DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD, MAHARASHTRA, INDIA

FACULTY OF SCIENCE AND TECHNOLOGY

2 YEARS P.G. PROGRAMME

COURSE STRUCTURE AND CURRICULUM

As Per National Education Policy 2020

Subject – ZOOLOGY
Course Structure for M.Sc. 1st and 2nd Year

FOR UNIVERSITY DEPARTMENT

Department of Zoology (Autonomous)
Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad-431004
(Effective from 2023-24)

As per NEP 2020

Credit distribution structure for Two Years PG Program with Multiple Entry and Exit Options

Class: M.Sc. First Year Semester: Ist Semester
Subject: Zoology Theory + Practical

Course type	Course Code	Course name	Teaching Scheme (Hrs/week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
DSC Core Course	**ZOO/DSC/520**	Biosystematics and animal diversity	3	-	3	-	14
	ZOO/DSC/521	Biochemistry	3	-	3		
	ZOO/DSC/522	Ecology (Principles and Practices)	3		3		
	ZOO/DSC/523	Practical based on ZOO/DSC/520		3	-	1	
	ZOO/DSC/524	Practical based on ZOO/DSC/521	-	3	-	1	
	ZOO/DSC/525	Practical based on ZOO/DSC/522	-	3	-	1	
	ZOO/DSC/526	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**ZOO/DSE/527**	Helminthology - I	3	-	3	-	04
	ZOO/DSE/528	Protozoology – I	3	-	3		
	ZOO/DSE/529	Entomology – I	3	-	3		
	ZOO/DSE/530	Endocrinology – I	3	-	3		
	ZOO/DSE/531	Marine Biology -I	3	-	3		
	ZOO/DSE/532	Practical based on ZOO/DSE/527	-	2	-	1	
	ZOO/DSE/533	Practical based on ZOO/DSE/528	-	2	-	1	
	ZOO/DSE/534	Practical based on ZOO/DSE/529	-	2	-	1	
	ZOO/DSE/535	Practical based on ZOO/DSE/530	-	2	-	1	
	ZOO/DSE/536	Practical based on ZOO/DSE/531					
RM	**ZOO/RM/537**	Research Methodology I	4	-	4	-	04
			16	**12**	**16**	**06**	**Total credits 22**

Class: M.Sc. First Year Semester: IInd Semester

Subject: Zoology Theory + Practical

Course type	Course Code	Course name	Teaching Scheme (Hrs/week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
DSC Core Course	**ZOO/DSC/570**	Genetics and Bioinformatics	3	-	3	-	14
	ZOO/DSC/571	Cell and Molecular Biology	3	-	3	-	
	ZOO/DSC/572	Biophysics	3	-	3	-	
	ZOO/DSC/573	Practical based on ZOO/DSC/570	-	2	-	1	
	ZOO/DSC/574	Practical based on ZOO/DSC/571	-	2	-	1	
	ZOO/DSC/575	Practical based on ZOO/DSC/572	-	2	-	1	
	ZOO/DSC/576	Practical Skill/advanced technique		4		2	
DSE (Choose any one from pool)	**ZOO/DSE/577**	Helminthology - II	3	-	3		04
	ZOO/DSE/578	Protozoology – II	3	-	3		
	ZOO/DSE/579	Entomology – II	3	-	3	-	
	ZOO/DSE/580	Endocrinology – II	3	-	3	-	
	ZOO/DSE/581	Marine Biology -II	3	-	3		
	ZOO/DSE/582	Practical based on ZOO/DSE/577	-	2	-	1	
	ZOO/DSE/583	Practical based on ZOO/DSE/578	-	2	-	1	
	ZOO/DSE/584	Practical based on ZOO/DSE/579	-	2	-	1	
	ZOO/DSE/585	Practical based on ZOO/DSE/580	-	2	-	1	
	ZOO/DSE/ 586	Practical based on ZOO/DSE/581	-	2	-	1	
RM	**ZOO/OJT/FP/587**	OJT/FP	-	8	-	4	04
					12	**10**	**Total credits 22**

For Practical – 1 Credit = 30 clock Hrs. (For 13 Practical compulsory – 3 Hours each)
Total credits for theory = 16 credits
Total credits for practical = 6 credits

As per NEP 2020

Credit distribution structure for Two Years PG Program with Multiple Entry and Exit Options

Class: M.Sc. Second Year Semester IIIrd Semester
Subject: Zoology Theory + Practical

Course type	Course Code	Course name	Teaching Scheme (Hrs/week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
DSC Core Course	**ZOO/DSC/620**	Developmental biology	3	-	3	-	14
	ZOO/DSC/621	Immuno-biology	3	-	3		
	ZOO/DSC622	Applied Biotechnology -I	3		3		
	ZOO/DSC/623	Practical based on ZOO/DSC/620		3	-	1	
	ZOO/DSC/624	Practical based on ZOO/DSC/621	-	3	-	1	
	ZOO/DSC/625	Practical based on ZOO/DSC/622	-	3	-	1	
	ZOO/DSC/626	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**ZOO/DSE/627**	Applied Parasitology - I	3	-	3	-	04
	ZOO/DSE/628	Animal Physiology– I	3	-	3		
	ZOO/DSE/629	Molecular Biology -I	3	-	3		
	ZOO/DSE/630	Fishery Science-I	3	-	3		
	ZOO/DSE/631	Practical based on ZOO/DSE/627	-	2	-	1	
	ZOO/DSE/632	Practical based on ZOO/DSE/628	-	2	-	1	
	ZOO/DSE/633	Practical based on ZOO/DSE/629	-	2	-	1	
	ZOO/DSE/634	Practical based on ZOO/DSE/630	-	2	-	1	
RM	**ZOO/RP/635**	Research Project -I	4	-	4	-	04
			16	**12**	**16**	**06**	**Total credits 22**

As per NEP 2020

Credit distribution structure for Two Years PG Program with Multiple Entry and Exit Options

Class: M.Sc. Second Year Semester: IVst Semester
Subject: Zoology Theory + Practical

Course type	Course Code	Course name	Teaching Scheme (Hrs/week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
DSC Core Course	**ZOO/DSC/650**	Evolution And Behavior	3	-	3	-	14
	ZOO/DSC/651	General and Comparative Physiology	3	-	3		
	ZOO/DSC/652	Animal Biotechnology II	3		3		
	ZOO/DSC/653	Practical based on ZOO/DSC/650		3	-	1	
	ZOO/DSC/654	Practical based on ZOO/DSC651	-	3	-	1	
	ZOO/DSC/655	Practical based on ZOO/DSC652	-	3	-	1	
DSE (Choose any one from pool)	**ZOO/DSE656/**	Applied Parasitology- II	3	-	3	-	04
	ZOO/DSE/657	Animal physiology – II	3	-	3		
	ZOO/DSE/658	Molecular biology – II	3	-	3		
	ZOO/DSE/659	Fishery Science – II	3	-	3		
	ZOO/DSE/660	Practical based on ZOO/DSE/656	-	2	-	1	
	ZOO/DSE/661	Practical based on ZOO/DSE/657	-	2	-	1	
	ZOO/DSE/662	Practical based on ZOO/DSE/658	-	2	-	1	
	ZOO/DSE/663	Practical based on ZOO/DSE/659	-	2	-	1	
RM	**ZOO/RP/664**	Research Project	6	-	4	-	04
			16	**12**	**16**	**06**	**Total credits 22**

Class: M.Sc. First Year: Zoology First Semester

1: DSC – ZOO/DSC/520 Biosystematics and animal diversity
ZOO/DSC/521 Biochemistry
ZOO/DSC/522 Ecology (Principle and Practices)
ZOO/DSC/523 Practical based on Biosystematics and Animal Diversity
ZOO/DSC/524 Practical based on Biochemistry
ZOO/DSC/525 Practical based on Ecology (Principle and Practices)
ZOO/DSC/526 Practical Skilled-based Advance technique

2: DSE – (Choose any one from Pool/Basket)
ZOO/DSE/527 Helminthology I
ZOO/DSE/528 ProtozoologyI
ZOO/DSE/529 Entomology I
ZOO/DSE/530 Endocrinology I
ZOO/DSE/531 Marine Biology I
ZOO/DSE/532 Practical based on Helminthology I
ZOO/DSE/533 Practical based on Protozoology I
ZOO/DSE/534 Practical based on Entomology I
ZOO/DSE/535 Practical based on Endocrinology I
ZOO/DSE/536 Practical based on Marine Biology I

3: RM-1 - ZOO/RM/537 Research Methodology - I

Second Semester

1: DSC – ZOO/DSC/570 Genetics and Bioinformatics
ZOO/DSC/571 Cell and Molecular Biology
ZOO/DSC/572 Biophysics
ZOO/DSC/573 Practical based on Genetics and Bioinformatics
ZOO/DSC/574 Practical based on Cell and Molecular Biology
ZOO/DSC/575 Practical based on Biophysics
ZOO/DSC/576 PracticalSkilled-based Advance technique

2: DSE – (Choose any one from Pool/Basket)
ZOO/DSE/577 Helminthology II
ZOO/DSE/578 ProtozoologyII
ZOO/DSE/579 Entomology II
ZOO/DSE/580 Endocrinology II
ZOO/DSE/581 Marine Biology II
ZOO/DSE/582 Practical based on Helminthology II
ZOO/DSE/583 Practical based on Protozoology II
ZOO/DSE/584 Practical based on Entomology II
ZOO/DSE/585 Practical based on Endocrinology II
ZOO/DSE/586 Practical based on Marine Biology II

3: RM-1 - ZOO/OJT/FP/587 OJT/FP

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
Department of Zoology

M. Sc. First Year (Semester – I)

Paper No. ZOO/DSC/520- BIOSYSTEMATICS AND ANIMALDIVERSITY

Contact Hours: 45 credits- 3

Learning Objectives:

- To give a thorough understanding in the principles and practice of systematic
- To help students acquire an in-depth knowledge on the diversity and relationships in animal world
- To develop an holistic appreciation on the phylogeny and adaptations in animals

Learning Outcomes:

- The students will learn the basic principle and practices used in systematic.
- The students will learn and understand the diversity in animal world and their adaptations.
- The students will learn about the phylogeny, the tools and salient features of taxonomic publications.

BIOSYSTEMATICS 30hrs

UNIT I:

Concepts Biological Classification and techniques in systematic 8 hrs.

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation, curetting and process of identification.

Taxonomic characters of different kinds-quantitative and qualitative analysis of variation, Process of typification, different zoological types and their significance.

Three Domain Concept in Systematics, two, five and six kingdom classification.

UNIT II:

Methods of Biosystematics and Taxonomic publication 8 hrs.

Classical and modern Methods- Concept of species- taxonomic diversity within species. Typological, Biological, Evolutionary, Phylogenetic, Cladistics and Molecular Taxonomy. Phylocode, Tree of Life and Bar-coding of Life. Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees.

. International Code of Zoological Nomenclature (ICZN), Rules and formation of Scientific names of different taxa. Homonymy and Synonymy. Phenetics, Keys, types, use of keys, merits and demerits

ANIMAL DIVERSITY 30hrs.

UNIT III: `

Basics of Prokaryotes and Eukaryotes Origin of Protista and lower Metazoans, **9 Hrs**

Levels of organization in animal kingdom.

Edicaran and Burgess Shale fauna. Cambrian explosion-causes and consequences. Possible theories of metazoan origin, and Metamerism-evolutionary advantages.

Porifera, Cnidaria-, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudo-coelomata- evolutionary relationships and adaptive modifications (Polymorphism) only.

UNIT IV:

Protostomes; Deuterostomes; Lesser Protostomes and Echinodermata 9hrs.

Phylogenetic position of Molluscs, Adaptive Radiation in Molluscs and Annelids. Phylogeny of Arthropod-Monophyly and Polyphyly, Reasons for the success of Arthropods. Major classes under Arthropod and adaptive radiation.

Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha, echinodermata-Phylogeny only.

Hemichordates and Ancestry of Chordates 6 hrs.

Position of hemichordate , cephlochordata and urochordata in the animal kingdom, evolutionary significance

Vertebrate Phylogeny-Agnatha,Ostracoderms and Gnathostomes- Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes.

UNIT V

Terrestrial Vertebrates - Birds and Mammals 5 hrs.

Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats.

Reptiles–origin and adaptive radiation (Skull of reptiles and its importance in biosystematics). Mesozoic world of reptiles and extinction.

Origin of birds and mammals. Structural and functional modifications for aerial life. Class Mammalia: Prototheria, Metatheria and Eutheria. Adaptive radiation in mammals.

REFERENCES

1. Alfred,J.R.BandRamakrishna.2004.*Collection, Preservation and Identification of Animals*. Zoological Survey of India Publications, Calcutta.
2. Anderson,T.A.2001.*Invertebrate Zoology*(2nd edn).Oxford University Press, NewDelhi. Barnes,R.D.1982.*Invertebrate Zoology*(6thedn).Toppan International Co.,NY
3. Barrington,E.J.W.1969.*Invertebrate Structure and Functions*.English LanguageBookSociety. Benton, M.J.2005. *Vertebrate Paleontology* (3rd edn). Blackwell Publishing Com.Oxford,UK. Campbell,N.AandJ.B.Reece.2009. *Biology*(8th edn).Benjamin Cummings Publ. NY,USA
4. David, M.H, Craig Moritz and K.M.Barbara.1996.*MolecularSystematics*.SinauerAssociates,Inc. Hyman,L.H.1940–1967.*The Invertebrates*(6vols).McGraw-Hill Companies Inc.NY
5. Hickman Jr., Cleveland, Larry Roberts, Susan Keen, Allan Larson, and David Eisenhour .2011. *Animal Diversity*. McGraw-Hill Companies, Inc. NY
6. Kapoor,V.C.1991.*Theory and Practice of Animal Taxonomy*. Oxford and IBH PublishingCo.,Pvt. Ltd. New Delhi.
7. Margulis, Lynnand M.J.Chapman2001.*Kingdoms and Domains:An Illustrated Guidetothe Phyla of Life on Earth*(4th edn.).W.H.Freeman & Company,USA
8. Mayr,E.1969.*Principles of Systematic Zoology*. McGrawHill Book Company, Inc.,NY. Mayr,E.1997.*This is Biology: The Science of Living world*. Universities Press Ltd.
9. Narendran, T.C. 2008. *An introduction to Taxonomy*. Zoological survey of India.
10. Niles,E.2000. *Life on earth:an Encyclopedia of Biodiversity, Ecology and Evolution*(Vol.1&II).ABC- CLIO, Inc. CA,USA
11. Pat,W.1996.*InvertebrateRelationshipsPatternsinAnimalEvolution*.CambridgeUniversity

Press Pechenik, J.A.2000.*Biology of the Invertebrate* (4thedn). McGraw-HillCompanies,Inc.NY,USA. Pough Harvey F, Christine M .Janis and John B. Heiser 2002. *Vertebrate Life* (6thedn).Pearson Education Inc. New Delhi.

12. Rupert E.Edward.,R.S. Foxand R.D. Barnes.2006. *Invertebrate Zoology: A Functional Evolutionary Approach.* Thomson/Cole, Singapore
13. Strickberger, M.W. 2005. *Evolution.* Jones and Bartett Publishers, London. Waterman,A.J.1971.*Chordate Structure and Function*.MacmillanCo.London
14. Winston, J.E.2000. *Describing species: Practical Taxonomic Procedures for Biologists*. Columbia University Press, Columbia, USA.
15. Young, J.Z. 1950. *Life of Vertebrates*. Clarendon Press, Oxford, UK.

Paper No. ZOO/DSC/521 - BIOCHEMISTRY

Contact Hours: 45 credits- 3

Learning Objectives:

- To understand the chemical nature of life and life process
- To provide an idea on structure and functioning of biologically important molecules
- To generate an interest in the subject and help students explore the new developments in biochemistry.

Learning Outcome:

The students will learn how the metabolic processes are interrelated

The bimolecular interactions

UNIT I

Introduction **5hrs.**

1. Water: structure, solvent properties, biological importance. pH and acid-base balance. Henderson–Hasselbalch Equation, Buffers-biological importance.

Carbohydrates

1. Introduction to Carbohydrates - Monosaccharide, and Disaccharides: sugars of biological importance.
2. Structural representations of sugars-Acetal and hemiacetal, ketal and hemi-ketal linkages,
3. Isomerism–structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars.
4. Polysaccharides**:** Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratin sulphate, Dermatan sulphate. Glycoproteins and Mucoproteins.

UNIT II

Lipids **10hrs.**

1. Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification.
2. Simple fats: Triacylglycerol (Triglycerides).Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins, waxes . Prostaglandins- structure, types, and functions.

Proteins

1. Structure, classification and Properties of aminoacids. Reactions (due to carboxyl group, amino group and side chains).Primary structure of protein (*e.g.* insulin). Classification and properties of proteins. Conformation of proteins-chemical bonds. Secondary structure- alpha helix, Collagen helix, Beta Pleated sheet, stabilizing forces, Ramachandran angles and Ramachandran map.
2. Fibrous proteins- occurrences and importance examples (Keratin,Collagen,Elastin,Resilin,Fibrous muscle proteins).Chaperons. Tertiary

structure-*e.g.*Myoglobin.Quaternary structure–*e.g.*Haemoglobin.

Nucleic Acids

1. Introduction Nucleic acids. Structural organization of DNA (Watson–Crick model). Characteristic features of A,B,C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation. 3. Biological roles of nucleotides and nucleic acids.

UNIT III .

Enzymes **15hrs.**

1. Classification- (I.U.B.system),. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Activesite.co-enzymes, iso-enzymes. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering**.**

Carbohydrate Metabolism

1. Glycolysis–Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis – (from aminoacid and lactacte).
2. 2.Glycogen metabolism-Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca^{+2}Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis.
3. 3.Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria.

UNIT IV

Metabolism of Proteins **10 hrs.**

1. Amino acid Metabolism-Deamination,Transamination and Trans-deamination.Formation and disposal of ammonia.
2. Urea cycle.Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.

