DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

NAAC- 'A $^{+}$' Grade

CIRCULAR NO.SS/M.Sc.Zoology./Deptt./NEP/17/2025

It is hereby inform to all concerned that, the syllabus prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, ***Academic Council at its meeting held on 21st July 2025 has been accepted the Revised Syllabus of M. Sc. Zoology First and Second Year (Ist to IVth Semester) under the Faculty of Science & Technology as per National Education Policy-2020*** run at the University Department, Dr. Babasaheb Ambedkar Marathwada University as appended herewith.

This is effective from the Academic Year 2025-26 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SS/M.SC.ZOO/DEPTT./
2025/ 1429-35
Date:- 31/ 07/ 2025.

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Deputy Registrar,
Academic Section

Copy forwarded and necessary action to :-

1] **The Head, Department of Zoology**
2] The Deputy Registrar, Post Graduate Section,
3] The Director, Board of Examinations & Evaluation,
Dr.Babasaheb Ambedkar Marathwada University,
Chhatrapati Sambhajinagar.
4] The Director, University Network & Information Centre, UNIC,
with a request to upload this Circular on University Website.

Copy to :-

1] PA to the Hon'ble Vice Chancellor, Office
2] PA to the Pro. Vice-Chancellor, Office
3] PA to the Registrar, Office
Dr. Babasaheb Ambedkar Marathwada University,
Chhatrapati Sambhajinagar.

JD*31072025/-

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHTRAPATI SAMBHAJINAGAR MAHARASHTRA, INDIA -431004

FACULTY OF SCIENCE AND TECHNOLOGY

2 YEARS P.G. PROGRAMME

COURSE STRUCTURE AND CURRICULUM

As Per National Education Policy 2020

Revised M. Sc. ZOOLOGY

Ist to IVth Semester

FOR UNIVERSITY DEPARTMENT

Department of Zoology (Autonomous)

Dr. Babasaheb Ambedkar Marathwada University,

Chhatrapati Sambhajinagar-431004

(Effective from 2025-26)

Dean 14/7/2025

Faculty of Science & Technology

Head of the Department

Dept. of Zoology

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	**SAD415001T**	Biosystematics and animal diversity	3	-	3	-	14
	SAD415011T	Biochemistry	3	-	3		
	SAD415021T	Ecology (Principles and Practices)	3		3		
	SAD415001P	Practical based on SAD415001T		2	-	1	
	SAD415011P	Practical based on SAD415011T	-	2	-	1	
	SAD415021P	Practical based on SAD415021T	-	2	-	1	
	SAD415031P	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**SBD415041T**	Helminthology - I	3	-	3	-	04
	SBD415051T	Protozoology – I	3	-	3	-	
	SBD415061T	Entomology – I	3	-	3	-	
	SBD415071T	Endocrinology – I	3	-	3	-	
	DSE 531	Marine Biology -I	3	-	3	-	
	SBD415041P	Practical based on SBD415041T	-	2	-	1	
	SBD415051P	Practical based on SBD415051T	-	2	-	1	
	SBD415061P	Practical based on SBD415061T	-	2	-	1	
	SBD415071P	Practical based on SBD415071T	-	2	-	1	
	DSE 536	Practical based on DSE 531	-	2	-	1	
RM	**SRD415081T**	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	**SAD415502T**	Genetics and Bioinformatics	3	-	3	-	14
	SAD415512T	Cell and Molecular Biology	3	-	3	-	
	SAD415522T	Biophysics	3	-	3	-	
	SAD415502P	Practical based on SAD415502T	-	2	-	1	
	SAD415512P	Practical based on SAD415512T	-	2	-	1	
	SAD415522P	Practical based on SAD415522T	-	2	-	1	
	SAD415532P	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**SBD415542T**	Helminthology - II	3	-	3		04
	SBD415552T	Protozoology – II	3	-	3		
	SBD415562T	Entomology – II	3	-	3	-	
	SBD415572T	Endocrinology – II	3	-	3	-	
	DSE 581	Marine Biology -II	3	-	3	-	
	SBD415542P	Practical based on **SBD415542T**	-	2	-	1	
	SBD415552P	Practical based on **SBD415552T**	-	2	-	1	
	SBD415562P	Practical based on **SBD415562T**	-	2	-	1	
	SBD415572P	Practical based on **SBD415572T**	-	2	-	1	
	DSE 586	Practical based on **DSE/581**	-	2	-	1	
RM	**SLD415582P/ SMD415592P**	OJT/FP	-	8	-	4	04
			12	**20**	**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	**SAD416003T**	Developmental biology	3	-	3	-	14
	SAD416013T	Immunobiology	3	-	3	-	
	SAD416023T	Applied Biotechnology -I	3	-	3	-	
	SAD416003P	Practical based on SAD416003T	-	2	-	1	
	SAD416013P	Practical based on SAD416013T	-	2	-	1	
	SAD416023P	Practical based on SAD416023T	-	2	-	1	
	SAD416033P	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**SBD416043T**	Applied Parasitology - I	3	-	3	-	04
	SBD416053T	Animal Physiology– I	3	-	3		
	SBD416063T	Molecular Biology -I	3	-	3		
	SBD416073T	Fishery Science-I	3	-	3		
	SBD416043P	Practical based on SBD416043T	-	2	-	1	
	SBD416053P	Practical based on SBD416053T	-	2	-	1	
	SBD416063P	Practical based on SBD416063T	-	2	-	1	
	SBD416073P	Practical based on SBD416073T	-	2	-	1	
RM	**SRD416073P**	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: IVth 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	**SAD416504T**	Evolution And Behavior	3	-	3	-	12
	SAD416514T	General and Comparative Physiology	3	-	3		
	SAD416524T	Applied Biotechnology II	3		3		
	SAD416504P	Practical based on SAD416504T		2	-	1	
	SAD416514P	Practical based on SAD416514T	-	2	-	1	
	SAD416524P	Practical based on SAD416524T	-	2	-	1	
DSE (Choose any one from pool)	**SBD416534T**	Applied Parasitology- II	3	-	3	-	04
	SBD416544T	Animal physiology – II	3	-	3		
	SBD416554T	Molecular biology – II	3	-	3		
	SBD416564T	Fishery Science – II	3	-	3		
	SBD416534P	Practical based on SBD416534T	-	2	-	1	
	SBD416544P	Practical based on SBD416544T	-	2	-	1	
	SBD416554P	Practical based on SBD416554T	-	2	-	1	
	SBD416564P	Practical based on SBD416564T	-	2	-	1	
RM	**SRD416574P**	Research Project	-	6	-	6	06
			12	**14**	**12**	**10**	**Total credits 22**

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	**SAD415001T**	Biosystematics and animal diversity	3	-	3	-	14
	SAD415011T	Biochemistry	3	-	3		
	SAD415021T	Ecology (Principles and Practices)	3		3		
	SAD415001P	Practical based on SAD415001T		2	-	1	
	SAD415011P	Practical based on SAD415011T	-	2	-	1	
	SAD415021P	Practical based on SAD415021T	-	2	-	1	
	SAD415031P	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**SBD415041T**	Helminthology - I	3	-	3	-	04
	SBD415051T	Protozoology – I	3	-	3	-	
	SBD415061T	Entomology – I	3	-	3	-	
	SBD415071T	Endocrinology – I	3	-	3	-	
	DSE 531	Marine Biology -I	3	-	3	-	
	SBD415041P	Practical based on SBD415041T	-	2	-	1	
	SBD415051P	Practical based on SBD415051T	-	2	-	1	
	SBD415061P	Practical based on SBD415061T	-	2	-	1	
	SBD415071P	Practical based on SBD415071T	-	2	-	1	
	DSE 536	Practical based on DSE 531	-	2	-	1	
RM	**SRD415081T**	Research Methodology I	4	-	4	-	04
			16	**12**	**16**	**06**	**Total credits 22**

Paper No. SAD41500 1T BIOSYSTEMATICS AND ANIMAL DIVERSITY

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 anholistic 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.

Unit I Biosystematics **15 Hrs**

1. Hierarchy of categories and higher taxa.
2. Taxonomic Procedures-collection, preservation, curetting and process of identification.
3. Three Domain Concept in Systematics, two, five and six kingdom classification.
4. Zoological types, process of typification, Taxonomic Keys, use of keys, merits and demerits.
5. International Code of Zoological Nomenclature (ICZN), Rules and formation of Scientific names of different taxa. Homonymy and Synonymy.
6. **Species concepts** –
   6.1. Nominalistic Species concept,
   6.2. Morphological species concept,
   6.3. Biological species concept,
   6.4. Evolutionary species concept,
7. Cladistics

Unit II Protostomes **15 Hrs**

1. Classification and relationship of various phyla
2. Acoelomate and Coelomate, Protostomes and Deuterostomes, Bilateria, and Radiata;
3. Status of Protista, Parazoa, Onychophora, and Hemichordata;
4. Evolutionary advantages. Symmetry, Coelom and Metamerism
5. **Protozoa:** General classification, General features and life history of *Plasmodium.*
6. **Porifera:** Skeleton, canal system, and reproduction.
7. **Cnidaria:** Polymorphism, defensive structures and their mechanism;
   7.1. Coral reefs and their formation;

7.2. General features and life history of *Obelia* and metagenesis.

8. **Platyhelminthes:** Parasitic adaptation; general features and life history of *Fasciola* and *Taenia* and their pathogenic symptoms.
9. **Nemathelminthes:** General features, life history of *Ascaris*.

Higher Protostomes

10. **Annelida:** Coelom and metamerism; General characters and Reproduction in Earthworm.
11. **Arthropoda:** Crustacean parasites, vision and respiration in arthropods (Prawn, cockroach, and scorpion);
12. Reasons for the success of Arthropods.
13. **Mollusca:** Feeding, respiration, locomotion, general features and life history of *Pila*; Torsion, and detorsion in gastropods.

