiversity- Sources of information, Data collection and management- Taxon data sheet, Biodiversity indices.

UNIT II

Zoo geographical regions of the world and Ecological subdivisions of India; Biodiversity Hotspots; Biome essays- Tropical and Temperate forests, Tundra forests, Boreal forests, Cave and Mountains, Coastal ecosystems, Mangroves and Estuaries, Coral reefs, Lakes and Rivers.

UNIT III

Unique Indian animals- Diversity and distribution; Endemic species, Species interaction- Concept of niche, territory and home range, Keystone species; Capturing and marking techniques- entrapment, darting, tagging and banding; Population analysis- territory mapping, line transect, capture-recapture, pellet count, pug mark, call track count; Radio telemetry; Still and Video photography.

UNIT IV

Threats to Biodiversity- Habitat destruction, Climate change, Exotic species introduction, Over exploitation; Diseases and their control; Species extinction; IUCN Red list criterions and categories; Biodiversity conservation- *insitu* methods- National parks and Sanctuaries; ex-situ methods- Captive breeding program- role of Zoos and Botanical gardens. Gene bank/ seed bank.

UNIT V

Legal aspects- National and International conventions- CITES, TRAFFIC; Wildlife laws- Wildlife (protection) Act-1972; Indian biodiversity laws; Special projects- Project Tiger, Gir

Lion project, Project Elephant, Crocodile breeding project. Biodiversity Act, Earth summit, Ramsarconvention.

REFERENCES

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ZOP 557: WILDLIFE CONSERVATION AND MANAGEMENT - LABORATORY
2 Hours/Week

COURSE OUTCOME

1. Students will be trained in the collection, preservation and identification of important groups of regional fauna.

2. The data on diversity, richness, population structure of animal groups and their ecological role in the study area will be assessed using appropriate methods and documentation will be done. This will help the students to know the current conservation status of the species and in the implementation of possible step in saving the regionally threatened species.

Experiments

1. Habitat analysis: Aquatic habitat- water quality analysis- salinity, pH, Temp etc Terrestrial habitat- Soil analysis- Nutrient test
2. Species diversity analysis: collection, preservation and identification of local species of animals- vertebrates and invertebrates (aquatic and terrestrial)
3. Food habit analysis of insectivorous animals- Lizards, Bats etc
4. Identification of bird species by audio- visual methods
5. Live transect analysis, Quadrate analysis and Biomass analysis
6. Biodiversity indices- calculation and interpretation,
   i) Simpson's index
   ii) Evenness
   iii) Morishita Horn
7. Construction of Rank abundance curve, Comparison of Rank abundance curve,
8. Pitfall trap, Beat sheet, sweep nets for insects.
9. Pug mark and hoof mark castings.
10. Visit to observe and record types of ecosystem and associated flora and fauna. (Protected and unprotected areas, Biological parks etc)

ZOS554- STATISTICS AND BIOINFORMATICS

Teaching Hours 10 /Unit

COURSE OUTCOME

1. It is an important course and students are trained to use different statistical tools applicable to biological research and field work.
2. Terminologies used, data collection, tabulation, graphical representation of data are dealt.
3. Data analysis, types of data analysis and errors, accuracy, methods for large sample analysis are discussed.
4. Some of the recent tools and various soft wares used for statistical analysis are discussed.
5. Information on databases for protein and genome analysis, networking and bioinformatics tools are also introduced.
6. Skill based course that grooms students in application of statistics and bioinformatics in data analysis. On successful completion they can take up data analysis assignments
7. They learn data handling skills such as recording, collating and analysing data using appropriate techniques and equipment.

UNIT I

Basic Concepts & Descriptive Statistics: Biostatistics terminology, variables in biology, Levels and measurements of biological data, Classification, tabulation and frequency distribution of the data, graphical representation of data by histogram, Polygon, Ogive curve and pia diagram. Measures of central tendency, measures of dispersion, Comparison of two CVs; Skewness- Kurtosis.

UNIT II

Correlation & Regression: Positive and Negative correlation and calculation of Karl-Peasrson's Co-efficient of correlation, Spearman's rank correlation, Partial and multiple correlation, regression analysis; Sample linear and non-linear regression; multiple regression, regression equation, Calculation of an unknown variable using regression equation, Confidence interval level of confidence.

UNIT III

Errors in measurements & Statistical Analysis: Errors, Accuracy, Precision, general theory of Errors, Classification, standard errors. Ways of expression of precision, Accuracy detection of determinates errors, Statistic analysis of biochemical data with spread sheet applications, Use of statistical packages, Data management with computer Basic idea of significance test – Hypothesis testing. **,** Null and alternative hypothesis; Large sample tests (z-test); Test of significance of single and two sample means; Testing of single and two proportions - Small sample tests: F-test — testing of single mean; Testing of two sample means using independent t test, paired t test; ANOVA and Chi-Square Tests: One-way and two-way ANOVA – Latin Square tests for association and goodness of fit; testing linkage; segregation ratio.

UNIT IV

Information theory and Bioinformatics Network:Biological data exploration through internet Resources– EMB net, NCBI, BTIS network, Bioinformatics landscape intrinsic & extrinsic view, Cheminformatics and medical informatics. Biological databases sequence databases, Protein sequence databases, Structural databases, PDBs, Motif databases, Protein motif database, Genome databases, Proteome databases etc.