Metabolism of Lipids **.**

1. Betaoxidation. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies-Ketogenesis, Ketolysis, Ketosis.

UNIT V

Nucleic Acid and Mineral Metabolism **5 hrs.**

1. Catabolism of purines and pyrimidines. Major and minor nutrients. Role of Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride, Sulphur and Iron.
2. Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Lipid peroxidation. Preventive antioxidants.

REFERENCES

1. Creighton, T.E. *Protein Structure and Molecular Properties*. 1993. W.H. Freeman & Co, NY. Deb,A.C.2004.*Fundamentals of Biochemistry*.NewCentral Book Agency(P)Ltd.NewDelhi.
2. Elliott,W.H . and.C. Elliott. 2003. *Biochemistry and Molecular Biology*. Oxford University Press, Oxford,UK.
3. Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. 2007. *Outlines of Biochemistry*. (5thedn).John Wiley &Sons Inc., NY.
4. Garret, R.H. and C.M. Grisham. 1995. *Biochemistry*. Saunders College Publishers,USA.
5. Lenhninger,A.L.2008. *Principles of Biochemistry*.5thedn).CBS Publishers and Distributors, NewDelhi.
6. Hanes,B.D.and N.M.Hoopar.1998.*Instant notes:Biochemistry*. University of Leeds, Leeds,UK. Horton, H.R., Morsan, L.A., Scrimgeour, K.G.,Perry, M.D and J.D.Rawn.2006. *Principles of Biochemistry.* Pearson Education International, New Delhi.
7. Keith Wilson and John Walker. 2008. *Principles and Techniques of Biochemistry and Molecular biology*(6thedn). Cambridge University Press, UK.
8. Murray, K., Granner, D.K., Maynes, P.Aand V.W.Rodwell. 2006. *Harper's Biochemistry* (25thedn).McGraw Hill, New York, USA.
9. Oser, B.L.1965. *Hawk's Physiological Biochemistry*. Mc Graw Hill Book Co. New Delhi.
10. PalmerTrevor.2001.*Enzymes:Biochemistry,Biotechnology&Clinicalchemistry.*HorwoodPubl.Com., England.
11. RamaRao,A.V.S.S.1986.*TextBook of Biochemistry*.L.K.&SPublishers,NewDelhi.
12. Styer,L.2011.*Biochemistry*.(7thedn).W.H.Freeman & Co.NY.
13. Voet,D.andJ.G.Voet.2004. *Biochemistry*.JohnWiley&Sons.,NY.
14. Zubay,G.1989.*Biochemistry*. McMillan Publishing house PublishingCo.,NewYork.

Paper No. ZOO/DSC/522 - ECOLOGY: PRINCIPLES AND PRACTICES

Contact Hours: 45 credits- 3

Learning objectives:

- To provide an understanding on the basic theories and principles of ecology
- To help study various disciplines in ecology
- To learn current environmental issues based on ecological principles
- To gain critical understanding on human influence on environment

Learning Outcome

- The student will learn the theories that governs the principle of ecology .
- The students will learn the various aspects of ecology
- The students will learn the environmental issues at local , national and global level.

UNIT I

Ecology and Environment & Ecosystem-Structure and Function 10hrs.

Physical Environment-biotic and abiotic interactions. Concept of Homeostasis; concepts of habitats- host as habitat, niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

Ecosystem and Landscapes, pathways in ecosystem, energy in the environment-Laws of thermodynamics, Cybernetic nature of ecosystem, and Gaia hypothesis.

Energy flow in the ecosystem. Primary productivity, Biomass and productivity measurement. Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids, Biogeochemical cycles-patterns and types (CNP).

UNIT II :

Population and Community Ecology 15hrs.

Population group properties, density and indices of relative abundance,Concept of rate. Natality and mortality. Population age structure, Growth forms and concept of carrying capacity.

Population fluctuations, density dependent and density independent controls. Life history strategies, *r & k* selection.

Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality.

Population interactions-types, positive and negative, interspecific and intraspecific interactions. Ecological and evolutionary effects of competition.

Concept of community-community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, concept of climax.

UNIT III

Resource Ecology 15hrs.

Natural Resources: Soil-soil formation, physical and chemical properties of soil. Significance of soil fertility. Mineral resources with reference to India. Impact of mining on environment; Forest resources- deforestation, forest scenario of India. Aquatic resources-Freshwater and water scarcity, water conservation measures-case studies from India; Wetlands and its importance, international initiatives for wetland conservation-Ramsar sites. Sand mining and its impacts. Wetland reclamation-causes and consequences. Depletion of resources and impacts on quality of life.

Energy Resources-solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development.

Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology,

GPS and its application; EIA- tools and techniques, Ecosystem Modelling (Brief account only).

UNIT IV : Applied Ecology **10hrs.**

Environmental Pollution mitigation at international level, International protocols, Concept of waste, types and sources of solid wastes including e-waste; Environmental biotechnology and solid waste management-aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and sewage. Bioremediation-need and scope of bioremediation in cleaning up of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbers and trickling filters.

Radiation Biology-natural and man-made sources of radioactive pollution; radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters(two case studies),Disposal of radioactive wastes. Weak radiation LF-EMF.

UNIT V :

Biogeography and Conservation **10hrs.**

Major terrestrial Biomes, theory of island biogeography, bio-geographical zones of India; Western Ghats and its significance, Hot spots in India.

Restoration Ecology- need and policies, case studies and success stories - global and national;

Global environmental problems and debates-past and present; Participatory resource management, community reserves, sacred groves, bio villages.

REFERENCES

1. Abbasi, S.A. and Ramasami, E.V.1998. *Biotechnological Methods of Pollution Control*. Oxford University Press, Hyderabad.
2. Benton, A.H. and Werner, W.E. 1976. *Field Biology and Ecology.* Tata McGraw Hill, New Delhi.
3. Boitani,L andT.K.Fuller.2000. *Research Techniques in Animal Ecology*. Columbia University Press, USA
4. Daniel,C.D. 2010. *Environmental Science*.(8^{th}edn).Jones and Bartlett Publishers.
5. Mani, M.S. 1974.*Ecology and Biogeography in*

India..Dr.W.Junk,TheHague.

6. Misra, S P and Pandey S. N.2009. *Essential Environmental Studies*. AneBooksPvt. Ltd.
7. Odum, E P .1996. *Fundamentals of Ecology*. W.B Saunders College Publishing, Philadelphia.Peter, H.R., Berg, L.R., and Hassenzahl, D.M. 2008. *Environment.*(5th edn.).John Wiley Publishers.
8. Pianka,E.R.1981. *Competition and Niche Theory in "Theoretical Ecology".*(2nd edn.).In: May,R.M. (Ed.). Blackwell, London.
9. Rana,S.V.S.2009. *Essentials of Ecology and Environmental Science*.(4th edn.).PHI learning Pvt.Ltd., New Delhi
10. Simons, I.G. 1981. *Ecology of Natural Resources.* Edwin-Arnold Ltd., London.
11. Tietenberg,T.2004. *Environmental and Natural Resource Economics*.(6th edn.).Pearson, NewDelhi. Tyler,M.G.2007. *Living in the Environment.*(15th edn).Thomson Brooks/cole, NewYork.

Elective Courses

Paper No. ZOO/DSE/527- Helminthology I

Contact Hours: 45 credits- 3

Learning Objectives:

1. To impart basic knowledge of Helminthes, Cestodes and Trematodes.
2. To orient to major types of important cestodes and trematodes.
3. To develop the ability to collect, and identify important cestodes and trematodes from regions.
4. To develop experts in the field of Helminthology.

Learning Outcome:

1. The students will learn about helminths, cestodes, and trematodes.
2. The students will be able to identify. Parasites and can develop expertise.

Unit I: Introduction, history, and scope of Helminthology.

1. General organization and classification of Platyhelminthes up to order level.
   Cestodes (Cestodarians and Eucestodes), Trematodes (*Monogena, Aspidobothria* and *Digenea*)
2. Functional anatomy of Reproductive system
   a. Trematodes (*Digeneans*)
   b. Cestodes (*Pseudophyllideans* and *Cyclophyllideans*)
   c. Eggshell formation, the chemistry of eggshell formation, factor influencing embryonation and hatching.

Unit II:

1. Intramolluscan stages and their effect on molluscan hosts, effect on foot, hepatopancreas, Reproductive system, and general metabolism.
2. Various types of Cercaria.
3. Different types of larvae in cestodes and their pathogenicity.
4. Holdfast organs with their adaptation in cestodes.

Unit III:

1. Pathogenicity, control, treatment, prevention of some important Helminthes of medical and veterinary importance .
2. Life cycle patterns of Digenetic trematodes.
   a. Single intermediate host life cycles.
   b. Two intermediate host life cycles
3. Life cycle patterns in Cestodes
   a. No intermediate host life cycle
   b. Single intermediate host life cycle
   c. Two intermediate host life cycle

Unit IV:

1. Physiology of cestodes.
   a) Nutrition
   b) Carbohydrate metabolism
   c) Fat metabolism

Unit V:

1. Immunological reactions of trematodes: Basic concept of Immunology, Antigen-Antibody reaction, Innate and Acquired reaction, Host-parasite interaction.
2. Evasion and subversions of immune defenses. Role of Antihelminthes drugs

LIST OF BOOKS

1. Medical Parasitology by Markell, Voge and John, 8thed. W.B. Saunders Co.
2. The Biology of animal parasites, Cheng T.C. (1964)-Saunders International Student Edition
3. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
4. Text book Medical Parasitology Jaypee Brothers, - Medical Publishers, New York. - Panikar C.K.J(1988)
5. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
6. Parasitology (Protozoology and Helminthology) -Sood Pamnik (1993) CBSPublication and Distrubution, Delhi.
7. Human helmintology Manual for Clinical, Sanitarians Medical Zoologists - Faust, EmerestCaroll.
8. Systema Helminthum Vol. IV Monogenca and Aspidobothria -Yamaguti S.(1963) Inter- Science Publishers, London.
9. Synopsis of Digenetic Trematodes of Vertebrates - Yamaguti S. (1971) Vol. I & IIKeigakuPublishing Co., Tokyo, Japan.

REFERENCE BOOKS.

1. The Invertebrates Vol.II - Hyman L. H.
2. The Trematode - Dausese B
3. Text book of medical Parasitology - Dey
4. Text book of medical Parasitology - Sawitz
5. Parasitology-Nobel and Nobel
6. Structure of Nematode - Allen bird
7. An introduction to Nematodology - Chitwood
8. Organization and Biology of nematodes -Crool
9. Physiology of nematodes - Lee
10. Plant parasitic nematode - Parmonove
11. Principal of Nematodology - Throne
12. Plant Nematodology - Jenkins and Taylor
13. General Parasitology - Cheng
14. Clinical Parasitology - Craig Faust

15. Applied Parasitology - Hiware, Jadhav and Mohekar
16. Biochemistry of parasitism - Von Brand
17. Physiology of nematode parasite - Smith
18. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
19. Laboratory methods of work with plant and soil nematodes -Southey
20. Soil and fresh water Nematodes - Goodey.
21. Practical exercise in Parasitology-Halton, Behave, Marshall.
22. Animal Nematodes from Indian Mammals-Nama, Shinde and Jadhav.
23. Parasitology (Protozoology and Helminthology) -Chatterjee K. D. (1969)
24. The Zoology of Tapeworm.- Wardle and Mcleod (1952)
25. The advances in the Zoology of tapeworm from Wardle and Mcleod (1952)
26. Systema Helminthum Vol. II Cestoda. - Satyu Yamaguti (1959)
27. The Physiology of Cestodes. - J.D Smyth
28. Vertebrate Nematodes - York and Mapelston
29. Plant Parasitic Nematodes, bionomics & control - Christie
30. Modern Parasitology - Cox
31. Essential Parasitology-Schimdit
32. Parasitism - Cameron
33. Animal Parasitism - Read
34. Parasitism and Symbiology - Read
35. Physiology of nematode parasites - Bee
36. Nematodes Parasites of domestic animal - Levine
37. Structure of Nematodes -Allen Bird
38. Medical Parasitology (Protozoology and Helminthological) - Chatterjeei K. D
39. Laboratory Methods for work with plant and soil Nematodes.-Southey
40. An Introduction to Parasitology - Chandler and Read

Paper No. ZOO/DSE/528- Protozoology I

Contact Hours: 45 credits- 3

Course objective:

1. The basic concepts of Protozoan systematic
2. To study the systematic of Subkingdom Protozoa.
3. To study the biological importance of free-living Protozoa.
4. To study the methodology of collection and identification of free-living protozoa.
5. To study culture methods of free-living protozoa.

Learning Outcome:

1. The students will learn the economic importance of protozoans, their systematics, and techniques
2. The students will learn the different culture methods.

Unit - I

1. Classification of Protozoa up to order level
2. Factors influencing Growth of Protozoa
   i) Balanced growth.
   ii) Non balanced growth

Unit - II

1. Ecology of free-living Protozoa
   i) Marine Protozoa
   ii) Planktonic protozoa
   iii) Soil protozoa
   iv) Protozoan blooms

Unit - III

1. Nutrition in Protozoa
   a. Methods of feeding
      i. Filter feeding
      ii. Raptorial feeding
      iii. Diffusion feeding
   b. Digestion
   c. Nutritional requirements

Unit - IV

1. Metabolism in Protozoa
   i. Carbohydrate and Respiratory metabolism
   ii. Nitrogen metabolism
   iii. Lipid metabolism
   iv. Excretion and ionic regulation - Functioning of contractile vacuoles.

Unit - V

1. Heredity in Protozoa
   i. Bi-parental reproduction

ii. Uni-parental reproduction
iii. Non-Mendelian phenomena
iv. Mating types in ciliates

TEXT BOOKS:

1. Aikawa and Sterling - Intracellular Parasitic Protozoa
2. Baker - Parasitic Protozoa
3. Chandler and Read - An introduction to Parasitology
4. Chatterjee - Parasitology
5. Thomas C. Cheng-General Parasitology
6. Corliss - The ciliate Protozoa
7. Dogiel - An Introduction to Protozoology
8. Faust, Russel and Jung - Clinical Parasitology
9. Hall - Protozoology
10. Hoare - Trypanosomes of mammals
11. Kudo - Protozoology
12. Levine - An introduction to Protozoan parasites of domestic animals and of man
13. Manwell - An Introduction to Protozoa
14. Richardson & Kendall - Veterinary Protozoology
15. Sleigh - Biology of Protozoa
16. Vickerman - The Protozoa
17. Ward & Whipple - Fresh water Biology
18. Wenyon - Protozoology Vol. I & II

REFERENCE BOOKS:

1. Calkins Protozoa in Biological Research
2. Thomas C. Cheng - Research in Protozoology I-IV
3. Florkin and Scheer - Chemical Zoology Vol.-I
4. Hammond and Long - The Coccidia
5. Hutner and Lwaff - Biochemistry and Physiology of Protozoa Vol. I, II & III 6. John & John - How to know the Protozoa
6. Tayler & Baker - Cultivation of Parasites in Vitro

1.

Paper No. ZOO/DSE/529- Entomology I

Contact Hours: 45 credits- 3

Course Objective: -

1. To develop a strong foundation in entomology, including an understanding of the importance of insects to human society.
2. To familiarize the students with insects for their external and internal features,
3. To review important areas in insect biology such as morphology, physiology, ecology, behavior, genetics, phylogeny, ontogeny and population biology.
4. To develop a sufficient background for those students who wish to study more advanced entomological topics.

Learning Outcome:

1. The students will learn in depth the morphological and structure of Insects.
2. The students will gain knowledge of different physiological adaptation, physiological processes in different orders of insect.

Unit I:

1. Introduction to Entomology. Structure of typical insects, morphology, segmentation and tagmosis.
2. Head: Structure, Antennae and types, mouth parts.
3. Thorax: Segmentation, wings: structure, venation and modifications.
4. Legs: Structure of typical legs, types.
5. Abdomen: Appendages, segmentation.

Unit II:

Insect classification:

ii) Subclass-I Apterygote (Habit, Habitat, Life cycle, Classification)
Collembola, Protura, Diplura, Thysanura.

iii) Subclass-II Pterygote (Habit, Habitat, Life cycle, Classification)
Ephemeroptera, Odoneta, Pleoptera, Embioptera, Phasmida, Arthropoda

Unit III:

Dermaptera, Grylloblattodea, Zoraptera, Blattodea, Mantodea, Pscoptera, Mellophaga, Siphunculata, and Hemiptera.

Unit IV:

1. Endopterygota

Coleptera, Strepsiptera, Hymenoptera, Neuroptera, Plecoptera, Diptera, Siphonaptera, Trichoptera, Lepidoptera.

Unit V:

1. Apiculture:

Seasonal management of Honey bees.

Collection and storage of Bee-pollen, Honey, Royal-Jelly, Bee-venom, Propolly.
Management of Bee-pollination
Bee communication

2. Lac culture: Biology of lac insects, Biochemistry of Lac.

REFERENCES BOOKS: -

1. The insect structure and function, 4th Edition 92008). Chapman, R.F. Publisher- Cambridge University Press, London.
2. General Textbook Entomology, 10th Edn., (1977) Imms, A.D. Richard, O.W. & Davies, R.G. (Eds.) 1:Champman & Hall, London
3. General Entomology, 2nd edition (1973) Mani M.S. Oxford & IBH Publishing Company, Delhi.
4. Modern Entomology First edition: (1997) D.B. Tembhare, Himalay Publishing House Delhi
5. Principles of Insect Morphology, (1973). Snodgrass, R.E. Publisher - Tata McGraw Hill, Bombay.

ADDITIONAL REFERENCE BOOKS:-

1. The Principles of Insect Physiology, 2nd edition (2007) Wigglesworth, V.B. Publisher English Language Book Society and Methuen and Co. Ltd.
2. The Insects: Structure, Function and Biodiversity, (2004). Ambrose D.P. Publisher- Kalyani Publishers, New Delhi.
3. Introduction to Insect Biology & Diversity" Daly, H.V.,J.T. Doyen & P.R. Ehrlich (1981): International Student Edn. McGraw-Hill, Kogakusha, Japan.
4. Insects Physiology" Henning, W. (1981). Wiley-Interscince Publ., John Wiley & Sons, Chichester, England.
5. Journals and Internet resources.