Unit III Deuterostomes **15 Hrs**

1. **Echinodermata:** Feeding, respiration, locomotion, larval forms, general features, and life history of *Asterias*.
2. **Protochordata:** General features and life history of *Branchiostoma* and *Herdmania.*
3. Genearal classification of Agnatha and Gnathostomes
4. Gnathostomatoa : Placoderms, Acanthodians,
5. **Pisces:** Chondricthes and Osteocthes
   5.1. Respiration, locomotion, and migration.
   5.2. Structural and Functional adaptations of fishes
6. **Amphibia:**General classification, Diversity, distribution and threats , Neoteny and paedomorphosis.
7. **Reptilia:** Skull of reptiles and its importance in biosystematics, the status of *Sphenodon* and crocodiles.
8. **Aves:** Orders under class Aves. General Classification, flight adaptation, migration.
9. **Mammalia:** General classification, general features of egg-laying mammals, pouched-mammals, aquatic mammals and primates.

REFERENCES

- Alfred J.R.BandRamakrishna.2004.Collection, Preservation and Identification of Animals. Zoological
- Survey of India Publications, Calcutta. Anderson,T.A.2001.Invertebrate Zoology(2nd edn). Oxford University Press, New Delhi.
- Barnes, R.D.1982.Invertebrate Zoology(6thedn). Toppaninternational Co.,NY Barrington, E.J.W.1969.Invertebrate Structure and Functions.EnglishLanguageBookSociety. Benton,
- M.J.2005, Vertebrate Paleontology (3rd edn). Blackwell Publishing Com.Oxford, UK. Campbell,N.AandJ.B.Reece 2009. Biology(8thedn). Benjamin CummingsPubl.NY,USA

- David,M.H,Craig Moritz and K.M.Barbara. 1996. Molecular Systematics.Sinauer Associates, Inc.
- Hyman,L.H.1940-1967.The Invertebrates(6vols).McGraw-Hill CompaniesInc.NY Hickman Jr., Cleveland, Larry Roberts, Susan Keen, Allan Larson, and David Eisenhour.2011.
- Animal Diversity. McGraw-Hill Companies, Inc. NY Kapoor, V.C.1991.Theory and Practice of Animal Taxonomy Oxford and IBH PublishingCo..Pvt. Ltd. New Delhi.
- Margulis LynnandM.J.Chapman2001. Kingdoms and Domains: An IllustratedGuidetothe Phyla of Life on Earth(4th edn.).W.H.Freeman&Company, USA Mayr.E. 1969.Principles of Systematic Zoology.McGraw HillBookCompany, Inc., NY. Mayr,E. 1997.This is Biology: The Science of Living world. Universities PressLtd.
- Narendran, T.C. 2008. An introduction to Taxonomy. Zoological survey of India.
- Niles E.2000. Life on earth:an Encyclopedia of Biodiversity. Ecology and Evolution(Vol.1&I).ABC CLIO,Inc.CA,USA Pat, W.1996.Invertebrate Relationships-PatternsinAnimal Evolution.Cambridge University Press
- Pechenik,J.A.2000.Biology of the Invertebrate (4th edn).McGraw-Hill Companies, Inc. NY, USA. Pough Harvey F. Christine M Janis and John B. Heiser 2002. Vertebrate Life(6th edn). PearsonEducation Inc. New Delhi. Romer, A.S. and T.S. Parsons. 1985. The Vertebrate Body. (6th edn.) Saunders, Philadelphia.
- RupertE.Edward.,R.S.FoxandR.D.Barnes.2006 Invertebrate Zoology: Functional Evolutionary Approach Thomson/Cole, Singapore Strickberger, M.W. 2005. Evolution. Jones and Bartett Publishers. London.
- Waterman,A.J.1971.Chordate Structure and Function.MacmillanCo.London
- Winston, J.E.2000. Describing species: Practical Taxonomic Procedures for Biologists. Columbia University Press,Columbia, USA. Young, J.Z. 1950. Life of Vertebrates. Clarendon Press, Oxford, UK.

Paper No. SAD41501 1T - 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 students will learn the bimolecular interactions

Unit I Introduction **15hrs.**

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

Carbohydrates

2. **Introduction to Carbohydrates** - Monosaccharide, and Disaccharides: sugars of biological importance.
3. **Structural representations of sugars-**Acetal and hemiacetal, ketal and hemi-ketal linkages
4. **Isomerism–**structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars.
5. **Polysaccharides:** Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratin sulphate, Dermatan sulphate. Glycoproteins and Mucoproteins.
6. **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).
7. **Glycogen metabolism-**Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca+2Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis.
8. **Minor metabolic pathways of carbohydrates:** Pentose Phosphate pathway, Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria.

Unit II **15hrs.**

Proteins

1. Structure, classification and Properties of amino acids. 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.
3. **Amino acid Metabolism**-Deamination, Transamination and Trans-deamination.Formation and disposal of ammonia, Urea cycle.Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenicand ketogenic with examples.

Lipids

Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification.

4. **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.
5. **Betaoxidation.** Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies-Ketogenesis, Ketolysis, Ketosis.

Unit III **15hrs.**

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

Enzymes

4. **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.
5. **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.
6. **Enzyme regulation:** Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering**.**

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.AandV.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*.Horwood Publ.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. SAD41502 1T - 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

Unit I: Principles of Ecology and Dynamics of Ecosystem 15 hours

1. **Components of the physical environment:** climatic **(**light, temperature, humidity, precipitation), edaphic and topographic factors
2. **Biotic environment:** producers, consumers, decomposers, and their interactions
3. Concept of habitat and niche; Types of niche (Fundamental and realized niche), niche width and overlap, resource partitioning, character displacement.
4. **Energy flow:** Laws of thermodynamics, ecological efficiencies, Concept of homeostasis, Cybernetic nature of ecosystems; Gaia hypothesis, Primary productivity and biomass measurement
5. **Biogeochemical cycles:** carbon, nitrogen, phosphorus
6. **Ecosystem monitoring**: GIS, Physics of remote sensing, role of remote sensing in ecology, GPS and its application; EIA- tools and techniques.
7. **Ecological Modelling:** Predator-prey models, Epidemiological models, Harvest models, Foraging models.

Unit II: Population, Resources and Conservation Ecology 15 hours

1. **Population characteristics:** Natality, Mortality, Density, aggregation isolation, dispersal and territoriality
2. **Population dynamics:** Population fluctuations and explanatory models (Beverton-Holt, Ricker) density dependent and density independent controls, Allee's principle, Life history strategies, Survivorship growth curve, r & k selection.
3. **Population interactions:** Host-parasite interaction, Ecological and evolutionary effects of competition.
4. **Resource ecology:** Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development.
5. **Biogeography and Conservation:** Major terrestrial Biomes, theory of island biogeography, bio-geographical zones of India; Hotspots in India: Western Ghats, Indo-Burma, Himalaya.
6. **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.

Unit III: Applied Ecology **15 hours**

1. **Environmental Pollution and Mitigation:** Types and sources of pollution: air, water, soil, radioactive, e-waste; International environmental protocols and agreements (Kyoto and Montreal). External Exposure Assessment (Concentrations in water Air, soil and sediments), Internal Exposure Assessment (Bioconcentration Bioaccumulation and Bio magnification)
2. **Waste management:** Concept of waste, types and sources of solid wastes, solid waste management-aerobic and anaerobic systems; Liquid wastes and sewage treatment.
3. **Environmental Biotechnology Approaches:** Bioremediation-need and scope and mechanism; Phytoremediation, bio-augmentation, biofilms, biofilters, bio-scrubbers and trickling filters.
4. **Radioecology and Radiation biology:** Natural and anthropogenic sources of radioactive pollution; Radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters (two case studies- Chernobyl, Fukushima), Disposal strategies of radioactive wastes. Low-Frequency Electromagnetic Fields (LF-EMF) and ecological impact.
5. **Application of genetics for conservation:** Loss of genetic diversity, Resolving taxonomic uncertainties, e-DNA Application and Wildlife crime case studies.

References:

1. Begon, M., Howarth, R. W., & Townsend, C. R. (2021). *Ecology: From individuals to ecosystems* (5th ed.). Wiley-Blackwell.
2. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Brooks Cole.
3. Krebs, C. J. (2016). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). Pearson.
4. Molles, M. C., & Sher, A. A. (2018). *Ecology: Concepts and applications* (8th ed.). McGraw-Hill Education.
5. Smith, T. M., & Smith, R. L. (2020). *Elements of ecology* (9th ed.). Pearson.
6. Primack, R. B., & Sher, A. A. (2016). *Introduction to conservation biology* (2nd ed.). Sinauer Associates.
7. Singh, J. S., Singh, S. P., & Gupta, S. R. (2023). *Ecology, environment and resource conservation* (2nd ed.). Anamaya Publishers.
8. Sharma, P. D. (2022). *Ecology and environment* (13th ed.). Rastogi Publications.

Practical Paper No. SAD41500 1P (Practical based on SAD41500 1T)
Biosystematics and Animal Diversity

1. Museum specimen study of different groups of Invertebrates and Vertebrates.
2. Terrestrial ecosystem (Vegetation studies)- Abundance, Frequency. Density, Relative Diversity, Dominance, Raunkars biological spectrum, Index of Dominance etc.
3. Method of plankton collection, plankton identification and quantification from river or stream or lake water.
4. Methods of collection, preservation and identification of zooplankton.
5. Composition assessment of taxonomical diversity or biodiversity in habitat from local Grassland, Terrestrial and Wetland.
    a. Species diversity indices. Simpson index, Shannon index, Margalef's richness index etc.,
    b. Relative density. Relative frequency and relative abundance of species.
6. Methods of collection, preservation and identification with keys from different groups of organisms like, Parasites, hosts, insects, birds and fishes etc.
7. Construction of taxonomic Key identification up to genus/species level for different animals.
8. Visit to any biodiversity center /spots and submission of report Practical Paper.