UNIT V

Bioinformatics tools: Pair wise Alignment, Alignment algorithms, sequence analysis tools, BLAST (Basic Logical Alignment Search Tool) FASTA, Multiple Alignment, Sequence analysis, using EMBOSS, DNA micro array technique.

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6. Dixit, M. (2000) Internet an Introduction, Tata McGraw-Hill.
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ZOP 558: STATISTICS AND BIOINFORMATICS - LABORATORY
2 Hours/Week

COURSE OUTCOME

1. Expertise to collect, analyse and interpret data using appropriate statistical tools.
2. Attain mastery in biological data analysis using bioinformatics tools.

Experiments

Representation of Statistical data by: - Histogram, Ogive curves, Pie diagram.
Measurement of central tendencies: - Arithmetic & Geometric mean,mode and median.
To calculate the measures of dispersion.
a) Mean deviation.
b) Standard deviation and Coefficient of variation.
c) Quartile deviation.
4. Test of Significance.
a) Chi-Square test.
b) t- test.
5. Internet search for Bioinformatics resources.
6. DNA and Protein sequence, file format conversion.
7. Nucleic acids and Protein sequence database search.
8. Multiple sequence alignment and Conserved Amino acid residues.

ZOS555- RADIATION BIOLOGY

Teaching Hours 10 /Unit

COURSE OUTCOME

1. This course is included to discuss the principles of radioactivity and different sources of radiation.
2. The biological effects of both ionizing and non-ionizing radiations are discussed. It gives basic training to students to understand the harmful effects of radiations and protect themselves from accidental exposure to radiation resources.
3. The functional principles of different instruments that are used for measuring environmental/biological radiation levels are discussed with students.
4. The studies also include awareness of various radiation disasters across the world.
5. Students are trained to use different instruments so that they can take up the subject for getting jobs in radiotherapy or radiation related works.
6. As the instruments used in the radiation application and measurements needs a special handling procedure, helps students get special skills in the radiation biology fields. These training build confidence and awareness in students to use different radiation resources and they can be entrepreneurs in this field.

UNIT I

Radiological Physics**:** Atomic structure models, Constituents of atomic nuclei, Isotope, Isobars, Radioactivity, laws of Radioactivity, High energy Electromagnetic radiation and its properties, Radiation units- Units of radioactivity,mode of interaction of X & gamma rays- Photoelectric, Compton effect & Pair production.

UNIT II

Radiation detection and Measurement:Principles of radiation detection and measurement, Basic principles, Design & Working of physical dosimeters- Ionization chamber, Proportional counters, GM- Counter, Concepts of Gas amplification, Resolving time & Dead time, Scintillation Detectors, Thermoluminiscent Dosimeter, Semiconductor, Lithium detectors, Area survey meter, Film badge. Chemical dosimeters- Salient Features of Chemical dosimeter, Fricke dosimeter, methyl orange, FBX dosimeter, Free radical dosimeter, Ceric sulphate dosimeter,chlorobenzene dosimeter, High & low dose indicators.

UNIT III

Radiochemistry & Radiobiology:Radiolysis of water, G-value, Direct and Indirect action, Interaction of radiation with living system – Viruses, Prokaryotic & Eukaryotic cells, Effect of radiation on Nucleic acids, Proteins, Enzymes & Carbohydrates, Cellular effects of radiation, Mitotic delay, Inhibition of mitosis, Giant cell formation, Cell death, Cell recovery &Modification of Radiation damage, Genetic Effect, Chromosomal breakage and Aberrations, Somatic effect of radiation.

UNIT IV

Radiation safety measures:Natural & Man-made radiation exposures, Maximum permissible dose (MPD), Evaluation of external &internal radiation hazards, Radiation protection measures in industrial establishment, Radioisotope labs, diagnostic & therapeutic installation & during transportation of radioactive substances, disposal of radioactive waste, administrative & legislative aspect of radiation protection.

UNIT V

Applications of Radioactivity:Radioisotopes in biology, Agriculture, Plant breeding, Soil plant relationship & plant physiology, Medicine, (Therapy & diagnosis), Radiation Hormosis, Radioimmunoassay, Radio tracer techniques with illustrative examples.

REFERENCES

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ZOP 559: RADIATION BIOLOGY - LABORATORY

2 Hours/Week

COURSE OUTCOME

1. Students are trained to use different radiation resources and expose biological samples to radiation. In the meanwhile they are trained to use different safely measures to protect them from the radiation exposure.
2. They are trained to use different instruments for measuring radiation levels in the environment and biological samples.

Experiments

1. Fricke Dosimeter.
2. Free Radical Dosimeter (Alanine and Glutamine)
3. FBX Dosimeter.
4. Ferric Sulphate Dosimeter.
5. To determine the effect of UV and Gamma rays on *E. Coli*and elucidate cell survival curve.
6. To demonstrate the effect of Gamma rays on Enzymes, Proteins and DNA, using spectroscopic method and viscometer.
7. To demonstrate the effect of UV and Gamma rays on cell division.
8. To demonstrate the effect of Gamma rays on cell membrane.