Paper No. ZOO/DSE/530- Endocrinology I

Contact Hours: 45 credits- 3

Course objectives:

1. To learn the basic information about the various endocrine glands/ tissue, particularly ininvertebrates.
2. To learn the neuroendocrine system and their hormones.
3. To learn the physiological interaction of endocrine hormones and their regulationby environmental factors in invertebrates.

Learning outcome

1. The student will understand the basic structure of endocrine glands in invertebrates.
2. The students will learn the structure of neuroendocrine gland and their hormones.

Unit-I Endocrine mechanisms in Annelida

1. Neuroendocrine system in Annelida.
2. Growth and regeneration in Polychaetas.
3. The control of epitoky and relationship between gametogenesis and epitoky.
4. Growth and reproduction in Oligochaetes.
5. Endocrine control of gametogenesis in Polychaetas.

Unit - II Endocrine mechanisms in Mollusca

1. Neurosecretion in Lamellibranches.
2. Hormones and reproduction in Gastropods.
3. Hormones and reproduction in Cephalopoda.
4. Role of hormones in osmotic and ionic regulation in Gastropods.

Unit - III Endocrine Mechanisms in Insecta

1. Neuroendocrine system in Insecta.
2. Role of hormones in growth and metamorphosis in insects.
3. Moulting in adult insects and mode of action of developmental hormones in insects.
4. Reproductive system and endocrine control of oocyte development in insects

Unit - IV Endocrine Mechanisms in Crustacea

1. Neuroendocrine system in Crustacea.
2. Moult cycle and role of hormones in Moulting in crustaceans.
3. Sexual differentiation and role of hormones in gonadal activity in crustaceans.
4. Colour change and its hormonal control in crustaceans.

Unit - V Neuroendocrine Mechanisms in Echinodermata

1. Histomorphology of radial nerve neurosecretory system in starfish.
2. Neurosecretory hormones and control of reproduction in echinoderm.
3. Hormone types and their chemical nature in echinoderms.

BOOKS:

1. Highnam K. C. and Hill L: The Comparative Endocrinology of Invertebrates.
2. Adiyodi and Adiyodi: Reproductive Biology of Invertebrates Vol I&II
3. Laufer H. and Downer R.C.H. Endocrinology of selected Invertebrates Type
4. Journals and Internet resources
5. Boolootian R: Physiology of Echinodermata

REFERENCE BOOKS:

1. Patil Meena: Neurobiology and Electrophysiology of Decapod Crustaceans Lockwood, A.P.M: Aspects of Physiology of Crustacea.
2. Novak, U.J.A.: Insect Hormones
3. Rock Stein M.: The Physiology of Insect Vol. I.
4. Wilbur, K.M. and Young, C.M.: Physiology of Mollusca. Vol. I and IIMill, P.J. Physiology of Annelida

Paper No. ZOO/DSE/531 - MARINE BIOLOGY -I

Contact Hours: 45 Credits- 3

Learning Objective:
1. To learn about ocean ecosystem, sea weeds, marine plants, sea grasses and marine invertebrates and vertebrates.
2. Information regarding marine reptiles and marine mammals will be studied

Learning Outcomes:
Student will be able to
1. Describe the salient features and biological process of marine ecosystems.
2. Explain the types and divisions of various marine habitats.

Unit I: Introduction to Marine Biology.

Oceanographic studies in India. Ocean as a habitat, Classification of marine environment, Life in the Sea - factors affecting marine life, patterns of distribution and adaptations. Marine plants - cyanobacteria, chrysophyta,dinophyta, chlorophyta. Seaweeds - classification and distribution. Sea grasses and mangroves.

Unit II: Classification and biology of marine invertebrates.

Porifera - General characters, classification, and examples. Cnidarians - General characters, classification, and examples. Coral reefs - types, theories of formation and distribution. Polychaetes - General characters, classification and examples. General characters, morphology and distribution of Nemertinea, Entoprocta, Ectoprocta, Phoronida, Pogonophora, Sipuncula and Brachiopoda. Chaetognatha. Economically important forms in each taxon.

Crustacea - General characters, classification, comparative morphology. Crustacean appendages, larval forms, evolution, distribution with examples. Mollusca - Classification, general characters with reference to bivalves, gastropods and cephalopods. Echinodermata- General characters, classification and examples. Economically important forms in each taxon. biodeterioration and biofouling

Unit III: Marine vertebrates: Prochordata - Classification and comparative morphology, reproduction and early development, larval metamorphosis. Pisces - Cartilaginous and bony fishes: General characters, Classification and distribution.

Unit IV: Marine reptiles - Adaptive radiation of marine reptiles – sea snakes and turtles. Marine birds – General characters, adaptation and importance of coastal and marine birds.

Unit V: Marine mammals - General characteristics, classification and evolution of cetaceans and sirenians. Distribution, adaptations and importance. Endangered marine mammals. Conservation strategies.

Practical Paper No. ZOO/DSC/523(Practical based on ZOO/DSC-520) Biosystematics and Animal Diversity

1. Museum specimen study of different groups of Invertebrates and Vertebrates.
2. Terrestrial ecosystem (Vegetation studies) Abundance. Frequency, Density.
3. Diversity: Dominance, Rankers biological spectrum Index of Dominance, etc.
4. Method of plankton collection, plankton identification, and quantification from river orstream or lake water.
5. Methods of collection, preservation, and identification of zooplankton.
6. Composition assessment of taxonomical diversity or biodiversity in habitat from localGrassland, Terrestrial, and Wetland.

7. Composition assessment of taxonomic diversity/Biodiversity from different ecosystems-
    a. Species diversity indices.
8. Composition assessment of taxonomic diversity/Biodiversity from different ecosystems-
9. Relative density, Relative frequency, and relative abundance of species
10. Methods of collection, preservation, and identification with keys from different groups oforganisms like Parasites, hosts, insects, birds, fishes, etc.
11. Construction of taxonomic Key from the characters in an animal group.
12. Visit any biodiversity center /spots and submission of the report
13. Study of lower deuterostomes.
14. Study of upper deuterostomes.
15. Study of lower protostomes.
16. Study of upper protostomes.
17. Study of adaptive radiations based on the basic hand key structure.

Practical Paper No. ZOO/DSC/524(Practical based on ZOO/DSC/521)
Biochemistry

1. Preparation of Acid and Alkali solutions and acid-base titration
2. Preparation of Buffers of known pH, and buffering capacity.
3. Identification of Carbohydrates by Chemical tests
4. Estimation of Amino acid (Tyrosine)
5. Estimation of Protein by Lowry's method.
6. Estimation of Carbohydrates by Anthrone reagent method. (Glycogen)
7. Estimation of DNA by DPA method.
8. Separation of amino acids by Paper chromatography.

9. Study of factors affecting enzyme activity (Substrate concentration, pH, Temperature, and inhibitors)
10. Isolation of Casein protein from the milk.
11. Determination of isoelectric pH of Casein.
12. Estimation of Blood glucose by Glucometer.
13. Estimation of Chitin.
14. Estimation of urea by Nessler's reagent.
15. Estimation of starch by iodine test.

Practical Paper No. ZOO/DSC/525(Practical based on ZOO/DSC/522)
Ecology (Principles and Practices)

1. Study of ecosystem biodiversity of the local area.
2. Estimation of Dissolved oxygen,
3. Estimation of hardness of water sample. (Total Sodium and Potassium hardness)
4. Estimation of Salinity /Nitrates and phosphates from a given water sample.
5. Biomass analysis in a given ecosystem.
6. Species diversity in the community and its measurement- Alpha diversity- Simpsons diversityindex. Shannon index. Fisher alpha. Beta diversity- Sorensen's similarity index. Whittaker's index,Evenness, Gamma diversity. Guild and it's functioning in the community
7. Productivity estimation in a given ecosystem (Primary and Secondary)
8. Study of the efficiency of a sampling method.
9. Study of air quality and aerobiology in a given area.
10. Toxicology-Principles, toxicants- types. dose and effects. toxicity of heavy metals.
11. Measuring ecotoxicity using a lettuce seed assay.
12. Estimation of various physical parameters of water (SSP. Turbidity, TDS,etc.)
13. Visit any biodiversity center/National Park/Sanctuary and submission of a report.
14. Study of GPS and Identification of spots in an ecosystem.
15. Identification of Vegetation, and cropsbased on remote sensing.

Practical Paper No. ZOO/DSE/532(Practical based on ZOO/DSE/527)
Helminthology I

1. Collection of trematodesfrom various hosts.
2. Collection of cestodes from various hosts.
3. Preservation, staining, and identification of collected trematodes and preparation of their permanent slides (at least10).
4. Preservation, staining, and identification of collected cestodes and preparation of their permanent slides (at least10).
5. Study of different trematodes from permanent slides (at least 10).
6. Study of different cestodes from permanent slides (at least 10).
7. Examination of fecal samples for ova.
8. Collection and examination of molluscan hosts for larvae of trematodes.
9. Study the effect of helminth parasites (histopathology) on their host's tissue by micro-technique.
10. Study of identification of cestodes by using keys.
11. Study of identification of trematodes by using keys.
12. Study of trematodes of economic importance
13. Study of cestodes of economic importance.
14. Estimation of Protein/ glycogen content in Trematodes.
15. Estimation of Protein /glycogen content in cestodes.
16. **Submission**: At least five permanent slides are to be submitted at the time of the practical examination

Practical Paper No. ZOO/DSE/533(Practical based on ZOO/DSE/528)
Protozoology-I

1. Collection, observation of Marine protozoa in living condition-fixation, staining, and identification of protozoa.
2. Collection, observation of Planktonic protozoa in living condition-fixation, staining, and identification of protozoa.
3. Collection, observation of soilprotozoa in living condition-fixation, staining, and identification of protozoa.
4. Study of population density of ciliates in freshwater.
5. Study of oxygenin freshwater ciliates.
6. Study of carbon dioxidein freshwater ciliates.
7. Study of pH in freshwater ciliates.
8. Study of oxidized organic matterin freshwater ciliates.
9. Study of cyclosis in Paramecium.
10. Study of contractile vacuole to observe excretion.
11. Study of contractile vacuole to observe osmoregulation.
12. To study the slides of protozoans of medical importance.
13. To study the slides of protozoans of veterinary importance.
14. To make a permanent slides of any free living /any protozoan parasites from the soil.

Practical Paper No. ZOO/DSE/534(Practical based on ZOO/DSE/529)
Entomology I

1. Studyandmountvarious types of mouth parts, antennae, wings, legs, and genitalia of various insects. (2 in two insects).
2. Study of the morphology of Thysanura.
3. Study of the morphology of Pterygote.
4. Study of the morphology of Odonata.
5. Study of the morphology of Phasmida.
6. Study of the morphology of Grylloblattodea.
7. Study of the morphology of Blattodea.
8. Study of the morphology of Siphonaptera.
9. Study of the morphology of Coleoptera.
10. Study of the morphology of Hymenoptera.
11. Study of the morphology of Diptera.
12. Study of the morphology of Lepidoptera.
13. Study of the morphology of Siphunculata.
14. Study of the morphology of Neuroptera.
15. Study of the morphology of Mantodea.
16. Study of Bee management.
17. Study of mounting of Bee sting.

- The in the study of morphology of insect orders the example of insect, the emphasize must be made to study the insects of economic importance or insects of special adaptation or modification or pests can be studied as an example.

Practical Paper No. ZOO/DSE/535 (Practical based on ZOO/DSE/530)
Endocrinology I

1. Histomorphological study of neuroendocrine system in Annelida.
2. Histomorphological study of neuroendocrine system in Mollusca.
3. Histomorphological study of neuroendocrine system in Arthropoda
4. Dissection of nervous systems in Leech.
5. Dissection of nervous systems in crab.
6. Dissection of nervous systems in Cockroach.
7. Dissection of nervous systems in Slug.
8. Dissection of nervous systems in Snail.
9. Histopathological preparation of slides of neuroendocrine centers (at least 5).
10. Effect of optic – tentalectomy on weight changes in the slug, *Laevicaulis.*
11. Effect of brain removal on oxygen consumption in Leech.
12. Effect of eyestalk (bilateral) removal on integument chromatophores of freshwater prawn, *Caridina/Macrobrachium.*
13. Effect of eyestalk removal on oxygen consumption of freshwater crab/prawn.
14. Effect of eyestalk removal on blood glucose level in crab/prawn.

Practical Paper No. ZOO/DSE/536 - Practical based on ZOO/DSE/531

Marine Biology -I

1. Methods of collection of sea plankton, preservation techniques in plankton study and analysis. Identification of phyto and zoo plankton.
2. Taxonomic study of Marine invertebrates.
3. Taxonomic study of Marine vertebrates: Fishes (Cartilaginous and Bony), Reptiles and Mammals.
4. Morphological characters of fishes, crustaceans, molluscs and other invertebrates to identify their ecological adaptations.
5. Benthic fauna sampling and analysis.
6. Software applications in marine ecology – PRIMER and other software in analysis of benthic biodiversity studies.
7. Identification of larval stages of cultured fishes and shellfishes.

8. Theory and operation of equipment used for sampling water, sediment, plankton and benthos.
9. Water samplers- Nansen's reversing water bottle, Niskin water sampler.
10. Collection and identification of economically important Sea weeds and their adaptation.

Paper No. ZOO/RM/537 - RESEARCH METHODOLOGY

Contact hours: 60 **Credit 4**

Learning Objectives:

- To understand some basic concepts of research and its methodologies
- Identify appropriate research problem and parameters
- Prepare a project proposal
- To organize and conduct research in a more appropriate manner
- Write a research report/ proposal and thesis.

Learning Outcome

- The students will learn about the concepts of research with reference to life science.
- The students will learn about the research problems and parameters involved.
- The students will learn to prepare a research project proposal.
- The students will learn to write a reseach report, dissertation and thesis.

UNIT I

I. Science / Life Sciences and concept of Research **15hrs.**

Basic concepts-Knowledge, Information and Data-Science, Pseudoscience. Life Science-Definition, Laws, Characteristics. Scientific temper, Empiricism, Rationalism and Units of measurements. Basic concepts of research -Meaning, Objectives, Motivation and Approaches. Types of Research (Descriptive /Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical. Research methods versus Methodology, Research and scientific method. Research Process.

II. Research Formulation and design **15hrs.**

Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating there search problem, Selecting the problem and necessity of defining the problem. Literature review-Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review.

Hypothesis -Null and alternate hypothesis and testing of hypothesis -Theory, Principle, Law and Canon. Research Design-Basic principles, Meaning, Need and features of good design, Important concepts. Types of research designs. Development of are search plan-Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs. Data collection techniques.

III. Scientific Documentation and Communication 15hrs.

Scientific writing begins with a question. Scientific writing in computer age, Communication channels – informal and formal, compilations, Use of internet, Difference between subject directories and search engines, emails, Use of word processing to write more effectively, Revising with word processors. Writing of the first draft- Content, matters dealing with authorship, copy right. Standard structure- Introduction, Materials and Methods, result, Discussion and conclusion. The title, references, Abstract and summary. Title page, key words, and acknowledgement.Project proposal writing, Research report writing (Thesis and dissertations, Research articles,Oral communications). Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

VI. **Information Science, Extension, Ethics and Text , Tables and English language 15hrs**

Sources of Information -Primary and secondary sources. Library-books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents. Internet-Search engines and software, Online libraries, e-Books, e-Encyclopedia, TEDTalk, Institutional Websites.

Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications. Safety and precaution-ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards.

Extension: Lab to Field, Extension communication, Extension tools. Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

References

1. Alley, M (1996) The craft of scientific writing , 3rd Edition , New York , Springer-Velag
2. Blum, D and Knudson ,M (Eds) (1997) A field guide for Science writers, New York
3. Booth, V (1993) Communicating in science : writing a scientific paper and speaking at scientific meeting . 2nd ed .Cambridge, UK . Cambridge University Press.
4. Council of Biology Editors (1988) Illustrating Science ; Standards for publication . Bethesda, MD; Council of Biology Editors.
5. Day RA (1996) Scientific English . A guide for Scientist s and other professional s, 2nd nd Ed Phonies ,AZ. The Oryx Press.
6. Day RA (1998) How to write and publish a scientific Paper. 5Th Edition. Phoenix , AZ. The Oryx Press.