Practical Paper No.SAD41501 1P (Practical based on SAD41501 1T)
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. SAD41502 1P (Practical based on SAD41502 1T)
Ecology (Principles and Practices)

1. Study of ecosystem biodiversity of the local area.
2. Study of the efficiency of a sampling method
3. Measurement of Species Diversity in Ecological Communities: Alpha Diversity (Simpson's Index, Shannon-Wiener Index, Fisher's Alpha, Evenness), Beta Diversity (Sorensen's Similarity Index, Whittaker's Index), Gamma Diversity (Total Species Richness) and Identification of Functional Guilds
4. Biomass analysis in a given ecosystem.
5. Study of GPS and Identification of spots in an ecosystem.
6. Estimation of Dissolved oxygen by Winkler's method.
7. Estimation of hardness of water sample. (Calcium and Magnesium hardness)
8. Estimation of Chloride content and Salinity /Nitrates and phosphates from a given water sample.
9. Estimation of primary productivity in a given ecosystem.
10. Estimation of various physical parameters of water (Turbidity, TDS and TSS.)
11. Study of air quality and aerobiology in a given area.
12. Measuring ecotoxicity using a lettuce seed assay.
13. Identification of Vegetation, and crops based on remote sensing.
14. Case study-Heavy metal toxicity.
15. Visit any biodiversity center/National Park/Sanctuary and submission of a report.

Practical Paper No. SAD41503 1P Practical Skill/advanced technique

Laboratory Safety, Hygiene and Chemical Records.

1. Understanding MSDS (Material Safety Data Sheets)
2. Good Laboratory Record Practices (GLRP): Notebook, Data, and Sample Tracking"
3. Safety regulations: First aids for minor lab accidents
4. Fire safety procedures and use of extinguishers
5. Chemical laboratory records.
6. Safe handling and disposal of biological and chemical waste
7. Function of components of chemical laboratory.
8. Laboratory equipment: Parts, working principle, calibration, use, cleaning and maintenance. (Autoclave, Laminar Air flow, Incubator, pH meter, Centrifuge)
9. Quality control of laboratory findings.

Measurement and Calibration

10. Units of measurement. Preparation of reagent solutions and laboratory calculations. (Percent solution, Normality, Molarity)
11. Preparation of acid-base buffer.

Sterilization and Disinfection

12. Cleaning procedures (detergents, acid wash, rinsing, drying)
13. Demonstration of Sterilization Techniques: Moist Heat, Dry Heat, Flame, Surface Disinfection, and Filtration for Microbial Control.

Microscopic techniques.

14. Identification, labelling parts and understanding functions of stereomicroscope and compound microscope.
15. Use of phase contrast microscope to observe unstained live specimens.
16. Measurement of cell size using ocular and stage micrometer and capture image of biological specimen using eyepiece camera.
17. Demonstrate and use of Camera Lucida to trace and measure microscopic structure

Microtomy

18. Tissue Processing for preparation of Histological slides.
19. Microtome Sectioning of tissue.
20. Staining and Microscopic Observation of Tissue.

Microbiological techniques

21. Preparation of basic liquid media (broth) and solid media (Agar) for the cultivation of bacteria and fungi.
22. Isolation of microorganisms by serial dilution pour plate method, Spread plate technique and streak plate method.
23. Determination of growth curve of bacteria.
24. Staining: Gram staining and Spore staining of Bacteria; Methylene blue staining for yeast.
25. Biochemical analysis of microorganisms (IMViC, Starch test for amylase producing microorganism and Gelatin test for protease producing microorganisms)
26. Biochemical characterization of selected microbes.
27. Bacterial motility by Hanging drop method.
28. Microbiological analysis of food sample.
29. Isolation of microflora from human skin.
30. Microbiological analysis of Urine specimen.
31. Microbiological analysis of Blood sample.
32. Standard qualitative analysis of water

    Part A: Presumptive Test: Determination of Most Preferable Number of Coliform Bacteria.

    Part B: Confirmed Test

    Part C: Completed Test
33. Antibiotic potency test by Disc diffusion and Plate diffusion method (MIC)
34. Isolation of phages from sewage and quantification by plaque assay.

Paper No. SBD41504 1T - HELMINTHOLOGY I

Contact Hours: 45 **credits- 3**

Learning Objectives:

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

Learning Outcome:

- The students will learn about Helminthes, Cestodes, and Trematodes.
- The students will be able to identify Parasites and can develop expertise.

Unit – I **15 hrs**

1. Introduction, history and scope of Helminthology.
2. General organization and classification of helminthes up to order level.
   i) Trematodes (Monogeans, Aspidobothria and Digenea)
   ii) Cestode (cestodarians & eucestodes)
3. Functional anatomy of Reproductive system
   i) Trematodes (Digeneans)
   ii) Cestode (Pseudophyllideans & Cyclophyllideans).
4. Egg shell formation, chemistry of egg shell formation, factor influencing embryonation & hatching.
5. Holdfast organs with their adaptation in Cestode.

Unit- II **15 hrs**

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 cestode and their pathogenicity.
4. Variations in the Life cycle patterns of Digenetic Trematodes
   i) Single intermediate host life cycle.
   ii) Two intermediate host life cycle.
5. Life cycle patterns in Cestodes.
   i) No intermediate host life cycle
   ii) Single intermediate host life cycle
   iii) Two intermediate host life cycle.
6. Physiology of Cestode
   i) Nutrition
   ii) Metabolism – Carbohydrate and Fat metabolism

Unit - III **15 hrs**

Geographical distribution, habitat, morphology. (Structure) life cycle, pathogenicity, Immune responses, diagnosis treatment & prevention of the following Flatworm (Trematodes and Cestode).

1) Trematodes:

a) Monogenea: *Polystoma integrrimum*

b) Aspidobothria: *Aspiodogastar conchicola*

c) Digenea: 1. *Pragonimus westermani*

2. *Fasciolopsis buski*

3. *Gastrodiccoides hominis*

2) Cestode: 1. *Amphilina*

2. *Diphyhidium canium*

3. *Diphyllobothrium latum*

4. *Echinococcous granulosus*

5. *Taenia saginata*

LIST OF BOOKS

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

REFERENCE BOOKS.

- The Invertebrates Vol.II - Hyman L. H.
- The Trematode - Dausese B
- Text book of medical Parasitology - Dey
- Text book of medical Parasitology - Sawitz
- Parasitology-Nobel and Nobel
- Structure of Nematode - Allen bird
- An introduction to Nematodology - Chitwood
- Organization and Biology of nematodes -Crool
- Physiology of nematodes - Lee

- Plant parasitic nematode - Parmonove
- Principal of Nematodology - Throne
- Plant Nematodology - Jenkins and Taylor
- General Parasitology - Cheng
- Clinical Parasitology - Craig Faust
- Applied Parasitology - Hiware, Jadhav and Mohekar
- Biochemistry of parasitism - Von Brand
- Physiology of nematode parasite - Smith
- Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
- Laboratory methods of work with plant and soil nematodes -Southey
- Soil and fresh water Nematodes - Goodey.
- Practical exercise in Parasitology-Halton, Behave, Marshall.
- Animal Nematodes from Indian Mammals-Nama, Shinde and Jadhav.
- Parasitology (Protozoology and Helminthology) -Chatterjee K. D. (1969)
- The Zoology of Tapeworm.- Wardle and Mcleod (1952)
- The advances in the Zoology of tapeworm from Wardle and Mcleod (1952)
- Systema Helminthum Vol. II Cestoda. - Satyu Yamaguti (1959)
- The Physiology of Cestodes. - J.D Smyth
- Vertebrate Nematodes - York and Mapelston
- Plant Parasitic Nematodes, bionomics & control - Christie
- Modern Parasitology - Cox
- Essential Parasitology-Schimdit
- Parasitism - Cameron
- Animal Parasitism - Read
- Parasitism and Symbiology - Read
- Physiology of nematode parasites - Bee
- Nematodes Parasites of domestic animal - Levine
- Structure of Nematodes -Allen Bird
- Medical Parasitology (Protozoology and Helminthological) - Chatterjeei K. D
- Laboratory Methods for work with plant and soil Nematodes.-Southey
- An Introduction to Parasitology - Chandler and Read.

Paper No. SBD41505 1T - PROTOZOOLOGY I

Contact Hours: 45 credits- 3

Course objective:

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

Learning Outcome:

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

Unit – I **15hrs**

1. Classification of Protozoa up to order level
2. Factors influencing Growth of Protozoa - Balanced growth, Non balanced growth
3. Ecology of free-living Protozoa - Marine Protozoa, Planktonic protozoa, Soil protozoa, Protozoan blooms

Unit - II **15hrs**

1. Nutrition in Protozoa
   a) Methods of feeding - Filter feeding, Raptorial feeding, Diffusion feeding
   b) Digestion
   c) Nutritional requirements
2. Metabolism in Protozoa
   1. Carbohydrate and Respiratory metabolism
   2. Nitrogen metabolism
   3. Lipid metabolism
   4. Excretion and ionic regulation –
      a) Functioning of contractile vacuoles.
      b) Metabolic pathways in parasitic protozoa
      c) Role of oxygen and bioenergetics
      d) Energy metabolism in kinetoplastid flagellates
      e) Aerotolerant and anaerobic protozoans
      f) Metabolic adaptations in malarial parasites

Unit - III **15hrs**

Heredity in Protozoa:

a) Bi-parental reproduction
b) Uni-parental reproduction
c) Non-Mendelian phenomena
d) 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

Paper No. SBD41506 1T – ENTOMOLOGY I

Contact Hours: 45 **Credits: 3**

Course Objective:

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

Learning Outcome:

- The students will learn in depth the morphology and structure of insects.
- The students will get knowledge about different physiological adaptations, physiological processes in different orders of insects.

Unit I: Insect morphology **15 hrs**

1. Introduction to Entomology, Insect morphology, segmentation and tagmosis
2. Head – Structure of definitive insect head; Structure and types of antennae; Structure and types of mouth parts
3. Thorax – Segmentation; Wings – Origin, Structure, venation, modifications; Leg – General structure, types of legs
4. Abdomen – Segmentation, Appendages

Unit II: Integument, Digestive system and respiratory system **15 hrs**

1. Integument, Cuticle – Structure, moulting, sclerotization
2. Digestive System – Structure of alimentary canal and associated digestive glands and physiology of digestion
3. Respiratory System – Respiratory Structures and mechanism of respiration in terrestrial and aquatic insects.

Unit III: Circulation, excretion and reproduction **15 hrs**

1. Circulatory System – Structure, Haemocoel, the dorsal vessel, accessory pulsatile organs, Haemolymph – chemical composition, Haemocytes – structure and types, mechanism of circulation.
2. Excretory System – Structure of Malpighian tubules, Physiology of excretion and osmoregulation.
3. Nervous System – Central nervous system, Physiology and neuro-biochemistry; Sense Organs & Effector organs
4. Reproductive system – Male and female reproductive system, fertilization and development
5. Endocrine system – Structure and mode of action of hormones in metamorphosis.
6. Ectohormones – Pheromones, Sex pheromones and defensive mechanism.

Reference Books:

1. The insect structure and function, 4th Edition 92008. Chapman R. F, Publisher – Cambridge University Press, London.

2. General Textbook of Entomology, 10th Edn., (1977) Imms A. D, Richard O. W. and Devis R. G (Eds.) 1: Chapman & Hall, London

3. General Entomology, 2nd edition (1973) Mani M. S, Oxford & IBH Publishing Company, Delhi.

4. Modern Entomology, 1st edition (1997) D. B. Tembhare, Himalaya 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 Insect: Structure, Function and Biodiversity (2004). Ambrose D. P, Publisher – Kalyani Publications, New Delhi.

3. Introduction to Insect Biology & Diversity. Daly H. V., J. T. Doyen & P. R. Ehrlich (1981): International Student Edn. McGraw Hill , Kogakusha, Japam.

4. Insects: Textbook of Entomology, Evans E. H. (1984): Addison – Wesley, London.

5. Insects Physiology, Henning W. (1981): Wiley – Inrerscince Publ., John Wiley & Sons, Chichester, England.

6. Journal and Internet resources.

Paper no. SBD41507 1T – ENDOCRINOLOGY - I

Contact Hours: 45 credits- 3

Course objectives:

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

Learning outcome

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

Unit-I Endocrine mechanisms in Annelida and mollusca 18 Hrs

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.
6. Neurosecretion in Lamellibranches.
7. Hormones and reproduction in Gastropods.
8. Hormones and reproduction in Cephalopoda.
9. Role of hormones in osmotic and ionic regulation in Gastropods.

Unit - II Endocrine Mechanisms in Insecta and Crustacea 18 Hrs

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
5. Neuroendocrine system in Crustacea.
6. Moult cycle and role of hormones in Moulting in crustaceans.
7. Sexual differentiation and role of hormones in gonadal activity in crustaceans.
8. Colour change and its hormonal control in crustaceans.

Unit – III Neuroendocrine Mechanisms in Echinodermata 9 Hrs

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:

- To learn about ocean ecosystem, sea weeds, marine plants, sea grasses and marine invertebrates and vertebrates.
- Information regarding marine reptiles and marine mammals will be studied

Learning Outcomes:

Student will be able to

- Describe the salient features and biological process of marine ecosystems.
- Explain the types and divisions of various marine habitats.

Unit 1: Introduction to Marine Ecosystems 15 hrs

1. **Ocean as a habitat:** Classification of marine environments: Pelagic (neritic, oceanic), Benthic (littoral, abyssal), Coastal (estuaries, reefs).
   Key abiotic factors affecting marine life: Light (euphotic vs. aphotic zones), Temperature (stratification, thermoclines), Salinity (haloclines, osmoregulation challenges), Pressure (depth adaptations),
   Patterns of distribution: Latitudinal gradients, vertical zonation.
2. **Habitat-Specific Adaptations**
   Pelagic Zone: Buoyancy, camouflage.
   Benthic Zone: Burrowing, chemosymbiosis.
   Deep-Sea: Hydrothermal vent fauna, gigantism.
   Intertidal Zone: Desiccation tolerance, wave resistance.
3. **Oceanographic studies in India**: Key research institutions and findings.

Unit 2: Marine Invertebrates

1. **Porifera, Cnidaria, Polychaetes:** General characters, classification, examples
2. **Minor Phyla:** General characters, morphology, unique adaptations, distribution - Nemertinea, Entoprocta, Ectoprocta, Phoronida, Pogonophora, Sipuncula, Brachiopoda, Chaetognatha
3. **Major Groups:** General characters, classification, examples -
   Crustacea: Comparative morphology (appendages), larval forms, evolution.
   Mollusca: Classification - Bivalves, gastropods, cephalopods.
   Echinodermata: Regeneration, larval forms.
   Economically important species across all taxa
4. **Marine Bioprospecting:** Biodeterioration & biofouling.

Unit 3: Marine Vertebrates & Conservation

1. **Prochordata:** Classification, morphology, Reproduction, larval development and metamorphosis.
2. **Pisces:** Cartilaginous vs. bony fishes: Adaptations, distribution**.**
3. **Reptiles:** Sea snakes, turtles – adaptive radiation.
4. **Birds:** Coastal/marine birds – General characters, adaptations, ecological

importance/roles.

5. **Mammals:** General characters, classification, adaptations; Cetaceans, sirenians – evolution, distribution, importance. Endangered species, impact of climate change, conservation strategies.

Reference

1. Castro, P., & Huber, M. E. (2022). *Marine biology* (12th ed.). McGraw-Hill Education.
2. Nybakken, J. W., & Bertness, M. D. (2004). *Marine biology: An ecological approach* (6th ed.). Pearson Education.
3. Levinton, J. S. (2020). *Marine biology: Function, biodiversity, ecology* (5th ed.). Oxford University Press.
4. Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2004). *Invertebrate zoology: A functional evolutionary approach* (7th ed.). Brooks/Cole.
5. Brusca, R. C., Moore, W., & Shuster, S. M. (2016). *Invertebrates* (3rd ed.). Sinauer Associates/Oxford University Press.
6. Barnes, R. S. K., Calow, P., Olive, P. J. W., Golding, D. W., & Spicer, J. I. (2009). *The invertebrates: A new synthesis* (3rd ed.). Cambridge University Press.
7. Pechenik, J. A. (2021). *Biology of the invertebrates* (8th ed.). McGraw-Hill Education.
8. Denny, M. W., & Gaines, S. D. (2007). *Encyclopedia of tidepools and rocky shores*. University of California Press.
9. Hoese, H. D., & Moore, R. H. (1998). *Fishes of the Gulf of Mexico: Texas, Louisiana, and adjacent waters* (2nd ed.). Texas A&M University Press.
10. Perrin, W. F., Würsig, B., & Thewissen, J. G. M. (Eds.). (2009). *Encyclopedia of marine mammals* (2nd ed.). Academic Press.
11. Karleskint, G., Turner, R., & Small, J. W. (2012). *Introduction to marine biology* (4th ed.). Cengage Learning.
12. Nair, N. B., & Thampy, D. M. (1989). *Marine biology in India: Contributions from Indian researchers*. National Institute of Oceanography.
13. Qasim, S. Z. (1999). *India's oceanographic research and the Indian Ocean expedition*. Indian National Science Academy.
14. Raghunathan, C., & Venkataraman, K. (2020). *Marine biodiversity of India: Taxonomy, ecology, and conservation*. Zoological Survey of India.
15. Ghosh, A. K. (2013). *Marine resources and conservation in India*. The Energy and Resources Institute (TERI).

Practical Paper No. SBD41504 1P (Practical based on SBD41504 1T)

Helminthology I

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

Practical Paper No. SBD41505 1P (Practical based on SBD41505 1T)

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. SBD41506 1P (Practical based on SBD41506 1T)

Entomology - I

1. Study, mounting of types of mouth parts, antennae, wings, legs and genitalia of various insects (2 in two insects).

2. Dissections of Digestive system / Reproductive system / Nervous system of insects

3. The Study and preparation of permanent slides of any five organs of at least 2 insects.

4. Estimation of enzyme activities of Amylase, Invertase, Lipase & Protease in the alimentary canal / midgut of cockroach.

5. Detection of uric acid as an end product of excretion in any terrestrial insect.

6. Study of types and Total count of haemocytes in haemolymph of any one insect.

7. Determination of role of insect hormones in the pupation of insect larvae by ligature technique.

8. Study of eggs, larva and pupae/nymph

Practical Paper No. SBD41507 1P (Practical based on SBD41507 1T)

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 phytoplankton and zooplankton.
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. SRD41508 1T - RESEARCH METHODOLOGY

Contact hours: 60 **Credit- 4**

Learning objectives:

- Impart skills to develop a research topic and design
- Define a purpose statement, a research question or hypothesis, and a research objective
- Analyze the data and arrive at a valid conclusion
- Compile and present research findings

Learning Outcome

- Explain the basic aspects of research and its ethics
- Outline research problems, their types and objectives
- Formulate good research designs and carry out statistically relevant sampling
- Collect, collate, analyze and interpret data systematically
- Experiment with animals ethically
- Make use of literature and other search engines judiciously for research purposes

Unit I: Introduction to Research and Scientific Method **05 hours**

Introduction to Research: Meaning, Objectives, Motivation, Scope and utility of research Basic concepts: Knowledge, Information and Data-Science, Pseudoscience. Concept of theory: empiricism, deductive and inductive theory. Characteristics of scientific method. Understanding the language of research, Types of Research (Descriptive /Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical)

Unit II: Problem Identification and Formulation **10 hours**

1. **Problem Identification and Formulation**: Definition of research problem, Necessity of Defining the Problem, Criteria for selecting a research problem ,Types, objectives, and components of a research problem, Steps to identify a research problem.
2. **Literature review:** Definition, Critical literature review, Identifying gap areas from literature review and Importance of literature reviewing in defining a problem, Definition and types of research hypotheses, Testing of research hypothesis.