7. Gilsters ,P (1997) Digital Literacy , New York , John Wiley and Sons.
8. Gross, DV an dSIs,RF(1980) Scientific Writing ; The good , the bad and the ugly . J Vet Med Edu, 7(3) , 127-130.
9. International Code of Zoological Nomenclature (1999) 4th Ed London; International Trust for Zoological Nomenclature.
10. McMillan ,VE(1997) Writing papers in the biological Sciences , PA ; Spring House, Publishing Co.
11. Mathews, JR, Bowen JM and Mathews RW (2000)Successful scientific writing , Cambridge University Press.
12. Reubens, P (1992) Science and Technical Writing : A manual of style , New York ; Hennery Holt.
13. Ahuja,V.K. 2010. *Law of Copy Rights and Neighbouring Rights: National and International Perspectives.*LexisNexis- ButterworthsWadhwa, Nagpur
14. Ahuja,V.K.2007.*Law Relating to Intellectual Property Rights.* LexisNexis-ButterworthsWadhwa, Nagpur.
15. Anitha Goel.2010. *Computer Fundamentals*. Pearson Education India.
16. Bailey,N.T.J.1994. *Statistical Methods in Biology* (3rdedn). Cambridge University Press. Bright Wilson. 1990. *An Introduction to Scientific Research.* Dover Publications. NY. Chap T.Le.2003.*IntroductoryBiostatistics*. John Wiley &Sons, NJ, USA.
17. Clough,P. and C.Nutbrown.2002.*A Student's Guide to Methodology: Justifying Enquiry*. Sage, London. Daniel,W.W.2006. *Biostatistics: A Foundation for Analysis in the Health Sciences* (7thedn).JohnWiley & Sons, New York.
18. Dharmapalan,Biju.2012. *Scientific Research Methodology*. Narosa Publishing House, NewDelhi Finney,D.J.1980.*Statistics for Biologists*. Chapman and Hall, London
19. Frank, Harry and StevenC.Althoen,1995. *Statistics: Concepts and Applications.* Cambridge University Press
20. Glenn McGee.2003. *Pragmatic Bioethics*. The MIT Press, MA, USA
21. Jeremy R. Garret.2012. *The Ethics of Animal Research*. The MIT Press, MA. USA
22. KothariC.R.,2009. *Research Methodology: Methods and Techniques* (2ndedn.).New Age International Publishers, NewDelhi.
23. Pagano,MandK.Gauvreau.2000. *Principles of Biostatistics*. Brooks/Cole,CA,USA PaulOliver.2005.*WritingYourThesis.*Vistaar Publications.NewDelhi.
24. Peter Medawar.1979. *Advice to Young Scientist*. Harper and Row, London.
25. PhillippeCullet.2005.*Intellectual Property Protection and Sustainable Development.* LexisNexis- Butterworths Wadhwa,Nagpur
26. Prabhakara ,G.N. 2006.*Biostatistics*.Jaypee Bro. New Delhi
27. Pradeep Sinha and Priti Sinha.2010.*Computer Fundamentals.* BPB Publications., NewDelhi Rajathi A and P.Chandran,2010.*SPSS forYou.* MJP Publishers, Chennai.
28. Shane Torbert.2011. *Applied Computer Science*. Springer-verlag, New York.
29. Sudipto Das.2010. *A Complete Guide to Computer Fundamentals*. Lakshmi

Publishers(P)Ltd.New Delhi

30. SundarRao, P.S.S and J.Richard.2006.*Introduction to Biostatistics and Research Methods* (4thedn).Prentice Hall, New Delhi.
31. WHO.2011.*Laboratory Quality Standards and Their Implementation*. WHO Regional Office. New Delhi.
32. Zar, Jerrold H. 2008. *Biostatistical Analysis* (3rdedn.). Pearson Education Inc., New Delhi.

SECOND SEMESTER

Paper No. ZOO/DSC/570- Genetics and Bioinformatics

Contact Hours: 45 credits- 3

Learning Objectives:

- To understand basic unit cell and the molecular biology of the cellular function.
- To understand the protein secretion and sorting within the cell and laws of cell division and their regulation.
- To understand the central dogma of molecular biology.

Learning Outcome:

- The student will learn about the cell and cellular function at molecular level.
- The student will learn about the protein secretion, sorting and arranging the protein to different cell organelle.
- The student will learn in detail the central dogma of molecular biology in Prokaryotes and Eukaryotes.

GENETICS

UNIT 1: Principle of genetic transmission and molecular organization of chromosomes.

Extension of Mendellian principles; allelic variations and gene function- incomplete dominance, and co- dominance. Gene action, - penetrance and expressivity, gene interactions- epitasis, pleiotrophy, genomic imprinting, phenocopy.

Genome size, and C -value paradox, structure of eukaryotic chromosomes, nucleosome model, chromosome condensation, -euchromatin and heterochromatin, Repetitive nucleotide sequences in eukaryotic genomes. Kinetics of renaturation, Cot and Cot curve repetitive sequences. Mini and micro satellites, Molecular structure of centromere, and telomere. Polytene chromosome and lampbrush chromosome. Chromosome banding techniques.

UNIT II: Gene Fine structure

Evolution and concept of gene function and structure. The definition of gene. The standard genetic code, redundancy and wobble. DNA structure- alternate forms of Double Helix, Gene Synthesis (in vitro synthesis) – works of Khorana and Kornberg, Modern finding on the nature of gene. Interrupted genes in eukaryotes, Exons and Introns -R loops, significance of introns. Genes within genes (overlapping genes) Bacteriophage phi X174.

Transposable elements in Bacteria-IS elements, Composite transposons, Tn3elements, medical significance. Transposable elements in Eukaryotes - P elements, Retro-transposons, Significance of transposons.

UNIT III: Genetic linkages, Recombination and Chromosome Mapping

Chromosome theory of heredity, Linkage and recombination of genes in a chromosomes, crossing over as the physical basis of recombination, Stern's Experiments; molecular mechanisms of recombination (Holliday model), Gene conversion, Recombination mapping with two point and three point test cross in Drosophila. Coincidence and interference.

Genetic mapping, by tetrad analysis in *Neurospora*, Mitotic recombination, Genetic recombination in Phage rII locus, Complementation test. Deletion mapping, Conjugation mapping, Mapping by interrupted mating, Mapping with molecular markers, and mapping using somatic cells.

BIOINFORMATICS

Unit IV: Scope and Data bases

Bioinformatics, scope and applications. Biological data bases- Primary data bases- Nucleotide sequence data bases; Gen Bank , EMBL, DDBI ; DDBJ; Protein sequence data base, SWISSPROT, PIR,; Structure data bases; PDB,NDB; secondary data bases,; PPROSITE,PFAM,CATH; composite databases, OWL; Literature data base; Pub Med; Data base searching – Entrez; Database sequence submission-BankIt.

Unit V Sequence analysis

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenic trees. Structural genomics, functional genomics, comparative genomics, data mining in proteomics, Microarray, significance of proteomics and drug design.

REFERENCES

Genetics

1. Brooker , 1999. *Genetics: Analysis and Principles*. Addison- Wesley, NY.
2. DavidAllisandThomasJenuwein,2007.*Epigenetics*.ColdSpringHarborLaboratoryPress.
   Hartl,D.L.2000.*APrimerofPopulationGenetics*.SuinuaerAssociate,Inc,Massachusetts.
3. Gardner.J.E.,Simmons,J.MandD.P.Snustad.2007.*PrinciplesofGenetics*(8thedn).JohnWiley,India.
   Gilbert,S.F.2006.*DevelopmentalBiology*(9thedn).SinauerAssociates,Inc.,Publishers,Masachusettes. Griffiths*etal.*,2002.*ModernGeneticAnalysis*.W.H.Freeman,NY,USA.
4. Hartl,L.D.,andE.W.Jones.2009.*Genetics:AnalysisofGenesandGenomes*(7thedn).Jones& Bartlett Pub.,Inc.MA,USA.
5. Herskowiz I.H, 1977. *Principles of Genetics* .Collier
   Macmillan. Lewin B, 2008 .*Genes* (9thedn). Jones and Barlett Publishers Inc.

6. Klug,W.S.andMichaelR.Cummings,2009.*ConceptofGenetics*.PearsonEducati on.Inc. Russel,J,P.,2010.*Genetics*.PearsonInternationalEdn.
7. Snustard,PandM.J.Simmons,2010.*PrinciplesofGenetics*.JohnWileyandSons Strickberger,M.W.1968.*Genetics*.MacmillanPublishingCo.
8. Watson *et al.*, 2004. *Molecular Biology of Gene* (5th edn.). Pearson Education Inc.

Bioinformatics

1. Alberghina,LandH.V.Westerhoff(Eds).2008.*SystemsBiology-Definitions&Perspectives*.Springer- Verlag,Berlin.
2. AttwoodT.K.andParrySmith,D.2006.*IntroductiontoBioinformatics*.PearsonEducati on. BourneP.EandWeissigH,2003.*StructuralBioinformatics*.Wiley-Liss.USA
3. David W. M. 2004. *Bioinformatics, Sequence and Genome Analysis* (2nd edn). CSHP, New York Krane,D.EandM.L.Raymer.2006.*Fundamental concepts of Bioinformatics*.Pearson Education,New Delhi
4. Lesk A. M, 2005. *Introduction to Bioinformatics*. Oxford Press, New Delhi
5. PengchengFuandSvenPanke,(Eds.)2009.*SystemsBiologyandSyntheticBiology*.JohnWi ley& Sons, Inc.NJ,USA
6. Tisdall J. D, 2001. *Beginning Perl for Bioinformatics*.O'Reilly Media Inc.CA,USA
7. MasaruTomitaandTakaaiNishioka,2005.*Metabolomics.TheFrontierofSystemsBiology*.Spri nger Japan.

Paper No. ZOO/DSC/571- Cell and Molecular Biology

Contact Hours: 45 credits- 3

Learning Objectives:

- To understand basic unit cell and the molecular biology of the cellular function.
- To understand the protein secretion and sorting within the cell and laws of cell division and their regulation.
- To understand the central dogma of molecular biology.

Learning Out come

- The student will learn about the cell and cellular function at molecular level.
- The student will learn about the protein secretion, sorting and arranging the protein to different cell organelle.
- The student will learn in detail the central dogma of molecular biology in prokaryotes and Eukaryotes.

Unit 1 Introduction of cell:

Evolution of cell- From molecules to first cell, From prokaryotes to eukaryotes, Prokaryotes and eukaryotic genomes, single cell to multicellular organism.

Plasma membrane structure and function, Nature of cytoskeleton, microfilament, intermediate filaments, Microtubules, Actin filaments, cilia and centrioles, Organization of cytoskeleton. Cell- cell communication. Cell junctions and extracellular matrix, cell – cell adhesion and communications, cell matrix adhesion, collagen -the fibrous protein of the matrix, non collagen components of the extra cellular matrix.

UNIT II: Cell growth and Division

Overview of the cell cycle and its control, The molecular mechanism for regulating mitotic and meiotic events, Amitosis, cell cycle control, Checkpoints in cell cycle regulation. Cell to cell signaling, overview of the extracellular signaling, Identification of cell surface receptors, G-protein coupled receptors, and their effectors, second messengers, enzyme linked cell surface receptors, interactions and regulation of signaling pathways.

Unit III: Protein secretion and sorting :

Organelle biogenesis and protein secretion, synthesis and targeting of- mitochondria, chloroplast, peroxisomal proteins, translational modifications in the ER, intracellular traffic, vesicular traffic, in secretary pathways, protein sorting in the Golgi bodies, traffic in the endocytic pathways, exocytosis.

UNIT IV : DNA Model and chromatin structure

Types of DNA and RNAs, Chromosome structure, chromatin and Nucleosomes; Genome sequence, and chromosome diversity, Chromosome duplication and segregation, The nucleosome, chromatin structure, euchromatin, heterochromatin, constitutive and facultative heterochromatin, regulation of chromatin structure, and, nucelosome assembly, Nucleolus. Gene and genome organization- Split genes, Gene clusters, Histones, Non histones, Nucleosomes, Chromatin, chromosomes structure, in prokaryotes and eukaryotes, Basic processes, Replication of DNA- Prokaryotes and eukaryotic DNA replication. Mechanism of DNA replication, Enzymes and accessory proteins, involved in DNA replication, Replication errors, DNA, Damages, and their repairs.

UNIT V : Transcription and mRNA processing

Prokaryotic and Eukaryotic transcription, General and specific transcription factors, Regulatory elements, and mechanism of transcription regulation(Lac operon), Transcriptional and post transcriptional gene silencing: Initiation, elongation, and termination of transcription, capping, polyadenylation, Splicing, editing, mRNA stability, RNA interference, Microarray. Translation: Genetic code, prokaryotes and eukaryotic translation and ribosome structures, the translation machinery, mechanisms of chain initiation, elongation, and termination, regulation of translation , co and post translation modifications of proteins, epigenetic.

REFERENCES

1. Alberts,B.,Johnson,A.,Lewis,J.,Raff,M.,Roberts,K.AndWalter,P.2008.*MolecularBiology ofthe Cell*.GarlandScience.-TaylorandFrancisgroup,USA.
2. Becker,W.M.,Kleinsmith,L.J.andHardin,J.2007.*TheWorldoftheCell*.Pearson,NewDelhi . Clark,D.P.2010.*MolecularBiology*.ElsevierPublishers,London.
3. Cooper,G.M.andHausman,R.E.2009.*Thecell:AMolecularApproach*(5thedn).SinauerAss ociates, Inc,ASMPress,WashingtonDC.
4. Griffiths, A.J.F., Wesler, S.R., Carroll, S.B. and Doebley, J. 2008. *Introduction to Genetic Analysis.*
5. W H Freeman and Company,USA
6. Hyde,D.R.2010.*GeneticsandMolecularBiology*.TataMcGrawHillEducationPrivateLtd.,Ne w Delhi.
7. Karp, G. 2010. C*ell and Molecular Biology* (6thedn). John Wiley and Sons,Inc.NJ,USA.
8. Klug, W.S. and Cummings, M.R. 2004. *Concepts of Genetics*. Pearson International, New Delhi.
   Krebs,J.E.,Goldstein,E.S.andKilpatrick,S.T.2011.*Lewin'sGenesX*.JonesandBartlettpublishe rs,NY.
   Lodish,H.,Berk,A.,Kaiser,C.A.,Krieger,M.,Scott,M.P.,Bretscher,A.,Ploegh,H.andMatsu daira,
9. P. 2007. *Molecular Cell Biology* (6th edn). W H Freeman & Company.
10. Pierce,B.A.2008.*Genetics: A conceptual approach*.WHFreemanandCompany. Pollard,T.D. and Earnshaw, W.C. 2008. *Cell Biology*. Saunders Elsevier.

11. Snustad, D.P. and Simmons, M.J. 2010. *Principles of Genetics*. John Wiley and Sons.
12. Watson,J.D.,Baker,T.A.,Bell,S.P.,Gann,A.,Levine,M.andLosick,R.2009.*MolecularBiologyof the Gene.*Pearson.

Paper No. ZOO/DSC/572- Biophysics

Contact Hours: 45 credits- 3

Learning Objectives:

- To understand universal law as applied to biological system.
- Better understanding to f the concept from physical laws and application
- To understand the various physical mechanisms happening in a biological system.

Learning Outcome.

- The student will learn the application and concept of the physics in biological processes.

UNIT 1: Diffusion and Osmosis

Diffusion – Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants. Electrochemical gradients, capacity and resistance, Stokes-Einstein Equation and Graham's Law, Facilitated diffusion, Gibbs- Donnan Equilibrium.

Plasma membrane:-Internal composition, cell penetration, permeability of cell membrane, permeability coefficient.

Osmosis –Osmotic concentration and osmotic pressure, Van't Hoff's Laws.

Biological significance of osmosis and animal and plants.

UNIT II: Biophysics cell Membrane

Physicochemical properties of cell membrane, conformational properties of cell membranes, Membrane transport, - endocytosis, exocytosis, nutrient transport across membranes, porins, facilitated diffusion, porter molecules, Facilitated transport:- Symport, antiport, uniport, anion porter, glucose porter, Active transport: Proton pumps, Na^+ K^+ pumps and Ca^{++} pumps, ionic channels . Functions of cell membrane, Artificial membranes.

UNIT III: Bioenergetics

Thermodynamics -Laws of thermodynamics, Entropy, Enthalpy, Free energy, Reversible thermodynamics, and irreversible thermodynamics; System – open, closed, and isolated Photo-bioenergetics. Photosynthesis– light and dark reactions, redox couple and redox potential. Chemo-bioenergetics; electron transport and oxidative phosphorylation, Chemiosmotic theory and binding changes mechanism of ATP synthesis.

UNIT IV: Biomechanics and Neurophysics

Striated muscle- contractile proteins, Mechanical properties of muscle, contraction mechanisms, role of calcium ions, Biomechanics of the cardiovascular system – Blood pressure, electrical activity of during the heart beat, Electrocardiography.

Nervous system–synapse, Physics of membrane potential bioelectric potential: Diffusion potential, membrane potential- muscle and nerve, voltage clamp, Sensory mechanism- The eye-visual receptor, electrical activity and visual generator potentials, Neural aspects of vision, Visual communication and bioluminance.

Hearing : Physical aspects, - the ear,, elementary acoustic, theories of hearing, Signal transduction- mode of transport, signal transduction in the cells.

UNIT V: Radiation Biophysics

Ionizing radiations , units of radioactivity, exposure and dose.

Interaction of radiation with matter: Photoelectric effect, ion pair production, absorption and scattering of electrons.

Biological effects of radiations; effect on nucleic acids, proteins, enzymes, and carbohydrates, cellular effects, of radiations, somatic and genetics,

Nuclear medicine; Internally administered radioisotopes, radioiodine in thyroid function analysis, Renal , liver, and lung function analysis.

Applications of radioactive tracers, Radiations protection and therapy.

REFERENCES

1. Ackerman, E (1962) Biophysical Science. Prentice Hall Inc. NJ,USA
2. Alonso,A and Arrondo, JLR(2006) Advanced Techniques in Biophysics. Springer, UK
3. Arora ,MP (2007) Biophysics. Himalayan Publishing House, New Delhi.
4. Baker,EJ and Silverton RE(1978) Introduction to Medical Laboratory Technology , ELBS , London ,UK
5. Das , D (1991) Biophysics and Biophysical chemistry , Academic Publishers , Calcutta.
6. Edward,A.L.(1997) Radiation Biophyscis Academic Press, NY,USA.
7. Ernster, L. (Ed.). (1985). *Bioenergetics*. Elsivier, NewYork,USA.
8. GhatakK.L.(2011).*Techniques and Methods in Biology*. PHI Learning Pvt. Ltd. New Delhi GuptaA.2009.*Instrumentation and Bio-Analytical Techniques.* Pragati Prakashan, Meerut.
9. Hoope, W. e*t.al*. 1983. *Biophysics.* Springer Verlag, Berlin.