Unit III: Research Design, Sampling, and Animal Handling **10 hours**

1. **Research Design**: Meaning and Need of research design, Features of a good research design
2. Types: Exploratory, Descriptive, and Experimental designs, Variables: Independent, Dependent, Controlled.
3. **Sampling Techniques**: Types of Sampling: Probability and Non-probability, Sampling Errors (Type I & II), Sample size determination, Observation methods and experimental setup
4. **Animal Handling (Ethical Research Practice)**: Guidelines: Institutional Animal Ethics Committee (IAEC), Use of animal models, Drug administration routes, Toxicity testing: LD_{50}, ED_{50}

Unit IV: Data Analysis, Research Tools, Reporting and Research ethics 15 hours

1. **Data Analysis and Interpretation**: Basics of statistical analysis and inference, Correlation, Regression, Multivariate techniques, Use of Figures and Graphs in data presentation
2. **Research Report Writing**

   Standard structure: Introduction, Review of Literature, Materials and Methods, Result, Discussion, Conclusion

   Other components: Title, Acknowledgement Abstract, Keywords, Table of contents, References, Appendices.

   Types of research reports and scientific articles: Thesis and dissertations, Research articles, Oral communications.

   Writing and interpreting research results
3. **Research Tools and Literature Use**: Information -Primary and secondary sources, Use of Research Guides, Handbooks, Academic databases for biological sciences (PubMed, Scopus, Web of Science, and Google Scholar), Effective search strategies for literature review
4. **Ethical Principles in Research**

   Informed Consent, Confidentiality, Non-maleficence, Beneficence

   Misconduct in Research: Plagiarism, Fabrication and falsification of data, Misuse of funds or authorship.

   Ethical Guidelines and Committees: Role of Institutional Ethics Committees (IEC) and Institutional Animal Ethics Committees (IAEC), National and international guidelines (e.g., CPCSEA, ICMR, Helsinki Declaration)

References:

1. Babbie, E. R. (2015). *The practice of social research* (14th ed.). Cengage Learning.
2. Creswell, J. W. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
3. Day, R. A., & Gastel, B. (2016). *How to write and publish a scientific paper* (8th ed.). Cambridge University Press.
4. Ghosh, B. N. (2003). *Scientific method and social research*. Sterling Publishers.
5. Indian Council of Medical Research. (2017). *National ethical guidelines for biomedical and health research involving human participants*. https://ethics.ncdirindia.org/
6. Kothari, C. R., & Garg, G. (2019). *Research methodology: Methods and techniques* (4th ed.). New Age International Publishers.
7. Ministry of Environment, Forest and Climate Change. (n.d.). *CPCSEA guidelines for laboratory animal facility*. Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA). https://cpcsea.nic.in
8. Publication Manual of the American Psychological Association (7th ed.). (2020). American Psychological Association.
9. Trochim, W. M. K., & Donnelly, J. P. (2007). *The research methods knowledge base* (3rd ed.). Atomic Dog Publishing.

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	SAD415502T	Genetics and Bioinformatics	3	-	3	-	14
	SAD415512T	Cell and Molecular Biology	3	-	3	-	
	SAD415522T	Biophysics	3	-	3	-	
	SAD415502P	Practical based on SAD415502T	-	2	-	1	
	SAD415512P	Practical based on SAD415512T	-	2	-	1	
	SAD415522P	Practical based on SAD415522T	-	2	-	1	
	SAD415532P	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	SBD415542T	Helminthology - II	3	-	3		04
	SBD415552T	Protozoology – II	3	-	3		
	SBD415562T	Entomology – II	3	-	3	-	
	SBD415572T	Endocrinology – II	3	-	3	-	
	DSE 581	Marine Biology -II	3	-	3	-	
	SBD415542P	Practical based on **SBD415542T**	-	2	-	1	
	SBD415552P	Practical based on **SBD415552T**	-	2	-	1	
	SBD415562P	Practical based on **SBD415562T**	-	2	-	1	
	SBD415572P	Practical based on **SBD415572T**	-	2	-	1	
	DSE 586	Practical based on **DSE/581**	-	2	-	1	
RM	SLD415582P/ SMD415592P	OJT/FP	-	8	-	4	04
			12	**20**	**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

Paper No. SAD 41550 2T – 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-I: Classical Genetics **15 hrs**

1. Definition, Terminology and Scope of Genetics – Mendel and his Contribution – Hybridization Techniques of Mendel. Mendelian Principles – Monohybrid and Dihybrid Crosses, Simple Mendelian Traits in Man, Extensions of Mendelian principles, Polygenetic Inheritance, Multiple Alleles – Blood Group Inheritance in human.
2. Interaction of Genes – Allelic and Non-Allelic Interaction – Complementary, Supplementary, Duplicate and Epistatic interaction.
3. Structure and Types of Chromosome. Sex Chromosomes, Sex Determination in Animals
4. Human and Honey Bee. Heterochromatization and Barr Bodies.
5. Genome size, and C-value paradox, Kinetics of renaturation, Cot and Cot curve repetitive sequences.

Unit II: Gene structure, Genetic linkages, Recombination and Chromosome Mapping **15 hrs**

1. Concept of Gene – Gene Expression Control in Prokaryotes, Eukaryotes, and Phages. The standard genetic code, redundancy and wobble. DNA structure - alternate forms of Double Helix, Gene Synthesis (in vitro synthesis).
2. Chromosomal theory of inheritance, Mechanism and Theories of Linkage and Crossing Over. Chromosomal and Gene Mapping Methods. Linkage Maps, Tetrad Analysis, Mapping with Molecular Markers and QTL Mapping. Recombination of genes in a chromosome, Stern's Experiments; molecular mechanisms of recombination (Holliday model), Gene conversion. Transposable elements in Bacteria, Transposable elements in Eukaryotes and significance of transposons.

Unit III – BIOINFORMATICS **15 hrs**

1. Scope & applications of bioinformatics
2. Biological databases: NCBI, GenBank, UniProt, PDB; Sequence file formats (FASTA, GenBank files); Sequence retrieval & database searches (Entrez, BLAST)
3. Sequence alignment: pairwise (global & local), multiple sequence alignment (ClustalW/MUSCLE)
4. Phylogenetic analysis basics (Neighbour Joining, UPGMA trees, PHYLIP); Gene prediction tools (ORF finder, GeneMark basics); Primer design principles
5. Brief introduction to molecular docking / structural bioinformatics
6. Significance of proteomics and drug design.

REFERENCES:

Genetics

1. Brooker, 1999. *Genetics: Analysis and Principles*. Addison-Wesley, NY.
2. David Allis and Thomas Jenuwein, 2007. *Epigenetics*. Cold Spring Harbor Laboratory Press. Hartl, D.L. 2000. *A Primer of Population Genetics*. Suinauer Associate, Inc, Massachusetts.
3. Gardner, J.E., Simmons, J.M. and D.P. Snustad. 2007. *Principles of Genetics* (8^{th} edn). John Wiley, India.
4. Gilbert, S.F. 2006. *Developmental Biology* (9th edn). Sinauer Associates, Inc., Publishers, Massachusetts.
5. Griffiths et al., 2002. *Modern Genetic Analysis*. W.H. Freeman, NY, USA.
6. Hartl, D.L., and E.W. Jones. 2009. *Genetics: Analysis of Genes and Genomes* (7th edn). Jones & Bartlett Pub., Inc. MA, USA.
7. Herskowitz I.H., 1977. *Principles of Genetics*. Collier Macmillan.
8. Lewin B., 2008. *Genes* (9th edn). Jones and Bartlett Publishers Inc.

Bioinformatics

1. Alberghina, L. and H.V. Westerhoff (Eds.). 2008. *Systems Biology - Definitions & Perspectives*. Springer-Verlag, Berlin.
2. Attwood, T.K. and Parry-Smith, D. 2006. *Introduction to Bioinformatics*. Pearson Education. Bourne, P.E. and Weissig, H. 2003. *Structural Bioinformatics*. Wiley-Liss, USA. David W.M. 2004.
3. *Bioinformatics, Sequence and Genome Analysis* (2nd edn). CSHP, New York. Krane, D.E. and M.L. Raymer. 2006. *Fundamental Concepts of Bioinformatics*. Pearson Education, New Delhi.
4. Lesk, A.M. 2005. *Introduction to Bioinformatics*. Oxford Press, New Delhi.
5. Pengcheng Fu and Sven Panke, (Eds.). 2009. *Systems Biology and Synthetic Biology*. John Wiley & Sons, Inc. NJ, USA.
6. Tisdall, J.D. 2001. *Beginning Perl for Bioinformatics*. O'Reilly Media Inc. CA, USA.
7. Masaru Tomita and Takaai Nishioka, 2005. *Metabolomics. The Frontier of Systems Biology*. Springer Japan.

Paper no. SAD41551 2T - 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 I Organization of cell, Cell growth and Division : **15Hrs**

1. Plasma membrane structure and function in detail
   1.1. Types of lipid in membrane structure, types of protein in membrane structure
   1.2. Membrane asymmetry
   1.3. Properties of nerve cell membrane, Action potential and impulse transmission
2. Organization of cytoskeleton
   2.1. microfilament
   2.2. intermediate filaments,
   2.3. Microtubules,
3. Extracellular matrix
4. Cell junctions: cell adhesion and communications,
5. Cell matrix adhesion,
6. Collagen -the fibrous protein of the matrix, non collagen components of the extra cellular matrix.
7. Overview of the cell cycle and its control
8. The molecular mechanism for regulating mitotic and meiotic events,
9. Amitosis, cell cycle control,
10. Checkpoints in cell cycle regulation.
11. Cell- cell communication: Cell to cell signaling, overview of the extracellular signaling,
12. G- protein coupled receptors, and their effectors, second messengers, enzyme linked cell surface receptors, identification of cell surface receptors,

Unit II: Protein secretion and sorting : **15Hrs**

1. Organelle biogenesis
2. Protein secretion :
3. Translational modifications in the ER
4. Processing and packaging in Golgi Complex
5. Targeting of proteins to

5.1. Outside cell
5.2. Mitochondria,
5.3. Nucleus

6. Mitochondria: structure, function and oxidative phosphorylation
7. Organization of Nucleus:
8. Chromosome structure in detail, DNA structure and its types
9. The nucleosome concept : nucelosome assembly, Histones and Non histones,
10. Chromosomes structure, in prokaryotes and eukaryotes,
    10.1. chromatin structure, (Euchromatin, heterochromatin)
    10.2. Constitutive and facultative heterochromatin,
11. Epigenetic regulation
12. Nucleolus.
13. Gene and genome organization- Split genes, Gene clusters,

UNIT III : Fundamental Processes : 15Hrs

1. Replication of DNA- Prokaryotes and eukaryotic DNA replication**.**
2. Enzymes and accessory proteins, involved in DNA replication,
3. Mechanism of DNA replication,
4. Replication errors
5. DNA damages, and their repairs.

Prokaryotic and Eukaryotic transcription:

6. General and specific transcription factors
7. Regulatory elements and mechanism of transcription regulation in Prokaryotes (Lac operon)
8. Difference in transcription of prokaryotes and Eukaryotes.

Transcription: Initiation, elongation, and termination of transcription

9. Post translational modifications in eukaryotic mRNA :
    9.1. Capping,
    9.2. Polyadenylation,
    9.3. Splicing and editing,
10. mRNA stability
11. RNA interference,

Translation: Genetic code and ribosome structures,

12. Prokaryotes and eukaryotic translation
13. Translation machinery,
14. Mechanisms of chain initiation,
15. Elongation, and termination,
16. Regulation of translation ,
17. Epigenesis

REFERENCES

1. Alberts,B.,Johnson,A.,Lewis,J.,Raff,M.,Roberts,K.AndWalter,P.2008.*MolecularBiol ogyofthe Cell*.GarlandScience.-TaylorandFrancisgroup,USA.

2. Becker,W.M.,Kleinsmith,L.J.andHardin,J.2007.*TheWorldoftheCell*.Pearson,NewD elhi. Clark,D.P.2010.*MolecularBiology*.ElsevierPublishers,London.
3. Cooper,G.M.andHausman,R.E.2009.*Thecell:AMolecularApproach*(5th edn).Sinauer Associates, 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., New Delhi.
7. Karp, G. 2010. C*ell and Molecular Biology* (6th edn). 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*.JonesandBartlettpubli shers,NY.
   Lodish,H.,Berk,A.,Kaiser,C.A.,Krieger,M.,Scott,M.P.,Bretscher,A.,Ploegh,H.andMa tsudaira,
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.*Molecular Biologyof the Gene.*Pearson.

Paper No. SAD41552 2T- 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 I

Diffusion and Osmosis 15hrs.

1. **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.
2. **Plasma membrane**: Internal composition, cell penetration, permeability of cell membrane, permeability coefficient.
3. **Osmosis :** Osmotic concentration and osmotic pressure, Van't Hoff's Laws. Biological significance of osmosis and animal and plants.
4. Physicochemical properties of cell membrane, conformational properties of cell membranes, Membrane transport, - endocytosis, exocytosis, nutrient transport across membranes, porins, facilitated diffusion, porter molecules,
5. **Facilitated transport:** Symport, antiport, uniport, anion porter, glucose porter, Active transport: Proton pumps, Na^+ K^+ pumps and Ca^{++} pumps, ionicchannels. Functions of cell membrane, Artificial membranes.

Unit II: 15hrs.

Bioenergetics

1. **Thermodynamics :** Laws of thermodynamics, Entropy, Enthalpy, Free energy, Reversible thermodynamics, and irreversible thermodynamics; System – open, closed, and isolated Photo- bioenergetics.
2. **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.

Biomechanics and Neurophysics

3. **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 heartbeat, Electrocardiography.
4. **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 bio luminance.
5. **Hearing:** Physical aspects, - the ear, elementary acoustic, theories of hearing, Signal transduction- mode of transport, signal transduction in the cells.

Unit III **15hrs.**

Radiation Biophysics

1. Ionizing radiations, units of radioactivity, exposure and dose.
2. Interaction of radiation with matter: Photoelectric effect, ion pair production, absorption and scattering of electrons.
3. Biological effects of radiations; effect on nucleic acids, proteins, enzymes, and carbohydrates, cellular effects, of radiations, somatic and genetics,
4. Nuclear medicine; Internally administered radioisotopes, radioiodine in thyroid function analysis, Renal, liver, andlung function analysis.
5. 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,New Delhi
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

Weesner,F.M.1960. *General Zoological Microtechniques.* The Williams &Wilkins Co.,Baltimore, USA

Practical Paper No. SAD41550 2P (Practical based on – SAD41550 2T)

Genetics and Bioinformatics

1. Problems based on mendelian & non-mendelian inheritance
2. Human pedigree analysis exercises
3. Determination of blood groups and suggestions on Medico-legal problems regarding parentage disputes using blood groups.
4. Identification of blood group, a case study of multiple alleles.
5. To study the life cycle stages of *Drosophila melanogaster* and studying sexual dimorphism.
6. To study the different mutants in Drosophila.
7. To prepare a squash of salivary glands from Chironomus (midge) larvae for observing polytene (giant) chromosomes.
8. Database search and data retrieval using NCBI and SWISS-PROT
9. Methods of sequence alignment-BLAST and Clustal W.
10. Study of construction of Phylogenetic trees (PHYLIP., MEGA)
11. Protein structure visualization using RASMOL.
12. Karyotype analysis & identification of chromosomal anomalies
13. Studies on recombination mapping using Drosophila crossing or problems from theoretical data.

Practical Paper No. SAD41551 2P (Practical based On SAD41551 2T)

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.
5. Effect of drugs on cell division (Colchicine or any other inhibitor)
6. Study of mitochondria by vital staining technique.
7. Genotoxicity by Micronuclei test.
8. Induction of puff and study of puffing pattern in polytene chromosomes.
9. Preparation of different cell types as hepatocytes/ parenchymal cells
10. Study of tumor and cancerous cells (Use permanent slides)
11. Preparation of Microtome section, spreading.
12. Histochemical staining of carbohydrates (PAS).
13. Histochemical staining of Protein (Bromophenol blue).
14. Histochemical staining of lipids (Sudan Black).
15. Histochemical staining of DNA (Feulgen stain).
16. Case study associated with the cytoskeleton.
17. Separation of proteins by SDS-PAGE.

Practical Paper No. SAD41552 2P (Practical based on SAD41552 2T)

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
17. Estimation of Chlorophyll.

Practical Paper No. SAD41553 2P

Practical Skill/advanced technique

Biostatistics

1. Calculate the percentile for the values.
2. Determination of mean, mode, median, standard deviation, variance, standard error using formula/calculator/computer.
3. Problems on probability.
4. Binomial and Poisson distribution.–Determination of Correlation Between Two Biological Variables
5. Z score
6. Problems of chi square test with reference to goodness of fit and homogeneity.
7. T test: Unpaired and paired.
8. Analysis of variance (ANOVA) for comparing 3-4 variables.
9. Problems of hypothesis testing: one and two directional.

Pathology and Immunological assays

10. Specimen collection and laboratory preparation in hematology.
11. Estimation of Bleeding time and clotting time.
12. Plasma separation and serum separation from given blood sample
13. Blood group analysis.
14. Total RBC count from human blood and Identification of defective RBC's from given blood sample for Thalassemia/Sickle cell anemia/Protozoan parasite.
15. Total WBC count and Differential count on WBC from human blood
16. Estimation of blood glucose by glucometer.
17. Estimation of hemoglobin by using Sahli's method.
18. Estimation of ESR of given blood sample.
19. Precipitation reaction: the ring test
20. Agglutination reaction: The febrile antibody test
21. IgG purification
22. Widal Test
23. ELISA test (Indirect/Sandwich/Dot)

Dairy and Industrial processes.

24. Determination of Phosphatase activity of milk.
25. Detection of Mastitis through milk test.
26. Detection of calcium and phosphorous in milk.
27. Methylene blue reductase test.
28. Demonstration of fermentation by using yeast.
29. Sperm Counting Using a Hemocytometer.
30. Determination of sperm motility.

Paper No. SBD41554 2T - 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 **15 hrs**

1. Phylogeny of the nematodes and related groups. Economic importance. Burden of helminthes disease worldwide and in India.
2. General organization of Nematodes.
3. Classification of Nematodes up to family level.

Unit - II Nematode as Animal Parasite **15 hrs**

1. Nematode ultra-structure: complex system and processes.
   Body wall of nematodes: cuticle, Epicuticle (Hypodermis), muscle layer, Hydrostatic Skeleton.
2. Nervous system: Cephalic sense organs Amphids, labial and cephalic papillae. Caudal sense organs– caudal papillae, plasmids.
3. Digestive system: Feeding and nutrition's in Nematodes. Essential foods, blood feeding by Hookworms and other nematodes.
4. Secretary / excretory system
5. Reproductive system (Male, Female): Spicules, Fertilization, development and hatching of eggs.
6. Different life cycle patterns in Nematodes.
7. Structure, lifecycle, pathogenicity, control and prevention of following types.
   a. *Strongyloides stercoralis.* b. *Wacheriria bancrofti.*
   b. Trichenella sprilis. d. *Trichuris trichura.*
8. Chemotherapy: Drug used against helminthic infection in man, Drug resistance in human helminthes, trends in vaccines against helminthes and challenges.

Unit - III Nematode as Plant Parasite. **15 hrs**

1. Introduction and general life cycle, General organization, morphology, size and shape of plant Nematodes
2. Outline classification of plant nematode.
3. Feeding types, Feeding habits and modifications in anterior region.
4. Symptoms of Nematode injuries (Above ground and below ground).