10. Lehninger, A.L.1971. *Bioenergetics*. W.A. Benjamin, London,UK.
11. Narayanan,P.2000. Essentials of Biophyscis. New Age International (P) Ltd. Publishers , New Delhi. Pearse,A.G.E.1980.*Histochemistry*.Vol.&Vol.II.ChurchillLivingstone,NY,USA.
12. Pradeep T. 2007. *NANO: The Essentials. Understanding Nanoscience and Nanotechnology*.Tata McGraw Hill Education Pvt. Ltd., New Delhi.
13. Roy, R.N. 1996. *A Textbook of Biophysics*. New Central Book Agency (P) Ltd. Calcutta

    Sandhu,G.S.1990.*ResearchTechniquesinBiologicalSciences.*AnmolPublications,NewDelhi
14. Srivastava,P.K. 2006. *Elementary Biophysics. An Introduction*. Narosa Publishing House, New Delhi.
15. Varghese,T. and Balakrishna,K.M.2012.*Nanotechnology-An Introduction to Synthesis, Properties and Applications of Nanomaterials.* Atlantic Publishers and Distributors.(P)Ltd. NewDelhi
16. Weesner,F.M.1960. *General Zoological Microtechniques*. The Williams & Wilkins Co.,Baltimore, USA

Paper No. ZOO/DSE/577- Helminthology II

Contact Hours: 45 credits- 3

Learning Objectives:

- To understand the phylogeny, the biology and applied aspects of helminthes parasites in disease and plant parasites.
- The role of helminthes parasites in burden of disease.
- Genomics of helminthes

Learning Outcome

- The student will learn about the phylogeny , and importance of the helminthic parasites in control of disease.
- The student will learn about genomics and understand how helminthes survive in human body by manipulating the surface coat.
- The student will learn about the challenges in vaccine and drug resistance.
- The student will learn the skill to identify the plant nematodes and control measures in agricultural productivity.

Unit I

Phylogeny of the nematodes and related groups. Economic importance. Burden of helminthes disease worldwide and in India. Parasitic(plants and animal) and free or non pathogenic nematodes. *C. elegans* as model animal for genetic studies.

Unit II

Nematode ultra structure – complex system and processes

Body wall of nematodes: cuticle, Epicuticle (Hypodermis), muscle layer, Hydrostatic skeleton, Nervous system. Cephalic sense organs : Amphids, labial and cephalic papillae. Caudal sense organs– caudal papillae, plasmids. Spicules, inner body tube or digestive system – the stomadeum (foregut), The intestine (midgut), the Proctodeum (hind gut), Secretary / excretory system, Feeding and nutrition's in Nematodes. Essential foods, blood feeding by Hookworms and other nematodes. Male reproductive system, Female reproductive system. Fertilization, development and hatching of eggs. Moulting and Development in nematodes. Implications of nematodes ultra structural studies.

Unit III Nematodes as plant parasite,

Introduction and general life cycle, feeding types, symptoms of damages caused by nematodes, population dynamics, the threshold levels, nematode survival, Ecology, control of nematode disease- resistance/tolerance, crop rotation, chemical control, Biological control, organic amendments, physical control. Interaction with other organisms, classification of plant parasitic nematodes. Life cycle studies of followings -*a.* Root knot Nematodes (m*eloidogyne)* b. Citrus Nematodes (*Tylenchulus)*c. Bud and leaf Nematodes (*Aphelenchoides) d.* Seed gall Nematodes (*Anguina)*

Unit IV: Genomic epidemiology

Genomic epidemiology of filarial nematodes- Transforming the basis of the elimination, progress decisions- Introduction, parasitic transmission, morbidity and control/elimination

strategies- *Onchocerciasis volvulus,* and *Wucheria bancrofti,* Lymphatic filariasis, Parasitic population and genetics, and transmission zones, conceptual approach, understanding geographic and temporal variability in drug response, genomics tools to inform elimination program decisions.
Epidemiological biology, clinical pathology, immune response, diagnosis, treatment, pharmacotherapy, immunotherapy of *Trichenella spiralis, Trichuris trichura, Strongyloides stercoralis.*

Unit V:Chemotherapy
Drug used against helminthic infection in man, Drug resistance in human helminthes, cryopreservation of helminthes, Immunity to helminthes, trends in vaccines against helminthes and challenges.

References

1. Bird AF, Bird J (1991) The structure of nematodes, vol 2. Academic press, San Diego
2. Blaxter ML, Robertson WM (1998) The cuticle. In: Perry RN, Wright DJ (eds) The Physiology and biochemistry of free-living and plant-parasitic nematodes. CAB International, New York, pp 25–48
3. Gardner S (2001) Worms, Nematoda. In: Levin SA (ed) Encyclopedia of biodiversity. Academic Press, University of Nebraska, Lincoln
4. Lewbart G (2011) Nematodes, Nervouse system In: Invertebrate Medicine, 2nd (edn). John Wiley & Sons
5. Mehlhorn H (2008) Encyclopedia of parasitology, vol 3. Kluwer Academic Publishers, Great Britain
6. Mehlhorn H (2016) Encyclopedia of parasitology, vol 3. Kluwer Academic Publishers, Great Britain
7. Mehlhorn H (1988) Parasitology in Focus . Springer –Verlag , Berlin.
8. Brown, R.H. and Kerry, B.R. (1987). Principles and practice of Nematode control in crops.Academic Press, Sydney.
9. Dropkin, V. H. (1 980) . Introduction to plant nematologg. John Wiley & Sons, New York.
10. O'Brien, P.C. and Stirling, G.R. (199I). Plant nematology For practical nematologists. Queensland Department of Primary Industries Information Series g 1gOO23.
11. Southey, J.F. (ed.) (1986). Laboratory methods for work with plant and soil nematodes. Her Majesty's Stationery Of{ice, London.
12. Stirling, G.R. (f 991). Biological control of plant-parasitic nematode CAB International Slough, U.K.
13. Panikar C.K.J(1988) Text book Medical Parasitology. Jaypee Brothers, - Medical Publishers, New York. - (1988)
14. Smyth J.D (1977) The Parasitology of Trematodes. Oliver and Boyd Ltd. Edinburgh -
15. Sood Pamnik (1993) Parasitology (Protozoology and Helminthology) - CBS Publication and Distrubution, Delhi.
16. Hiware, Jadhav and Mohekar Applied Parasitology
17. Solbsy E.J.W(1982) Helminth, Arthropod and Protozoa of domesticated animal , London

Paper No. ZOO/DSE/578- Protozoology II

Contact Hours: 45 credits- 3

Learning Objectives:

1. To understand the genetics, nutritional and parasitic adaptation in human or in other vertebrates.
2. The students will also study the geomedical, aspects of protozoan's .

Learning outcome :

1. The student will understand the genetics , and the nutritional requirements and general organization of protozoan's.
2. The students will understand the genetics of the common parasites like trypanosomes and plasmodium.
3. The student will learn about the metabolic adaptation.

UNIT I Genetics of protozoa

Trypanosome- diploidy and sexual stages , chromosome number, survival in blood stream by coat changing, (Shedding). Molecular structure of the surface coat , Mechanism of variable surface glycoprotein e(VSG) gene expression in telomeres, control of VSG gene activity during "Fly" stage . Discontinuous transcription of VSG genes.

Plasmodium : Chromosome size, diploid and haploid stages, and meiosis, chromosome size polymorphism, Evolutionary relatedness of plasmodium sp by comparative DNA analyses, Importance of cloning genes for surface proteins , Cloning of genes, encoding the circum sporozoite protein. Gene encoding the S- antigens of merozoites, - merozoites and sporozoites share a common epitopes, Diversity surface antigens.

UNIT II Geo medical aspect of parasites

1. Factors influencing the distribution of protozoa.

Climatic and Atmospheric factors, - temperature , humidity , precipitation, and irradiation , and edaphic

Other factors - Oxygen, Carbon dioxide, pH , Light, Food , Nutrition

2. Immunity to protozoan parasite - Host reaction, Innate and acquired defense mechanism; Antigen of zooparasites, Special manifestation of Antigen – Antibody reaction as related to protozoan parasites.

UNIT – III General organization

1. General organization and morphology of the parasitic flagellates occurring in digestive tract of man. i. *Retartomonas intestinalis,* ii. *Chilomastix mesnili,* iii. *Giardia lamblia* iv. *Trichomonas tenax*

2. General organization of the Microspora - Structure of the spore, life cycle of *Nosema,* Diseases

caused by microspora in fishes and Arthropods.

3. General organization of the Myxospora – structure and development of the spore, Life cycle of *Myxobolus,* disease caused by Myxospora in fishes.

4 General morphology, life cycle, transmission and pathology of parasitic Amoebae of man and domestic animals. i. *Entamoeba histolytica ii. E. gingivalis*

UNIT –IV

1. Structure and life cycle pattern of acephaline and cephaline Gregarines.
2. Coccidia of poultry with special reference to the structure, treatment and control.
3. Parasitism in ciliophora – structure, Life cycle, Pathogenesis and control of i. *Balantidium coli*

ii. *Ichthioptherius multifilis*

UNIT V Nutrition in Protoza

Nutrition in Protoza

Preferred substarte glucose, aquciation of amino acids, Metabolism in parasitis protozioas. Bioenergetics and the role of oxygen , , energy metabolism in kinetoplastid flagelletes, Aerotelereant , Anaerobic protozoans, Malarial parasites.

Text Books:

1. Mehlhorn H (2008) Encyclopedia of parasitology, vol 3. Kluwer Academic Publishers, Great Britain
2. Mehlhorn H (2016) Encyclopedia of parasitology, vol 3. Kluwer Academic Publishers, Great Britain
3. Mehlhorn H (1988) Parasitology in Focus . Springer –Verlag , Berlin.

Paper No. ZOO/DSE/579- Entomology II

Contact Hours: 45 credits- 3

Learning Objectives

1. To understand the role of insects especially the economic importance.
2. To Learn about the insect pest s that damage our crops an d to learn about their control.
3. To learn about the insect /vectors of importance in medical and veterinary science.
4. To learn the molecular tools used in entomological research and their applications.

Learning Outcome

1. The student will understand the necessity of insect in economic, of crop.
2. The students will be able to identify the pests an d will be able to control the pest with appropriate control mechanism.
3. The students will learn about the molecular tools in entomological studies.

Unit I:

1. Structure of egg, sperm, Oogenesis, Spermatogenesis.
2. Developmental stages of insects: Hemimetabolous, Holometabolous insects.
3. Larvae types, pupae, Male and female reproductive structure.

Physiology of systems: Integument: Structure, Molting, Sclerotization; Digestive system: Physiology of digestion. Respiratory system: Structures, mechanisms of respiration, structure of trachea and respiration in terrestrial and aquatic insects.

Unit II:

1. Circulatory system: Structure, Haemocoel, Dorsal vessel, accessory pulsatile organs, Hemolymph – chemical composition, Hemocyte: Structure and types, mechanisms of circulation.
2. Excretory system: Structure and Malpighian tubules, Physiology of excretion and osmoregulation.
3. Nervous system: Central nervous system, Action potential.
4. Sense organs: Eyes, Chemoreceptors, Mechanoreceptors. Effector organs: Sound producing organs, light producing organs.
5. Endocrine system: Typical endocrine glands in insects, mechanism of hormone action, Moulting and development. Ectohormones: Pheromones, types and defensive secretors.

Unit III Principles of insect pest control

Chemical control: mode of action of insecticide, merits and demerits of chemical control. Modern trends in pest control. Biological control: Principles, procedure, Biological agents; success and limitations. Autocidal control – sterile male technique, genetic technique, the pheromone technique. Integrated pest management (IPM) Principles and application. The local dispersal and migration of insect pest and their importance in IPM strategies- example Aphids, and white flies.

Unit IV: Molecular tools use in Medical and Veterinary Entomology

Cloning genes, and genomics, cloning genes, Recombinant DNA technologies. Genomics: cataloguing an organisms complete genetic sequence, Library construction and genome assembly, Bioinformatics and data base, Genome and vector and vector borne pathogens, PCR and its applications, Diagnostic techniques: Rapid detection and quantification of

pathogens in hosts and vectors, Visualization of pathogens in host and vectors. Immune based diagnosis of host infection.

Unit V: Insect plant interactions:

Events during herbivory, -plant volatile perception and recognition, Insect as microbial host, salivary production and secretions. Insect Endosymbionts in plant signaling, Digestion and nutrition. Endosymbionts- mediated insect defense, Plant metabolite detoxification and Endosymbionts. Herbivory- site of damages, activation of phyto- hormonal pathways, and role of microbes. Microbial priming, below ground changes (Rhizosheres,), changes in above ground, - below ground interactions.

References :

1. Srivastava , KP (1996) Applied Entomology Vo1.I & II 2nd Edition, Kalyani Publishers, New Delhi.
2. Tembhare, D.B (2009) Modern Entomology , Himalaya Publishing House Delhi.
3. David , B.V. and Ananthakrishnan, T.N. (2004) Applied Entomology. 2nd edition, Tata McGraw Hill, New Delhi.
4. Daly, H. V., J. T. Doyen & P.R. Ehrilch (1981) " Introduction to Insect Biology & Diversity" International Student Edn. McGraw- Hill, Kogakusha, Japan.
5. Romoser, W.S (1982) The Science of Entomology. 2nd edition MacMillan, New York.
6. Disi, J., J. Simmons, and S. Zebelo. (2019). Plant growth-promoting rhizobacteria-induced defense against insect herbivores, pp. 385–410. *In* Field crops: sustainable management by PGPR. Springer, New York.
7. Harborne, J. 1988. Introduction to ecological biochemistry. Academic Press, London, United Kingdom.
8. Hartley, S. E., and A. C. Gange. 2009. Impacts of plant symbiotic fungi on insect herbivores: mutualism in a multitrophic context. Annu. Rev. Entomol. 54: 323–342.
9. Karban, R., and I. Baldwin. 1997. Induced responses to herbivory. University of Chicago Press, Chicago, IL, 319p.
10. Klowden, M. J. 2013. Physiological systems in insects. Academic Press, Cambridge, MA.
11. Mullen GR and Durden LA (2009) Medical and Veterinary Entomology 2nd Ed Academic Press. London
12. Nautiyal, C. S., and P. Dion. 2008. Molecular mechanisms of plant and microbe coexistence. Springer, New York
13. Reddy, G. V. 2012. Recent trends in the olfactory responses of insect natural enemies to plant volatiles, pp. 281–301. *In* Biocommunication of plants. Springer, Berlin, Heidelberg.
14. Schoonhoven, L. M., T. Jermy and J. J. van Loon. 1998. Insects and plants: how to apply our knowledge. pp: 343–365. *In* Insect-plant biology. From physiology to evolution; Chapman and Hall. Cambridge, U.K.
15. Wardle, D. A. 2002. Communities and ecosystems: linking the aboveground and belowground components, Princeton, New Jersey, Princeton University Press.

Paper No. ZOO/DSE/580- Endocrinology II

Contact Hours: 45 credits- 3

Learning Objectives:

- The students will learn about vertebrate hormones and their actions in vertebrates.
- The student will learn about hypothamic pituitary axis and the various hormones released, their role in sex determination.
- The student will learn about the male and female reproductive endocrinology
- The students will learn about other hormones secreted by other organs- like stomach, intestines, pancreases, etc.

Learning Out come

- The students will understand about the various hormones in vertebrate and their origin and roles.
- The students will understand the role of male and female reproductive hormones.
- The students will understand the hormonal actions and other hormones involved in metabolism and homeostasis.

Unit - I The vertebrate endocrine system

Classes of hormones. Hormone synthesis and control – a general concept. General mechanisms of hormone action. Termination of hormone action. Hormone circulation and metabolism. Plasma membrane hormone receptors, second messengers of hormone action, receptor signal transduction, Multiple membrane messengers, Eicosanoidids and hormone action, Cytosolic hormone receptors. Sex determination, differentiation of male and female gonads. Development and differentiation of genital ducts. Gonadal hormone synthesis. Gonadal steroids and brain differentiation.

Unit -II Hypothalamus and Pituitary gland

Structure of Hypothalamus and hypophysiotropins and their functions in brief. Control of Hypothalamo-hypophysial hormone secretion. Histomorphology of pituitary gland, hormones and their functions . Neurohypophysial hormones and their functions. Pars intermedia and role melanotropic hormones.

Hormones of pituitary, - families of pituitary hormones, Growth hormones, an dprolactin, The glycoprotein hormones, Pro-Opiomelanoocortin an dmelanocortins, Neurophysical hormones, Hypophysiotropic hormones, - thyrotropins releasing hormones, - thyrotropsin – releasing hormones, Gonsdotropins releasing hormones, (GnRH) , cortico tropin releasing hormones(CRH) Prolactn release inhbiting Factor (PIF) , prolactin releasing factor (PRF) , MSH – release inhibiting Factor (MIF).

Neurophysical hormones - oxytocin, vasopressin , vasotocin, mode of action , Melanotropic hormones. Control of MSH secrtion, - dopinergic control , Physiological roles.

Unit - III Reproductive Endocrinology

Female Reproductive endocrinology. Pregnancy, Parturition and Lactation mechanisms

Anatomy of female reproductive system and histology of ovary, ovarian cycle and its hormonal control. Ovarian steroid hormones and their physiological functions. Menstrual cycle in primates and its hormonal basis. Estrus cycle in rat and its hormonal basis.Role of hypothalamic, pituitary and ovarian hormones in pregnancy in mammals 3.Hormonal mechanism in parturition in mammals. Hormonal mechanism in lactation mammals. Menopause.

Male Reproductive Endocrinology ;

Anatomy of male reproductive system, histology of testis, spermatogenesis; hormones of testis and their functions. Endocrine control of testicular function, GnRH and Pituitary gonadotropins- inhibin , prolactinn, Role of androgens, , Spermatogenesis . Estrogen – physiological roles, fertility , male behavior, Epiphysical fusion , cardiovascular functions.

Unit V : Hormones in homeostasis , Gastro intestinal tract, thyroid and adrenal glands.

Hormonal control of – calcium homeostasis . Parathromone, calcitonin, vitamin D.
Gastro intestinal Hormones- Gastrin, Secretin , cholecystokinin(CCK), Gastric inhibiting peptides, Vasoactive Intestinal Peptide (VIP), Substance P , Somatostatin , motilin. Pancreatic hormones – Insulin and glucagon – physiological action. Thyroid hormone an dcontrol of thyroids hormone secretion. Adrenal steroid hormones- Glucocorticoids, Mineralocorticoids, Aldosterone, Renin – Angiotensin system. Neurohormones- Endorphins.