5. Population dynamics, the threshold levels, nematode survival, Ecology.
6. Controlling nemic diseases of plant (Cultural, biological, chemical, physical, legislative etc.)
7. Interaction with other organisms.
8. Life cycle studies of followings:
    a. Root knot Nematodes (*Meloidogyne*) b. Citrus Nematodes (*Tylenchulus*)
    b. Bud and leaf Nematodes (*Aphelenchoides*) d. Seed gall Nematodes (*Anguina*)

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. SBD41555 2T - PROTOZOOLOGY II

Contact Hours: 45 credits- 3

Learning Objectives:

- To understand the genetics, nutritional and parasitic adaptation in human or in other vertebrates.
- The students will also study the geomedical aspects of protozoans.

Learning outcome:

- The student will understand the genetics, and the nutritional requirements and general organization of protozoans.
- The students will understand the genetics of the common parasites like trypanosomes and plasmodium.
- The student will learn about the metabolic adaptation.

Unit I: Genetics, Molecular Biology, and Metabolism of Protozoa 15 hrs

1. Genetics of Trypanosome:
    a. Diploidy, sexual stages, chromosome number
    b. Antigenic variation and surface coat shedding
    c. Molecular structure of the surface coat
    d. Variable Surface Glycoprotein (VSG) gene expression and regulation at telomeres
    e. Discontinuous transcription and control in the "fly" stage
2. Genetics of Plasmodium:
    a. Chromosome size and polymorphism
    b. Diploid/haploid stages, meiosis
    c. Comparative DNA analysis and evolutionary insights
    d. Cloning of genes: circumsporozoite protein, S-antigen of merozoites
    e. Shared epitopes between sporozoites and merozoites, surface antigen diversity

Unit II: Host-Parasite Interaction 15 hrs

1. Geo-medical Aspects:
    a. Climatic and atmospheric influences: temperature, humidity, precipitation, irradiation
    b. Edaphic factors: oxygen, CO_2, pH, light, nutrition
2. Host-Parasite Interaction: Innate and acquired immunity against protozoa, Antigens of zooparasites, Antigen-antibody interactions specific to protozoan diseases

Unit III: Pathology and Transmission 15 hrs

1. Pathology and Transmission: Life cycle, morphology, transmission, and pathology of parasitic amoebae e.g.*Entamoeba histolytica, E. gingivalis*
2. Coccidia in poultry: structure, treatment, and control
3. Ciliophoran parasitism: *Balantidium coli, Ichthyophthirius multifiliis* - structure, lifecycle, pathogenesis, control
4. Parasitic Flagellates of the Digestive Tract (Human): *Retortamonas intestinalis, Chilomastix mesnili, Giardia lamblia, Trichomonas tenax*

5. Microspora and Myxospora: Spore structure and life cycle (*Nosema, Myxobolus*), diseases in fishes
6. Gregarines: Structure and life cycle

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. SBD41556 2T – ENTOMOLOGY II

Contact Hours: 45 **Credits: 3**

Course Objective:

- To develop a strong foundation in entomology, including understanding of the importance of insects to human society.
- To familiarize the students with identification of insect pests, vectors and their control methods.
- To introduce the students with entomological cottage industry.
- To develop a sufficient background for those students who wish to study more advanced entomological topics.

Learning Outcome:

- The students will learn in depth the identification and control of insect pests.
- The students will get knowledge about different entomological cottages industries.

Unit I: Phylogeny and Classification of Insects **15 hrs**

1. Classification of Apterygota orders up to families – Thysanura and Collembola
2. Classification of Pterygota orders up to families – Exopterygota – Odonata, Orthoptera, Mallophaga, Anoplura, Isoptera and Hemiptera.
3. Classification of Pterygota orders up to families – Endopterygota – Coleoptera, Hymenoptera, Neuroptera, Lepidoptera and Diptera.

Unit II: Insect as pest and Vectors **15 hrs**

1. Concept of pest: Origin of pest, Classification of Pests.
2. Insect pests of Jowar, Cotton, Sugarcane, Soybean, Vegetables, Fruit Crops, Stored grains, structural pests.
3. Study of insect vectors like mosquito, bed bug, flea, body louse, rat flea etc.
4. Rapid detection, visualization and quantification of pathogens in insect hosts and vectors, Immune based diagnosis of host infection.

Unit III: Applications of entomology in environmental wellbeing, agriculture and commercial sectors **15 hrs**

1. Chemical control: mode of action of insecticide, merits and demerits of chemical control
2. Modern trends in pest control
3. Biological control: Principles, procedure, Biological agents; success and limitations; Autocidal Control – sterile male technique, genetic technique, the pheromonal technique
4. Integrated pest management (IPM) Principles and applications.
5. Mulberry silkworm: life history, silk glands and silk production, silkworm diseases, applications of sericulture.
6. Lac Culture: Biology of lac insects, lac cultivation and economic importance of lac.
7. Types of honey bees, life cycle, seasonal management of honey bees, social organization and bee communication, economic importance of honey wax and apiary products.
8. Other important aspects of insects – Insects as pollinators, Insects in research, Butterfly farming, Insects in forensic entomology, Insect – plant interactions,

Text Books:

1. Applied Entomology, Vol. 1 2nd Edition. (1996). K.P. Srivastava, Kalyani Publishers, New Delhi.

2. Applied Entomology, Vol. 2 2nd Edition, (1996). K.P. Srivastava, Kalyani Publishers, New Delhi.

3. Modern Entomology (2009), D.B. Tembhare, Himalaya Publishing House, Delhi.

4. General and Applied Entomology. 2 edition (2004). David. B.V. and Ananthakrishnan, T.N. Publisher Tata McGraw Hill, New Delhi.

5. General Entomology. 2nd edition (1973) Mani M.S. Oxford & IBH Publishing Company, New Delhi.

6. Applied Zoology, Dr. Waykar B.B., Prashant Publication, Jalgaon.

Reference Books:

1. Applied Entomology, 2nd edition, P. G Fenemore. Alka Prakash, Publisher: New Age International.

Paper no. SBD41557 2T - 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 Outcome

- 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 10 Hrs

1. **Classes of hormones. Hormone synthesis and control** – a general concept.
   1.1. General mechanisms of hormone action.
   1.2. Termination of hormone action.
   1.3. Hormone circulation and metabolism.
   1.4. Plasma membrane hormone receptors,
   1.5. Second messengers of hormone action,
   1.6. Receptor signal transduction,
   1.7. Multiple membrane messengers
   1.8. Eicosanoids and hormone action
   1.9. Cytosolic hormone receptors.
2. Sex determination, differentiation of male and female gonads.
3. Development and differentiation of genital ducts.
4. Gonadal hormone synthesis.
5. Gonadal steroids and brain differentiation.

Unit -II Reproductive Endocrinology 20 Hrs

Hypothalamus and Pituitary gland

1. Histomorphology of pituitary gland, hormones and their functions
2. Structure of Hypothalamus
3. Different types of Hypothalamo hypophyseal axis and its feedback mechanism.
4. Control of Hypothalamo- hypophysial hormone secretion
5. Pars intermedia and role melanotropic hormones.
6. **Neurophysical hormones :** vasotocin, oxytocin, vasopressin , function and mode of action of these hormones
7. **Melanotropic hormones :** Control of MSH secretion, dopinergic control , Physiological roles.

Female Reproductive endocrinology.

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

Male Reproductive Endocrinology ;

1. Anatomy of male reproductive system,
2. histology of testis, spermatogenesis;
3. hormones of testis and their functions.
4. Endocrine control of testicular function,
5. GnRH and
6. Pituitary gonadotropins- inhibin , prolactinn,
7. Role of androgens:
   7.1. In Spermatogenesis .
   7.2. Its Physiological roles in fertility and male behavior,
8. Epiphysical fusion , cardiovascular functions.

Unit III : Hormones in homeostasis **15 Hrs**

1. **Hormonal control of calcium :** homeostasis . Parathromone, calcitonin, vitamin D.
2. **Gastro intestinal Hormones-** Gastrin, Secretin , cholecystokinin(CCK), Gastric inhibiting peptides, Vasoactive Intestinal Peptide (VIP), Substance P , Somatostatin , motilin.
3. **Pancreatic hormones** – Insulin and glucagon – physiological action.
4. Thyroid hormones: control of thyroids hormone secretion.
5. **Adrenal steroid hormones-** Glucocorticoids, Mineralocorticoids, Aldosterone, Renin – Angiotensin system.
6. **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. DSE 581- MARINE BIOLOGY -II

Contact Hours: 45 Credits- 3

Learning Objective:

- To learn about coastal systems, estuaries.
- To learn about ecology and adaptations of esturine organisms.

Learning Outcomes:

Student will be able to

- Describe the salient features marine tropic structure.
- Explain the types and divisions of various marine habitats.

Unit I: Marine Flora & Coastal Systems 15 hrs

1. **Marine Flora**
   Microalgae: Cyanobacteria, Chrysophyta, Dinophyta, Chlorophyta.
   Seaweeds: Classification, economic uses.
   Seagrasses & Mangroves: Adaptations, Biogeochemical roles
2. **Coastal systems**
   Coral Reefs: Types, formation theories, distribution, threats.
   Salt Marshes & Sand Dunes: Flood defence, biodiversity.
   Intertidal/Interstitial Zones: Endolithic life, tidal rhythms.
3. **Arabian Sea ecology**: Case study.

Unit II: Estuarine, Riverine & Population Ecology 15 hrs

1. **Estuaries:** Occurrence, Types, distribution (focus on India), Physical-chemical-biological aspects, mixing zones, Adaptations of organisms, economic importance.
2. **Rivers & biogeochemical cycles:** Transport of materials to oceans, Modification of dissolved and particulate matter during transport**,** Role in nutrient cycling.
3. **Population ecology:** Group attributes, Population growth models, Density-dependent vs. density-independent factors, Carrying capacity concepts.