Books Recommended

1. Hadley , M. E (2004) Endocrinology. Pearson education (Singapore)
2. Norman ,AW, Litwerck, G .(1987) Hormones. Orlando ,FL ; Academic press,
3. Larsen PR, Kronenberg ,HM, Melmed ,S and Polonsky , KS (Ed)(2003) Willams Text Book of Endocrinology , 10^{th} . Ed. Philadelphia, Saunders,

Paper No. ZOO/DSE/581 MARINE BIOLOGY -II

Contact Hours: 45 Credits- 3

Learning Objective:
1. To learn about coastal systems, estuaries.
2. To learn about ecology and adaptations of esturine organisms.

Learning Outcomes:
Student will be able to
1. Describe the salient features marine tropic structure.
2. Explain the types and divisions of various marine habitats.

Unit I: Sea as a biological environment – ecological factors – light, temperature, salinity, pressure. Adaptations to pelagic, benthic, oceanic and coastal zones.

Unit II: Coastal systems – mangroves, sea weeds, sea grass, salt marshes, sand dunes, coral reefs - intertidal and interstitial zones. Deep sea adaptations - Fauna of hydrothermal vents, cold seeps, whale falls and other reducing habitats. Ecology of Arabian Sea.

Unit III:

Occurrence, types and distribution of estuaries. Estuarine systems in India. Ecology and adaptations of estuarine organisms. Economic importance of estuaries.

Functions of rivers and river basins in transport of materials to the estuaries and oceans, their importance in biogeochemical cycles. Modification of dissolved and particulate matter.

Estuarine mixing zones. Physical, chemical and biological aspects of Estuary.

Unit IV: Animal associations in marine environment – endoecism, inquilinism, epizooism, mutualism, communalism, symbiosis and parasitism.

Community ecology - colonization and succession, mechanisms of succession.

Prey-predator relationship – density dependent and density independent factors.

Population ecology - group attributes, population growth, density variations and concept of carrying capacity. Environmental factors responsible for biorhythms. Circadian, tidal and lunar rhythms in marine and estuarine animals. Significance of biorhythms, biotic and abiotic factors influencing homeostasis.

Unit V: Marine ecosystems – concepts, principal components,.

Marine trophic structure - food chains, food web, ecological pyramids, energy flow in pelagic, benthic and deep sea and polar ecosystems. Anthropogenic changes in marine habitat. Species invasions. Impact of climate in Antarctic and Arctic ecosystems.

Text books and References

CMFRI. 2010. Marine Mammal Research and Conservation in India. Central Marine Fisheries Research Institute, Cochin: 20 pp.

George Karleskint, Richard Turner, James Small. 2009. Introduction to Marine Biology. Brooks Cole 598 pp.

Hyman, L., 1967. Invertebrate Zoology. Vols. I to IV. McGraw Hill Books Co., New York.

John F. Morrissey and James L. Sumich. 2012. Introduction to the Biology of Marine Life. Jones & Bartlett Learning Levinton, J.S., 2009. Marine Biol

Levinton, J.S., 2009. Marine Biology: Function, Biodiversity, Ecology. Third Edition. Oxford University Press, Oxford, UK: 640 pp.

Peter Castro and Michael Huber. Marine Biology. 11th Edition (2018). McGraw – Hill Education. 496pp.

Philip V. Mladenov. 2013. Marine Biology: A Very Short Introductio. Oxford University Press, USA 144 pp.

Reynolds, J.E. and Rommel, S.A. (Eds.). 1996. Biology of Marine Mammals. Smithsonian Institution Press, Washington, D.C. 896 pp.

Schreiber, E.A. and Burger, J. (Eds.) 2001. Biology of the Marine Birds, CRC press: 722 pp.

Steele, J.H., Thorpe, S.A. and Turekian, K.K. (Eds.) 2010. Marine Biology: A Derivative of the Encyclopedia of Ocean Sciences, Academic Press: 630 pp.

Practical Paper No. ZOO/DSC/573 (Practical based on ZOO/DSC/570)
Genetics and Bioinformatics

1. Determination of blood groups and suggestions on Medico-legal problems regarding parentage disputes using blood groups.
2. To study the culture of Drosophila melanogaster in laboratory. The sexual dimorphism
3. Study of life cycle stages of Drosophila melanogaster and maintaining the culture.
4. To study the different mutants in Drosophila.
5. Identification of blood group, a case study of multiple alleles.
6. Preparation and mounting of Chironomus larva - Giant Chromosomes
7. To Study of gene frequency using PTC tests (taster and non-tasters)
8. Database search and data retrieval using NCBI and SWISS-PROT
9. Database search and data retrieval using PDB and Expasy.
10. Methods of sequence alignment-BLAST and Clustal W.
11. Phylogenetic tree using PHYLIP.
12. Gene Prediction using GENSCAN/GRAI
13. Protein structure visualization using RASMOL.
14. Study of human karyotype.
15. Studies on recombination mapping using Drosphila crossing or problems from theoretical data.

Practical Paper No. ZOO/DSC/574 (Practical based on ZOO/DSC/571)
Cell and Molecular Biology

1. Orientation to good laboratory practices.
2. Study of different stages of Mitosis and Meiosis by using permanent slides.
3. Squash preparation of grasshopper testis to study meiotic stages.
4. Determination of mitotic index in the squash preparation of onion root tip. Effect of drugs on cell division (Colchicine or any other inhibitor)
5. Study of mitochondria by vital staining technique.
6. Genotoxicity by Micronuclei test.
7. Induction of puff and study of puffing pattern in polytene chromosomes.
8. Preparation of different cell types as hepatocytes/ parenchymal cells
9. Study of tumor and cancerous cells (Use permanent slides)
10. Preparation of Microtome section, spreading.
11. Histochemical staining of carbohydrates (PAS).
12. Histochemical staining of Protein (Bromophenol blue).
13. Histochemical staining of lipids (Sudan Black).
14. Histochemical staining of DNA (Feulgen stain).
15. Case study associated with the cytoskeleton.
16. Separation of proteins by SDS-PAGE.

Practical Paper No. ZOO/DSC/575 (Practical based on ZOO/DSC/572)
Biophysics

1. To study the ECG cycle for signals and the corresponding cardiac functions.
2. To study the measurement of blood pressure.
3. To study the phenomenon of cyclosis by ingestion of dye in Paramecium.
4. To study the osmotic relation in animals.
5. To study the osmotic hemolysis of erythrocytes in different concentrations of salt solutions.
6. To study the muscle excitation by using the Kymograph apparatus.
7. To study the effect of calcium ions on the heartbeat of a rat/ crab by using a kymograph.
8. Demonstration of background count of radiation by Geiger Muller counter.
9. Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei
10. Study of membrane fluidity.
11. Study of diffusion of biomolecules/ions (Flick's law).
12. To study membrane potential using fluorescence spectroscopy.
13. Passage of molecule through dialysis membrane and demonstration of Donnan membrane equilibrium.
14. Preparation of liposome
15. To analyze erythrocyte membrane lipid/proteins by TLC/SDS-PAGE
16. To study spectrophotometric assay of Hill reaction and estimation of Chlorophyll.

Practical Paper No. ZOO/DSC/576
Practical Skill/advanced technique

(This course will be carried out with in collaboration with Health center of University)

1. Function of components of chemical laboratories – Basic needs of a chemical laboratory.
2. Safety regulations: First aids and chemical laboratory records.
3. Laboratory equipments and basic laboratory operations.
4. Specimen collection.
5. Units of measurement, Preparations of reagent solutions and laboratory calculations.
6. Quality controls of laboratory findings.
7. Hematology; Introduction to Hematology.
8. Specimen collection and laboratory preparations in hematology.
9. Routine hematological tests.
10. Special hematological tests.
11. Hemostasis and coagulation.
12. Bleeding disorders.
13. Immuno-hematology or blood banking
14. Blood banking.

Practical Paper No. ZOO/DSE/582 (Practical based on ZOO/DSE/577)
Helminthology II

1. Collections and handling of Nematodes from locally available animals
2. Identification of collected Nematodes using standard methods.
3. Basic techniques of preservation Nematodes.
4. Basic techniques of mounting Nematodes
5. Fecal sample analysis for collection and identification of ova.
6. Study of permanent slides (At least 8).
7. Collection and identification of Phytonema.
8. Techniques of collection, fixation, mounting, and preparation of permanent slides.
9. Studies of nematodes of medical importance with permanent slides.
10. Submission of permanent slides at the time of examinations.
11. Study of life cycle of citrus nematodes.
12. Study of life cycle of root knot nematodes
13. Study of life cycle of bud and leaf nematodes
14. Immunological techniques in helminthology

Practical Paper No. ZOO/DSE/583 (Practical based on ZOO/DSE/578)
Protozoology II

1. Classification of parasitic protozoa.
2. Study of ciliates in the alimentary canal of vertebrates.
3. Study of ciliates in the alimentary canal of invertebrates.
4. Impregnation of ciliates with dry silver nitrate for the study of kinetic structure.
5. Study of hemoflagellates from vertebrate blood.
6. Preparation of blood smear, staining, and identification of staining of hemosporina.
7. Histopathology of host tissue caused by Apicomplexan parasites.
8. Examination of a fecal sample of vertebrate host for oocyst of coccidia.
9. Collection of coccidian oocysts by centrifugation method.
10. Observation of oocysts for sporulation.
11. Study of different mosquito vectors of protozoan parasites.
12. Collection of Myxozoa from fishes.
13. Study of binary fission and conjugation in ciliates.

Practical Paper No. ZOO/DSE/584 (Practical based on ZOO/DSE/579)
Entomology- II

1. To study the types and total count of hemocytes in the hemolymph of cockroach / grasshopper/ any insect.
2. Study and mounting of Head, and mouth parts of typical insect and their modifications.
3. To study and mounting of Abdominal Spiracle in cockroach or grasshopper.
4. Study and mounting of thoracic spiracles in cockroach or grasshopper.
5. Dissection of central nervous system of cockroach.
6. To dissect and study the retro-cerebral complex in cockroach. Identification of corporaallata and carpora cardiacum or dissection of ring gland in Lepidoptera.
7. To study the plant insect interaction - Using ants and plant extract or flower extracts
8. To study of attraction or repulsion of ants / insects different feeds.
9. Study and mounting of sense organ- Eyes/ Antenna
10. Study and mounting of sound producing organs.
11. Effect of hormones on molting in insects by ligation techniques.
12. Determination of LD50.
13. Amplification of insect DNA by using PCR and its importance in entomology.
14. Study of insect phylogeny using bioinformatics tools.
15. Study bacteria in insect gut.
16. Estimation of uric acid in Malpighian tubules.
17. Insect pheromones with reference to honey bee.
18. Biochemical studies of royal jelly in Honey bee.
19. Field visit for demonstration of pest damage/ to the entomology Department of Agricultural University farm.

Practical Paper No. ZOO/DSE/585 (Practical based on ZOO/DSE/580)
Endocrinology II

1. *In situ* demonstration of endocrine glands in rats or by demonstration using visual aids.
2. Histological study of endocrine glands in different vertebrate representatives.
3. Anatomical studies of the reproductive system in rat.
4. Study of the estrous cycle in rat.
5. Endocrine gland removal in rats- Orchidectomy
6. Endocrine gland removal in rats- vasectomy
7. Endocrine gland removal in rats- Adrenalectomy
8. Endocrine gland removal in rats- Thyroidectomy
9. Effect of thyroxin on oxygen consumption in fish
10. Chromatophores and color changes in fish (a) Effect of background and (b) Effect of MSH injection.
11. Determination of cholesterol in the adrenal gland of rats.
12. Effect of insulin on blood glucose levels in fish/rat
13. Histological techniques: preparation of permanent slides for the histological structure of endocrine glands of rats (at least 5 be submitted).

Practical Paper No. ZOO/DSE/586 - Practical based on ZOO/DSE/581

Marine Biology -II

1. Estimation of different ecological parameters (Salinity, pH, TDS, Turbidity, Hardness, etc.)
2. Oxygen consumption by fresh water fish.
3. Report on field visit to a marine ecosystem and intertidal zone.
4. Induced breeding in fishes (carps).
5. Live feed culture and artificial feed preparation.
6. Evaluation of standing stock. Diel variation in plankton in estuary/bay.
7. Estimation of primary production by light and dark bottle method.
8. Chlorophyll estimation.
9. Preparation of whole mounts of planktons.
10. Visit to intertidal regions- Rocky shores, Sandy shores, Mud flats, mangrove and estuaries.

Dr. Babasaheb Ambedkar Marathwada University
Chhatrapati Sambhajinagar
Department of Zoology
M.Sc. Second Year (Semester -III)

Paper No. ZOO/DSC/620 - DEVELOPMENTAL BIOLOGY

Credits- 3

Contact Hours: 45

Learning Objectives:

- To impart knowledge in evolving areas of biological science with respect to developmental biology.
- To impart an understanding of fundamental processes governing development of life.
- To inculcate interest in research in developmental biology and to create manpower for this region.

Learning Outcomes:

By the end of the course students will be able to:

- Explain basic concepts of developmental biology.
- Gain detailed knowledge about developmental biology and organogenesis.
- Learn about gametogenesis, embryological development, cleavage mechanisms, gastrulation and role of hormones in metamorphosis and regeneration.

Unit I: Theories of Development

1. Preformation and epigenesis
2. **Gametogenesis** (i) Spermatogenesis. Growth of Spermatocytes and acrosome formation spermiogenesis, Capacitation (ii) Oogenesis. (a) Growth of Oocyte and vitellogenesis. (b) Organization of Egg cytoplasm: role of egg cortex, (c) Morphogenic determination in egg cytoplasm.
3. **Fertilization:** Block to polyspermy (Fast and Slow);
4. Significance of fertilization in development and the essence of activation of the egg (Molecular mechanism)

Unit II

1. Early embryonic development, Patterns of cleavage; Morulation and Blastulation.
2. Gametogenesis in chordates (tunicates to mammals); (a) Fate maps (b) Mechanism of gastrulation (c) Morphogenic movements (d) Significance of gastrulation.
3. Primary embryonic induction: (a) concepts of potencies; prospective fates; Progressive determination, Totipotency and pluripotency.
4. Nuclear transfer experiment (b) Induction of the primitive nervous system (Spemann's primary organizers) (c) Nature and regionally-specific properties of inductors, (d) Competence (e) Abnormal inductors (f) chemistry and mechanism of action of inducing substances.

Unit III

1. Cell differentiation and differential activity.

2. Organogenesis (a) Morphogenetic processes in epithelia and mesenchyme in organ formation (b) Morphogenesis of brain. Neural cells and their derivatives (c) Development of the eye, heart and alimentary canal with its accessory organs.
3. Maternal contributions in early embryonic development.

Unit IV

1. Genetic regulation of early embryo development.
2. Embryonic adaptation (a) Evolution of cleidoic egg and its structural and physical adaptations (b) Development and physiology of extra of embryonic membrane in amniotes.
3. Metamorphosis in amphibians; (a) structural and physiological changes during Metamorphosis

Unit V

1. Types of regeneration. Physiological, reparative and compensatory hypertrophy, regenerative ability in Chordata
2. Morphological and histological process in amphibian limb regeneration.
3. Origin of cells; regeneration, de-differentiation, redifferentiation.
4. Pattern formation during amphibian limb generation.
5. Reasons for failure of limb regeneration ability in other Chordata and mammals.
6. Abnormalities of embryonic development; teratology
7. Morphogenesis and organogenesis in animals: cell and aggregation. Differentiation in *Dictyostelium* Axes and pattern formation in Drosophila. Amphibia and Chick
8. Organogenesis : Vulva formation in *Caenorhabditis elegans;* eye lens induction, limb development, Differentiation of neurons, Post embryonic development: Larval formation. Metamorphosis, environmental regulation of normal development, Sex determination.

Text books :

1. Developmental Biology by Gilbert Scott
2. Molecular biology of the cell by Albert et. Al
3. Molecular biology of the Gene by Watson et. At
4. Principle of Development by Wolpert.
5. Genes VIII/IX by Benjamin Lewin.
6. Developmental biology by Balinsky.
7. Developmental biology by Berril.
8. Developmental biology by Waddington.
9. Kpirmals; Medline and Bio-Med Net.

Paper No. ZOO/DSC/622 - APPLIED BIOTECHNOLOGY -I

Credits- 3

Contact Hours: 45

Learning Objectives:

- To create interest in technological advancements in biological sciences and its application to mankind.
- To familiarize the students with different diagnostic techniques with applications.
- To develop critical thinking about emerging techniques of biology, including nano-biotechnology and marine biotechnology.

Learning Outcomes:

By the end of the course students will be able to:

- Understand the applications of Biotechnology in Agriculture and waste-recycling.
- State principles and applications of various diagnostic techniques.
- Learn about the marine biotechnology and nano-biotechnology in detail.

Unit I: Biotechnology in Agriculture and waste recycling

Waste management: Definition, Solid waste suitable for composting, Methods of composting: Vermi-composting. Mineralization process in composting, Biochemistry of composting, factors involved, the infrastructure required –maturity parameters, value-added application methods.

Unit II: Biotechnology in Diagnosis and Molecular diagnosis

1. Introduction to molecular diagnosis, significance, scope rise of diagnostic industry, Biomarkers in disease diagnostics, Role of markers in disease diagnosis with examples.
2. Immunodiagnostic techniques: DNA reporter, Fluorogenic reporters, electro-chemiluminescent tags, and label-free immunoassays. PCR in molecular diagnosis, cellular and fundamental genomics in diagnostics.
3. Principles, techniques and application of Protein Sequencing, DNA Sequencing, CRISPR-CAS technology.

Family Genetic Inheritance for identifying rare and common genetic variants: NGS platforms, Illumina, ion Torrent, complete Genomics technology, Third generation sequencing (3GS); Pac bio –Single Molecule Real Time (SMRT) sequencing and Oxford Nanopore Technologies (ONT), Heliocose Single molecule sequencing, Complete genome Advanced sequencing.

Unit III: Marine Biotechnology

Significance, Marine-derived pharmaceuticals, Marine bioresources, Secondary metabolites, Marine action-bacterial metabolites and their pharmacological potential, Barophilic organisms and their applications. –Seaweeds for removal of metal pollutants. Green fluorescence proteins, red fluorescence proteins, characteristics, and applications.

Unit IV: Nanobiotechnology

Introduction: What is nanotechnology and nanobiotechnology, principles of nanoparticle synthesis using living organisms and characterization, Different morphological forms of nanoparticles (Nanospheres, Nano-capsules, Dendrimers), Applications of nanomaterials in drug delivery, importance of nanomedicine.

Unit V: Transgenic Animals

Transgenic mouse, Creation of gene knockout mice,

Transgenic livestock: Non-Breeding Strategies; Milk production, Growth and meat production, Breading Strategies- embryonic transfer, Sex selection, embryo cloning, Gene transfer in animals, Genetic engineered vaccine used with live stock, Animal Pharming, Genetic engineering in animals by nuclear transfer, Transgenic sheep, Transgenic poultry, and genetically altered fish.

References:

1. Satyanarayana,U (2010): Biotechnology , Books and Allied (P) ltd, Kolkata
2. Rastogi, Sc (2009): Biotechnology, Principle and Applications, Narosa Publishing House, Mumbai.
3. Patnaik, B.K, Kara, TC, Gosh, SN, Dalai, AK (2012) Text book of Biotechnology. Tata McGraw Hill Education Private Limited.
4. Chanarayappa (2006): Molecular Biotechnology, Principles and Practices, University Press Pvt limited. Hyderabad

Paper No. ZOO/DSC/621 - IMMUNO-BIOLOGY

Credits- 3

Contact Hours: 45

Learning Objectives:

- To inculcate knowledge about Immunobiology.
- To understand the aspects of human immunology such as antigens, antibodies, B- and T-lymphocytes and different cells of the immune system.
- To extend the knowledge about immune systems of the body and immune system in invertebrates and their association with vertebrate system.

Learning Outcomes:

By the end of the course students will be able to:

- Explain the tissues, cells and molecules involved in host defense mechanisms.
- Understand of types of immunity, Interactions of antigens, antibodies, complements and other immune components.
- Describe concepts of B-cell, T-cell, Toll-like receptors, hypersensitivity reactions and autoimmune diseases.

Unit I: Introduction to immune-biology and innate immunity

1. Different types of first defence barriers against pathogens, Anatomic and chemical basis of inflammatory Inducers.

2. **Innate immunity:** Cells involved in innate immunity, PAMPs and DAMPs, Microbial recognition and tissue damage initiates an inflammatory response.
3. PRRs, Types of Toll- like receptors (TLRs)
   - NOD-like rceeptors as sensors and bacterial infection and cellular damage.
   - NLRP in Cell death and inflammation,
   - RIG -1 like receptor in type – I interferon production and proinflammatory cytokines.
4. **Adaptive immunity:** Antigen-antibody receptor interactions, the strueture of antibodies and receptors. Arrangement of genes and maturity in the bone marrow. Secondary lymphoid tissues role in adaptive immunity/response

Unit II : Antigen recognition by B cell and T cell receptor :

Structure of typical antibody molecules, Interaction with the antibody molecule with Spceific antigen, Antigen recognition by T- cells, Primary immunoglobulin gene Rearrangement, T- Cell receptor gene rearrangement, Structural variations in immunoglobulin complex and its function.

Unit III : The development of mature lymphocyte receptor responses

Myeloid lineage Lymphocyte receptors signalling. Antigen receptor signalling

Lymphocyte activation. Co- stimulating. And inhibiting receptors modulation receptor singnaling in T and B Lymphoeytes, Development of B and T lymphocytes. Positive and negative selection of T Cells

Unit IV: The adaptive immune response:
Site for initiation of adaptive immune response (secondary lymphoid organs), Priming of Naive T cells by pathogens- activated dendritic cells, General properties of effector T - cells and their cytokines, T cell mediated cytotoxicity, B and T lymphocyte, Positive and negative selection of T cells.

Unit V: The immune system in health and diseases:
Immunodeficiency diseases, Evasion and subversion of immune defences, Non-lgE and lgE Mediated allergic defences and effector mechanism, Non-lgE mediated allergic diseases, Autoimmune disease and pathogenic mechanisms.

Reference Books:

1. Kuby lmmunology – RA Goldshy. Kinot. TJ. Osborne. BA.4th Ed W.H Freeman and Copany. New York
3. janeway s lmmunobilogy Murphy. K . Weaver. C. 9th Ed Carland and science. Laylor and Francis Group.
3. Text book of lmmunology Riott
4. Fundamental immunology – Colemean , Lombard, Sicard Wm Brown Publishers.
5. Understanding lmmunology – Peter Wood. Pearson Education

Paper No. ZOO/DSC/626 - PRACTICAL SKILL/ADVANCED TECHNIQUE

1. Elution of protein from Gel filtration and determine the molecular mass.
2. Determination of given amino acid by Thin layer chromatography (TLC)
3. Standard procedure for cell separation by centrifugal elutriation
4. Separation of DNA by Agarose gel electrophoresis and determine molecular mass.
5. SDS-PAGE electrophoresis of protein and determine molecular mass.
6. Study of Beer Lambert's Law for spectrophotometry.
7. Estimation of protein by Lowry's method or Micro Lowry method or dye binding technique.
8. Estimation of carbohydrate by Anthrone method.
9. Plasma separation from given blood sample
10. Serum separation from given blood sample and its electrophoresis.
11. Blood group analysis and clinical correlations.
12. Estimation of blood glucose by DuBois method or enzyme method.
13. Estimation of blood lipids.
14. Isolation of erythrocytes
15. Estimation of ESR of given blood sample.
16. Total RBC count from human blood
17. Identification of defective RBC's from given blood sample for Thalassemia/Sickle cell anemia/ Protozoan parasite.
18. Total WBC count from human blood
19. Differential count on WBC from human blood
20. Precipitation reaction: the ring test
21. Agglutination reaction: The febrile antibody test
22. IgG purification
23. Widal Test
24. ELISA test (Indirect/Sandwich/Dot)
25. Antibiotic potency test –Plate diffusion method (Minimum Inhibitory Concentration)
26. Study of cell viability by Trypan blue exclusion
27. Isolation of DNA from E. coli by mini prep method
28. Isolation of plasmid from bacteria
29. To observe Bacteriophage growth.

30. To isolate DNA from Bacteriophage.
31. Bacterial DNA amplification using PCR
32. Restriction digestion of DNA using nuclease
33. Transformation of DNA in bacteria
34. Gene expression by Gal-x
35. Visit to Food/Pharmaceutical industry

Elective Courses

Paper No. ZOO/DSE/627 - APPLIED PARASITOLOGY -I

Credits- 3

Contact Hours: 45

Learning Objectives:

- To understand the basic and general concepts of Parasitology.
- To study major types of parasites of medical and veterinary importance.
- To develop understanding of food and water borne diseases.

Learning Outcomes:

By the end of the course students will be able to:

- Enlist types of parasites and hosts along with their relationship.
- State the advantages and disadvantages of parasite in life.
- Explain Inter-specific biological relationships.

Unit I: Introduction to Parasitology

Inter-specific biological relationships phoresis, symbiosis, commensalism and parasitism. Parasitism-Definition and concept, Origin and evolution of parasites, Adaptation in parasites. Advantages and disadvantages in parasitic life, Types of Types of hosts - definitive and intermediate, primary secondary specific host, paratenic, carrier, Susceptible, Resistant, accidental, Vectors parasites

Unit II: Systematics and taxonomy

1.Systematics and taxonomy: Host as an environment, parasites ecological niche, infectious site, Parasitic populations: Quantitative descriptors- Macro and micro parasites, population structure, trophic relationships, multiple species interaction, Adaptations for transmission: parasitic reproduction, behavioral adaptations, Epidemiology: Macro-epidemiology, Micro-epidemiology.
2. Mathematical models: Host-switching or host capture, phylo-geography, apomorphic, ingroup and outgroup. Synapomorphies, monophyletic, paraphyletic, polyphyletic, cladogram, parasitism and sexual selection, evolution and virulence.

UNIT III: Immunology and pathology

1.Susceptibility and resistance, Innate defense mechanisms, cell signaling, cytokines and cytokine receptors, antimicrobial molecules and pattern recognition receptors (PRR), pathogen associated molecular pattern (PAMPs), complement, alternative pathways, classical pathways, Toll-like receptors, Glycosylphosphatidylinositol, other chemical defenses – interferons, tumor necrosis factors, cellular defense phagocytosis-phagocytes.
2.Adaptive immune receptors: Self and non-self-recognition in adaptive responses, antibodies, functions of antibody in host-defense, lymphocytes. Generation of humoral response, cell mediated response; inflammation.

Unit IV: Habitat and Environment

Habitat and environment of different parasites. Host parasite system, Host reaction to parasites, pathogenicity of Endo and Ectoparasites. General control of ecto and endoparasites, chemical, biological, physical, mechanical, cultural and legislative.

Economic importance of parasites, direct or indirect effect on human, animal, farm animals and Agriculture, poultry and fisheries pathogenicity. Major taxa of parasites of Medical and veterinary importance

Factors influencing parasitism; influence of season, host age and other phonological factor on parasitic population (prevalence and intensity)

Unit V: Biochemistry and Molecular biology

Energy metabolism, Energy stores, regulation of energy, energy metabolism in parasitic protozoa, lipid metabolism, metabolism of nitrogenous compound, Amino acid metabolism.

Gene expression, - telomeric gene expression, Discontinuous transcription of mRNA Editing in kinetoplastids flagellates, Transfection success in kinetoplastid flagellates. Homologous gene recombination, Genetic exchange in malaria parasites and trypanosomes, chromosome and gene mapping.

References:

1. Infectious Disease Epidemiology: theory and practice. 2nd edition. Nelson & Williams (Eds.). 2007.
2. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth=2
3. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co.
4. Reingold, A.L. Outbreak Investigations – A Perspective. Emerging Infectious Diseases 1998; 4(1): 21-27.
5. Modern Parasitology Ed FEG Cox, Blackwell Science
6. Foundations of parasitological (2009): GD Schmidt and LS Roberts. McGraw Hill Higher Education.
7. Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Global trends in emerging infectious diseases. Nature 2008; 451(21): 990-993.

Paper No. ZOO/DSE/628 - ANIMAL PHYSIOLOGY -I (INVERTEBRATE PHYSIOLOGY)

Credits- 3

Contact Hours: 45

Learning Objectives:

- To understand the basic physiological processes in invertebrates and their use in medical, non-medical and veterinary sciences.

Learning Outcomes:

By the end of the course students will be able to:

- Explain osmoregulation and hormonal regulation in various invertebrates.
- Describe physiological processes like digestion, respiration, excretion and reproduction in invertebrates.

Comment [MP1]: Addition of protozoa to nematodes

Part A: Physiology of Arthropods

Unit I: Crustacea

1. Osmotic and ionic regulation, mechanism of regulation, hormonal control of osmoregulation.
2. Structure and functions of heart: Significance of pericardial organs in heartbeat, blood Sugars in crustacean and its hormonal control.
3. Types of reproduction, genetic sex determination, sex reversals, factors affecting reproduction, hormonal control of reproduction

Unit II: Insecta I

1. Nutrition and choice of food, functional morphology of alimentary canal and associated glands, role of digestive enzymes.
2. Functional morphology of respiratory organs in insects, physiology and factors affecting respiration.
3. Structure and functions of photoreceptors, mechano-receptors and chemoreceptors, mechanism of reception.
4. Gametogenesis and factors affecting reproduction, hormonal control of reproduction.
5. Types of metamorphosis in insects and hormonal regulation of metamorphosis.

Part B: physiology of non-arthropods

Unit III: Annelida

1. Digestive system, transport of food through alimentary canal, regulation of digestion.
2. Types of reproduction, sexual development and maturation, factors affecting reproduction.
3. Growth and regeneration in polychaeta and its hormonal regulation.

Unit IV: Mollusca

1. Osmotic equilibrium, osmotic and ionic regulation in freshwater and Marine forms.
2. Respiratory organs, structural properties and functions of respiratory pigments.
3. Nitrogenous end products, urine formation and excretion.
4. Reproduction pattern (Gonochorium, Hermaphroditism, self-fertilization, parthenogenesis).
5. Factors influencing reproduction, formation control of reproduction, sex reversal.

Unit V: Echinodermata

1. Coelomic fluids and coelomocytes.
2. Respiratory organs, role of Peri–visceral coelomic fluid in respiration, factors affecting respiration.
3. Types of reproduction, breeding behavior, factors influencing reproduction, regeneration in echinoderms.

Reference Books:

1. Comparative animal physiology by Prosser C.L.
2. General and comparative physiology by - Florey W.A.
3. General and comparative physiology by Hoar W.B.
4. Animal physiology by Neilsen K.S.
5. Cell Biology by Ambrose and Fastly.
6. Principle of animal physiology by Wilson J.A.
7. Neural and integrative physiology by Prosser C.L.
8. Animal physiology by Gordon G.S.
9. Modern physiology by Strang F.L.

Paper No. ZOO/DSE/629 - MOLECULAR BIOLOGY -I

Credits- 3

Contact Hours: 45

Learning Objectives:

- To impart knowledge in evolving biological science at a molecular level.
- To impart an understanding of the fundamental process governing life and information flow.
- To inculcate interest in research molecular biology and creating a human resource for this region.

Learning Outcomes:

By the end of the course students will be able to:

- Explain chemical components of nucleic acids, structure of DNA, structure and types of RNA.
- Have a proper understanding of prokaryotic replication.
- Understand DNA damage and various genetic disorders.

UNIT I:

The Central dogma - Flow of information in biological system; Historical perspective, composition of RNA and DNA. Bases, Chargaff's rule Relationship between genes and proteins; Structure of DNA - Watson & Crick model – different forms of DNA (A,B,Z) - nearest neighbor base frequency (anti parallel nature) analysis. RNA – structure and functions; mRNA, rRNA & tRNA – structures and functions. Variation in size and shape of genomes; ultracentrifugation and electron microscopic methods to study the shape and size of genomes and genetic capacity; C-value paradox, Organelle genomes.

UNIT II:

Clusters and repeats: tandem repeats, mini- micro- satellites and interspersed genome-wide repeats and their significance. Pseudo genes and transposable elements. Globin gene clusters, gene duplication and gene evolution, gene conversion and codon usage.

Prokaryotic DNA Replication: Replicon, single and multi-copy replicons, linear and circular replicons, unidirectional and bidirectional replication, experimental methods, mapping origin of replication,

semi-conservative (Meselson and Stahl's experiment) and semi-discontinuous replication; experimental demonstrations.

Topological problems in DNA replication; topoisomerases, helicase and gyrase. Mechanism and classification of topoisomerases, assay of topoisomerases.

Priming DNA synthesis in bacteria; experimental evidence, components of primosome. Initiation at origin (oriC) of *E. Coli.* Creation of replication forks. Regulation of initiation at origins, sequestration of origins after replication, role of helicase, assay of helicase.

UNIT III:

Enzymology of DNA replication;

DNA polymerases, chemistry of nucleotide polymerization and in vitro assay.

Properties and functions of DNA polymerase-I, Kornberg enzyme. Subunit composition of polymerase –III holoenzyme, identification of functions of individual subunits by complementation and mutational studies.

mechanism of replication of *E. coli* DNA-trombone model, termination of replication. Hand-palm structure of DNA polymerases.

Processivity and fidelity of replication. Bacterial replication and its connection to cell cycle

UNIT IV:

Transcription in prokaryotes: The transcriptome, prokaryotic RNA polymerase; molecular composition, and

mechanism of transcription. Initiation of prokaryotic transcription; Structure of bacterial promoters. Effect of sigma factor on binding of RNA pol. to promoters. Structure and function of sigma factor, reuse of sigma factor (sigma cycle). Sigma movement relative to DNA: FRET assay. DNA melting at promoters, promoter clearance. Role of α-subunit in upstream element recognition.

Foot-printing of upstream elements with α-subunit. Elongation: Role of β-subunit in phosphodiester bond formation. Structure of elongation complex and core polymerase. Termination of transcription: Rho- dependent and independent, termination, RNA product under Rho dependent termination.

UNIT V:

Translation- Genetic code, feature of genetic code triplet codon, degeneracy, wobble hypothesis, variation in codon usage, structure of ribosome - A, P, E sites of ribosomes,

translation in prokaryotes - activation of amino acids, initiation: shine dalgarno complex, initiation factors, effect of GTP hydrolysis by IF2. exchange of ribosomal subunits. Elongation: elongation factors, peptide bond formation, termination: release factors. **Concept of gene:** Fine structure of gene, Beadle and Tatum's One gene one enzyme concept, One gene one polypeptide concept, Complementation test, Intragenic complementation, Cistron, Recon and Muton, Split gene, Jumping gene, Overlapping gene & multiple genes. Operon concept- lac operon, Arabinose and tryptophan operon.

Reference Books:

1. Molecular Biology of gene, 5th edition (2004), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Publisher – Pearson Education, Inc. and Dorling Kindersley Publishing Inc.
2. Molecular Biology, 4th edition (2007), Weaver R., Publisher – McGrew Hill Science.
3. Molecular Biology of Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts and James D. Publisher: Garland Publishing.
4. Essential Cell Biology, 2nd edition (2003), Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
5. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.
6. Genes X, (2010), Benjamin Lewin, Publishers – Jones and Barlett Inc.

Paper No. ZOO/DSE/630 – FISHERY SCIENCE -I

Contact Hours: 45 Credits- 3

Learning Objectives:

- To develop the scientific outlook and awareness in Inland water bodies and its great potential for fish and fish seed production.
- To familiarize the students with phylogeny of fish.
- Application of the fishery science for the biological productivity of inland waters.
- The commercial fish species exploitation by sharing ecological niches.

Learning Outcomes:

By the end of the course students will be able to:

- Identify the fish from both, marine and fresh water.
- Explain characters, classification and techniques related to fish.
- Develop knowledge about fisheries, conventional and non-conventional fishing methods.

Unit I:

General Characters and classification of fresh and marine water fish, Identification of larval stages of major carps, Identification of fish up to species level, General characters of bony and cartilaginous fish and phylogeny of fish.

Unit II:

Aquatic ecosystems, Fresh, brackish and marine water ecosystems, Productivity of ponds and its nutrient circulations, Identification of plankton, nekton and benthos, Role of plankton in fish culture.

Unit III:

Culture techniques of major carps, Breeding techniques, Induced breeding bundh breeding, breeding in happa, Types of fish culture-Cage culture, Pen culture, Monoculture, Polyculture, Types of hatcheries, hatching happa, Chinese hatchery, Maintenance and management of hatcheries. Hybridization

Unit IV:

Types of fish-ponds in fresh water fish culture, Layout and construction of ponds. Fertilization and management of various ponds. Fish diseases and their control measures. Setting up of home aquarium and maintenance of aquarium fish.

Unit V:

Major fisheries in India and fishing methods. Important Inland, cold water, Brackish, estuarine and marine fisheries of India. Conventional and non-conventional fishing methods.

Reference books:

1. Pillay,T.V.R. & M.A. Dill.- Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979.
2. Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.,1979.
3. Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
4. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982
5. Bardach, et. al. -Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
6. Chondar, C.L. -Hypophysation of Indian major carps. Satish Book Enterprise,Agra, 1980.
7. Santhanam, R. et. al. -A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co.Pvt. Ltd., 1987.
8. Cheng, T.C. -The Biology of Animal Parasites. Saunders, Philadelphia, 1964.
9. Ribelin, W.E. & G. Miguki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd.,Great Russel st., London, 1975.
10. Schauperclaus- Fish Diseases. Vol. I & II.Douglas P Anderson - Text Book of Fish Immunology
11. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi,Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
12. Shang, Y.C. -Aquaculture Economic Analysis – An Introduction. 1990.
13. Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963.
14. Howar, W.S. & D.J. Randal- Fish Physiology, Vols. 1–4, Academic Press, NY, 1970. Carl, B.E. Biology of Fishes- Saunders, 1979.
15. Day, F. -The fishes of India.

Practical Paper No. ZOO/DSC/623 – (Practical based on ZOO/DSC/620)
Developmental biology

1. Whole Mount of different types of sperms.
2. Study of sperm count by Neubar's chamber.
3. Types of eggs and cleavage patterns.
4. Study of morphogenetic movements during development.
5. Stages of development in frog.
6. Studies of whole Mount of chick development: 16,18,24,33,36,48,72,98 hours.
7. Developmental stages of pond snail, *Lymnaea.*
8. Chick embryo and determination of its age.
9. Studies of cell death in chick embryo.
10. Regeneration in *Planaria*/*Hydra.*

Practical Paper No. ZOO/DSC/624 – (Practical based on ZOO/DSC/621)
Immuno-biology

1. To determine the blood groups of given_—blood –samples by slide agglutination techniques.
2. To perform double immunodiffusion (DID) by using Outhterlony's methods.
3. To carryout Immunoelectrophoresis.
4. To determine hemocytes from cockroach hemolymh.
5. To determine the activity of Phenoloxidase in hemolymph of cockroaches.

Practical Paper No. ZOO/DSC/625 – (Practical based on ZOO/DSC/622)
Applied Biotechnology -I

1. ~~8.~~ Techniques for isolation of pure cultures.~~Cultural characteristics of microorganisms.~~
~~1.~~
2. ~~10.~~ Gram stain for differentiation of bacteria.
3. Nutritional requirements: Media for the routine cultivation of Bactria.
4. Determination of growth curve of bacteria.
5. Methylene blue reductase test.
6. Standard qualitative analysis of water: Confirmed test of bacteria.
7. Isolation colony characterization and Gram characteristics of bacteria from fermented food. (curd/ idli batter/ dhokla batter)
8. Testing of food adulteration (milk/ milk products/haldi or any food sample)
9. Determination of moisture in food sample. /Determination of ash in food sample
10. Antibiotic Potency test- Plate diffusion method (Minimum Inhibitory Concentration)
11. Visit to Food/ Pharmaceutical industry.

Formatted: Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Formatted: Font: (Default) Times New Roman, Complex Script Font: Times New Roman

Practical Paper No. ZOO/DSC/631 – (Practical based on ZOO/DSC/627)
Applied Parasitology -I

1. Study of different types of animal associations with suitable examples.
2. Study of different types of parasites, vectors etc.
3. Study of different/important ecto/endoparasites of poultry, fish, animal and human.
4. Study of hemoflagellates from vertebrate blood.
5. Preparation of blood smear, staining and identification of Haemosporina.
6. Study of different mosquito vectors of protozoan parasites.
7. Submission of permanent slides at the time of examination.

Practical Paper No. ZOO/DSC/632 – (Practical based on ZOO/DSC/628)
Animal Physiology -I

1. Effect of salinity on blood chloride content of crab.
2. Effect of temperature on Heartbeat. Q_{10} measurements in bivalve/crabs.
3. Estimation of glycogen from hepatopancreas and gonads of bivalve/crabs.
4. Estimation of protein from hepatopancreas and gonads of bivalve/crabs.
5. Estimation of lipid from hepatopancreas and gonads of bivalve/crabs.
6. Estimation of cholesterol from hepatopancreas and gonads of bivalve/crabs.
7. Oxygen consumption in relation to sex and size/temperature of bivalve/leech/crabs.
8. Acid phosphatase activity in hepatopancreas of crab/bivalve.
9. Alkaline phosphatase activity in hepatopancreas of crab/bivalve.
10. Estimation of ascorbic acid from hepatopancreas and gonad of crab/bivalve.
11. Chromatophores in crustaceans and effect of background on color change.

Practical Paper No. ZOO/DSC/633 – (Practical based on ZOO/DSC/629)
Molecular Biology -I

1. Extraction of genomic DNA from bacterial DNA
2. Determination of Molecular size of DNA.
3. Restriction digestion of DNA.
4. Determination of molecular weight of different DNA fragments by running a standard marker on agarose gel electrophoresis.
5. To isolate and clearing of the DNA fragment of interest from the agarose gel.
6. To perform transformation of DNA into bacterial cells.
7. To isolate DNA of bacteriophage lambda
8. To separate immunological proteins (alpha, beta and gamma) from serum by Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE).
9. To prepare master plate and carry out its replica plating.

10. Extraction of RNA from *E coli.*

Practical Paper No. ZOO/DSC/634 – (Practical based on ZOO/DSC/630)
Fishery Science -I

1. Identification of fish up to species level with suitable examples from each class.
2. Analysis of water: Turbidity, pH, dissolved oxygen, carbon dioxide, alkalinity, chlorinity.
3. Identification of plankton, nekton and benthos.
4. Fishing crafts and gears, hatching happa.
5. Identification fish parasites.
6. Identification of fish food (at least twenty)
7. Visit to fish breeding center.

FOURTH SEMESTER

Paper No. ZOO/DSC/650 - EVOLUTION AND BEHAVIOR

Contact Hours: 45 Credits- 3

Learning Objectives:

- To study the origin of various animal groups.
- To study the mechanism involved in evolution.
- To study the significance and pattern of evolution.
- To study the behavioral mechanisms.

Learning Outcomes:

By the end of the course students will be able to:

- Explain various theories of evolution.
- Describe the origin of biomolecules and their metabolism.
- State the evolutionary time scale and evolution of organisms.

Unit I

1. Geological time scale. Concept of evolution and theories of organic evolution.
2. Lamarckism, Darwinism, Neo-Darwinism and Modern Synthetic Theory. New concepts regarding Lamarckism and Darwinism.
3. Evolutionary forces (i) Natural selection (ii) Mutation (iii) isolation and its role in species formation (iv) genetic drift (v) Migration (vi) Meiotic drive, Hardy-Weinberg law of genetic equilibrium

Unit II

1. Molecular population genetics, patterns of change in nucleotides and amino acid sequences, Ecological significance of molecular variations, Emergence of Non-Darwinism hypothesis.
2. Genetic of quantitative traits in population, Genotype-environment interaction, inbreeding depression and heterosis, Molecular analysis of quantitative traits, phenotypic plasticity.
3. Genetics and speciation, biological concept of species, evolutionary species concept, phylogenetic species concept,
4. Speciation: patterns and mechanism of reproductive isolation, models of speciation (Allopatric, Sympatric, Parapatric).

Unit III

1. Molecular evolution: Genetic evolution, Evolution of gene families, Molecular drive, Assessment of molecular variation, origin of higher categories: Micro and macroevolution, Trends in Human evolution.
2. Characteristics of evolution, Extinction, replacement, irreversibility of specialization, etc.

3. Adaptive diversity and nature of adaptation; Adaptive radiations and recent views, occupation of new environment and niche, mimicry and coloration.

Unit IV

1. Introduction to animal behavior, definition, concept of ethology, scope and limitations. Orientation, classification of various types of taxis and kinesis.
2. Social behavior in primates (a) Primate societies (b) Social sounds, olfactory, tactile, visual, vocal and acoustic (c) Status: Dominance and hierarchy, territorial behavior, courtship and mating, aggregation

Unit V

1. Reproductive behavior in fish (Stickle back or any other fish).
2. Behavior in insects: courtship behavior in Drosophila, Social behavior, Communications, Concealment behavior, Pheromones in behavior.
3. Human behavior: Learning, Habituation, conditioned reflex: Trial and error; Latent learning, learning and discrimination, imprinting, neural mechanism of learning, Molecular mechanism of memory, Altruism.
4. Instinctive behavior: concept, Phyletic decent, and physiology
5. Methods of studying behavior: Brain lesions, electrical stimulation, drug administration.

Reference Books:

1. Varma and Agrawal - Genetics and Evolution
2. Dobzhansky, Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press.
3. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
4. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
5. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
6. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
7. Varma and Agrawal – Evolution
8. Animal behavior and Evolutionary Approach by Alcock
9. Perspectives in animal behavior Goodenough, Wiley 1993
10. An introduction to animal behavior 5thed. Cambridge Univ Press. By Manning

Paper No. ZOO/DSC/651 - GENERAL AND COMPARATIVE PHYSIOLOGY

Contact Hours: 45 Credits- 3

Learning Objectives:

- To study the physiological processes in detail for medical, non-medical and veterinary science purposes.
- To gain knowledge about various biological systems.

Learning Outcomes:

By the end of the course students will be able to:

- Explain various biological systems and their regulation in detail.
- Describe the origin of biomolecules and their metabolism.

Unit I: Energy sources and their Distribution:

1. Anaerobic stages in Terrestrial evolution, Origin of aerobic world (Photosynthesis) and animal and its environment.
2. Regulatory mechanisms: Factors at enzyme activity, at organ system level, Autonomic nervous system, endocrine system, coordinated regulations
3. Nutrition: Nutritive requirement, collection of food, Digestion, Absorption, Correlation of digestive activities, energy balance, BMR.

Unit II: Exchange of gases, cardiovascular system and excretory system

1. Integumentary, Bronchial respiration, Aquatic to aerial breathing (Lungs, Trachea and Respiratory mechanisms).
2. Transporting of oxygen, Co_2, Regulation of fluid volume, Phagocytosis, the reticulo-endothelial system, coagulation of blood, energy-producing reactions and energy utilizing reactions, Comparative physiology of excretion, kidney, nitrogenous waste in mammals, and in animals, formation of urine, urine concentration, waste elimination, regulation of water balance, electrolyte balance and acid base balance.
3. Competitive anatomy of heart structure, myogenic heart, specialized tissue, neural and chemical regulation of all above.

Unit III: Environmental reactions:

1. Temperature and rates of biological activities, Temperature compensation in poikilotherms and homeotherms.
2. Water and electrolyte problems of terrestrial living, Regulatory mechanisms, Oxygen as limiting factor in the environment, effect of environment on oxygen demand, effect of hydrostatic pressure, buoyancy and biological clocks.
3. Comfort zone, Body temperature – Physical, chemical, neural, acclimatization and Acclimation.

Unit IV: Various interactions and Animal activities:

1. Molecular basis of cellular irritability and pain, Chemoreception, Mechanoreception, Temperature receptors, Mechanism producing movement, amoeboid movement, electric organ, Luminescent organs, Pigment cells, Interneural transmission, Integrative systems of neurons, Physiology of behavior.
2. Neurons, Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscles, bone and posture.

Unit V: Reproduction and Development:

Reproductive mechanisms, Invertebrate hormones of reproduction, Vertebrate control, regeneration, metamorphosis, Stolonization andepitoky in polychaete worms, Arthropod growth and metamorphosis, Growth, molting and metamorphosis in the vertebrates.

Reference Books:

1. Comparative Animal Physiology by Prosser C.L.
2. General and Comparative Physiology by Floren W.A.
3. General and Comparative Physiology by Hoar W. B.
4. Animal Physiology by Neilsen K.S.
5. Principles of Animal Physiology by Wilson J.A.
6. Animal Physiology by Gordon G.L.
7. Modern Physiology by Strang F.L.
8. Animal Physiology by Mohan and Arora

Paper No. ZOO/DSC/652 – APPLIED BIOTECHNOLOGY -II

Contact Hours: 45 Credits- 3

Learning Objectives:

- To create interest in Biotechnology.
- To familiarize the students with different diagnostic techniques with applications.
- To develop critical thinking about immerging techniques of biology, including nano-biotechnology and marine biotechnology.

Learning Outcomes:

By the end of the course students will be able to:

- Explain biofuels, biotransformation of reclaimant metabolites and green technologies.
- Describe principles and applications of DNA finger printing, Human genome project etc.
- Understand stem cells, policies, storage and applications.

Unit I: Biotechnology in environment: Generation of plant origin alternative fuels

1.First-generation biofuels: Bio-alcohol (Corn, Sugarcane), Syngas, Biodiesel, Biogas; Second-generation biofuels: Cellulose biofuels, biohydrogen, bioethanol; Third-generation biofuels: Algae fuel.

2.Biotransformation of reclaimant Metabolite (with examples), the ecological impact of microbes, green technology; Definition, concept and implication, the role of green technologies towards sustainable development.

Unit II: Biotechnology in Human Welfare

Application to forensic science: Principle of DNA fingerprinting, application of DNA profiling in forensic medicine for solving crimes and paternity disputes. Genetically modified crops and food; Health concerns, Human genome project: Its implication in health and diseases. GUaRDIAN; Genomics for precision medicine in India.

NGS Strategies for Family based Genetic analysis –Family based Genome Wide Association Studies (GWAS), advantages and disadvantages. Target specific sequencing- Panel gene sequencing; Whole Exome Sequencing (WES), Whole Genome Sequencing; Linkage analyses in Era of NGS.

Unit III: Bioinformatics Pipelines for Variants:

General variants calling workflow using WS and WGS data, Specialized Pipelines for family Based Variants analysis: Genetic resources for variant analysis, classification of Genetic variants. Cloud based bioinformatics services for Analysis of Genomic Data , Selecting an NGS and Bioinformatics Strategies; Common sequencing errors a with NGS Analysis, Analytical, Ethical and regulating challenges in analysis of NGS.

Unit IV: Systems, synthetic biology and stem cell technology in biotechnology.
Introduction to system biology; principles of system biology, modeling in systems biology, applications of system biology in biotechnology, Introduction to synthetic biology, principle and applications and scope of synthetic biology for the production of bioactive metabolite.
Introduction, what is a stem cell, types, Therapeutic applications of stem cells in human degenerative diseases (Examples). Stem cell policies and ethics, cord blood banking, and long-term storage of stem cells.

Unit V: Pharmaceutical biotechnology
Introduction, Use of Microbes in pharmaceutical industries, Microbial Drug Discovery, Screening at molecular level, Construction and design strategies. Rational drug discovery, Preclinical and clinical trials, Estimation of toxicity; LD 50 and ED 50.

References:

1. Satyanarayana,U (2010): Biotechnology , Books and Allied (P) ltd, Kolkata
2. Rastogi, Sc (2009): Biotechnology, Principle and Applications, Narosa Publishing House, Mumbai.
3. Patnaik, B.K, Kara, TC, Gosh, SN, Dalai, AK (2012) Text book of Biotechnology. Tata McGraw Hill Education Private Limited.
4. Chanarayappa (2006): Molecular Biotechnology, Principles and Practices, University Press Pvt limited. Hyderabad
5. Frontier in Genetics –Reviews

Elective Courses

Paper No. ZOO/DSE/656 - APPLIED PARASITOLOGY -II

Contact Hours: 45 Credits- 3

Learning Objectives:

- To know basic and general concepts of parasitology.
- To understand major types of parasites of medical and veterinary importance.
- To design and evaluate an intervention to control food and waterborne diseases.
- To prepare the experts in the field of medical and veterinary parasitology.

Learning Outcomes:

By the end of the course students will be able to:

- Explain parasite and its relation to global public health.
- Describe about parasites, host and their relationship.
- Have knowledge about various types of parasites and their life cycles.

Unit I: Parasites and Health

Parasite and Global Public Health, Global burden of infectious diseases, Biology, epidemiology and control of waterborne and foodborne parasites, Ecological changes and emerging diseases. General pattern of parasitic transmission,Parasitic zoonosis, Bioterrorism threats.

Unit II: Clinical and pathological signs of parasite infection.

1. Parasitic diseases of:
   a) Alimentary canal: GI tract, liver, abdominal cavity, protozoal entities, coccidiosis, Trematode infection, strongyloidiasis, Tricho-strongyloidiasis, Oxyurid infection.
   b) Urinary system: *Klossiella equi*, *Dioctophymerenale*.
2. Nervous system: Coenurosis, *Parastrongylus cantonensis*, *Stephanurus dentatus*.
3. In human: Giardiasis, Toxoplasmosis, Leishmaniasis, Trypanosomiasis, Malaria, Taeniasis, Echinococcosis, Fascioliasis, Trichuriasis, Hook worm diseases, Tick mites.

Unit III: Strategies in the fight against parasites

1.Approaches to control of parasitic diseases: Analysis of biological systems, Targets for intervention, Approaches, measures against parasitic diseases, water supplies, excreta disposals, Agricultural hygiene, personal hygiene, housing environmental management, control of vectors and intermediate hosts, trichinosis, treatment, immunization.

2.Strategies-planning and control: Malaria, Human Schistosomiasis, Guinea worm disease.