Unit III: Marine Community Dynamics & Human Impacts 15 hrs

1. **Species interactions:**
   a. Symbiosis, parasitism, mutualism, commensalism, Endoecism, inquilinism, epizooism
   b. Prey-predator dynamics, density-dependent/independent factors.
2. **Community ecology:** Colonization patterns, Ecological succession (primary/secondary), Mechanisms of succession, Biorhythms (circadian, tidal, lunar) – significance, environmental regulating factors, Biotic and abiotic factors influencing homeostasis.
3. **Anthropogenic threats:** Habitat destruction, Invasive species, Climate change impacts on polar ecosystems, Ocean acidification, Pollution (plastics, oil spills)
4. **Trophic structure:** Food chains/webs: Energy flow in pelagic, benthic, deep-sea, and polar ecosystems, Ecological pyramids (biomass, numbers, energy).

References

1. CMFRI. 2010. Marine Mammal Research and Conservation in India. Central Marine Fisheries Research Institute, Cochin: 20 pp.
2. George Karleskint, Richard Turner, James Small. 2009. Introduction to Marine Biology. Brooks Cole 598 pp.
3. Hyman, L., 1967. Invertebrate Zoology. Vols. I to IV. McGraw Hill Books Co., New York.
4. John F. Morrissey and James L. Sumich. 2012. Introduction to the Biology of Marine Life. Jones & Bartlett Learning Levinton, J.S., 2009. Marine Biol
5. Levinton, J.S., 2009. Marine Biology: Function, Biodiversity, Ecology. Third Edition. Oxford University Press, Oxford, UK: 640 pp.
6. Peter Castro and Michael Huber. Marine Biology. 11th Edition (2018). McGraw – Hill Education. 496pp.
7. Philip V. Mladenov. 2013. Marine Biology: A Very Short Introductio. Oxford University Press, USA 144 pp.
8. Reynolds, J.E. and Rommel, S.A. (Eds.). 1996. Biology of Marine Mammals. Smithsonian Institution Press, Washington, D.C. 896 pp.
9. Schreiber, E.A. and Burger, J. (Eds.) 2001. Biology of the Marine Birds, CRC press: 722 pp.
10. 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. SBD41554 2P (Practical based on SBD41554 2T)

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 different Nematodes and their medical and veterinary importance using
7. permanent slides (at least 08).
8. Collection and identification of Phytonema.
    a. Site selection, Sample collection method and Phytonema collection.
    b. Lab work, fixation, mounting, and preparation of permanent slides
9. Techniques of collection, fixation, mounting, and preparation of permanent slides.
10. Study of life cycle of citrus nematodes, root knot nematodes, bud and leaf nematodes.
11. Immunological techniques in helminthology.
12. Submission of permanent slides at the time of examinations.

Practical Paper No. SBD41555 2P (Practical based on SBD41555 2T)

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. SBD41556 2P (Practical Based on SBD41556 2T)

Entomology - II

1. Collection, preservation, sketching, identification and classification of insects of following orders- Thysanura, Collembola, Odonata, Orthoptera, Mallophaga, Anopleura, Isoptera, Hemiptera, Coleoptera, Neuroptera, Hymenoptera. Lepidoptera. and Diptera and insects from Marathwada.
2. Identification damage symptoms, and management practices of pests of Jowar Cotton, Sugarcane, soybean, Vegetables, Fruit Crops. Stored grains.
3. Collection and study of predatory, pollinator insects, biological control agents, and forensic insects
4. Study of insect vectors like mosquito, bed bug, flea, body louse, rat flea.
5. Study of silk worm - adult, caterpillar, cocoon and types of silk worms.
6. Study of Indian species of honeybee and study of life cycle of honeybee.
7. Field visit for demonstration of pest damage/Sericulture farm/Apiculture farm.

Practical Paper No. SBD41557 2P (Practical based on SBD41557 2T)

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. Live feed culture and artificial feed preparation.
4. Evaluation of standing stock. Diel variation in plankton in estuary/bay.
5. Estimation of primary production by light and dark bottle method.
6. Chlorophyll estimation.
7. Preparation of whole mounts of planktons.
8. Impact of pH & Pollutants on Algae-Daphnia Microecosystem
9. Visit to intertidal regions- Rocky shores, Sandy shores, Mud flats, mangrove and estuaries.
10. Report on field visit to a marine ecosystem and intertidal zone

RM –Practical Paper no. SLD415582P On Job Training (OJT) /

Practical Paper no. SMD415592P Field Project (FP)

(Credits – 4)

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	**SAD416003T**	Developmental biology	3	-	3	-	14
	SAD416013T	Immunobiology	3	-	3	-	
	SAD416023T	Applied Biotechnology -I	3	-	3	-	
	SAD416003P	Practical based on SAD416003T	-	2	-	1	
	SAD416013P	Practical based on SAD416013T	-	2	-	1	
	SAD416023P	Practical based on SAD416023T	-	2	-	1	
	SAD416033P	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	**SBD416043T**	Applied Parasitology - I	3	-	3	-	04
	SBD416053T	Animal Physiology– I	3	-	3		
	SBD416063T	Molecular Biology -I	3	-	3		
	SBD416073T	Fishery Science-I	3	-	3		
	SBD416043P	Practical based on SBD416043T	-	2	-	1	
	SBD416053P	Practical based on SBD416053T	-	2	-	1	
	SBD416063P	Practical based on SBD416063T	-	2	-	1	
	SBD416073P	Practical based on SBD416073T	-	2	-	1	
RM	**SRD416073P**	Research Project -I	4	-	4	-	04
			16	**12**	**16**	**06**	**Total credits 22**

Paper no. SAD41600 3T - DEVELOPMENTAL BIOLOGY

45 Contact hours **3 Credit**

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 **15 Hrs**

A.Gametogenesis, fertilization and early development:

1. Production of gametes-
    1.1. Spermatogenesis in mammals, structure of sperm,
    1.2. Oogenesis in mammals, Structure of egg and types.
2. Cell surface molecules in sperm-egg recognition in animals;

B. Zygote formation

1.1.Capacitation
1.2.Prevention to polyspermy (Fast block and slow block)
1.3.Acrosome reaction
1.4.Activation of Egg metabolism

2. Cleavage and patterns of embryonic cleavage
3. Blastula formation and fate map of blastula
4. Gastrulation and formation of 3 germ layers in animals (Ex. Frog and Chick)

UNIT II **15 Hrs**

C. Basic concepts of development:

1. Potency,
2. Commitment,
3. Specification,
4. Induction,
5. Competence,
6. Determination and differentiation;
7. Morphogenetic gradients;
8. Cell fate and cell lineages;
10. Genomic equivalence and the Cytoplasmic determinants;
11. Imprinting; mutants and transgenics in analysis of development.

D. Programmed cell death, aging and senescence.

1. Apoptosis
2. Senescence
3. Theories of aging-
    3.1. Programmed theories (ex. Programmed senescence theory, Telomeric theory,) and
    3.2. Error theories (ex. Free radical theory)

UNIT III **15 Hrs**

E. Morphogenesis and organogenesis in animals:

1. Cell aggregation and differentiation in *Dictyostelium*;
2. Axes and pattern formation in *Drosophila*,
    2.1. Segmentation genes,
    2.2. Homeotic genes
3. Amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans;*
4. Axis formation in Amphibians
    4.1. Spemann's Organizer experiment(Primary embryonic induction)
    4.2. Functions of organizer
5. Nuclear transplantation experiments of Briggs and King and Gurdon in the frog.
6. Nuclear transplantation and cloning in mammals.
7. Stem cells: The concept of totipotency, Embryonic stem cells
8. Eye lens induction, limb development and regeneration in vertebrates;
9. Differentiation of neurons,
10. Post embryonic development-
    10.1. Larval formation,
    10.2. Metamorphosis;
    10.3. Environmental regulation of normal development;
11. 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 al
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. Readings are also assigned from journals and from Internet resources such as Medline(Http//www.ncbi.nlm.nih,gov/entrez/quey.fcgi) and bio Med Net (http/www.bmn.com/) Wikipedia etc

Paper no. SAD41601 3T - IMMUNOBIOLOGY

Contact Hours: 45 **Credits- 3**

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: lntroduction to immune-biology and innate immunity 15 Hrs

Innate Immunity:

1. **Barriers:** Different types of first defence barriers against pathogens, Anatomic and chemical basis of inflammatory Inducers.
2. **Cells involved in innate immunity**
3. **PAMPs and DAMPs**
4. **Generation of Innate immune response:**
5. **Types of PRRs and its mechanism of action**
   - 5.1. TLRs - Toll- like receptors (TLRs), types and mechanism of action.
   - 5.2. NLRs- NOD-like rceeptors as sensors and bacterial infection and cellular damage.
   - 5.3. NLRP in Cell death and inflammation,
   - 5.4. RLRs - RIG -1 like receptor in type – I interferon production and proinflammatory cytokines.

Unit II: Cells and organs of the Immune System: 15Hrs

Primary Lymphoid organs (Thymus, Bone marrow) **and Secondary Lymphoid organs** (Lymph nodes, Spleen)

1. **Lymphatic system**
2. **Adaptive immunity:**
   - 2.1. Antigen concept, criteria of antigens, Nature of immunogen, Adjuvants, Epitopes
   - 2.2. Cell mediated immunity, humoral immunity,
   - 2.3. Immune response: primary and secondary response.
   - 2.4. Antibody structure, classes and functions.
   - 2.5. Antibodies (structure, specificity, diversity),
   - 2.6. Antigen-antibody interactions.

2.7. Antibody mediated effector functions

3. **Antigen processing and presentation**
   3.1. Major histocompatibility complex,
   3.2. Self MHC restriction of T cells
   3.3. Antigen processing and antigen presentation (endogenous and exogeneous processing pathways),

Unit III: **15 Hrs**

1. **Antibody diversity:** GOD Question
   1.1. Germ line and Somatic variation models
   1.2. Two gene model of Dreyer and Bennett
   1.3. Gene rearrangement model by Tonegawa
   1.4. Multigene organization of Ig Gene
2. T-cell and B-cell receptors, Accessory membrane molecules of T-cell
3. T cell maturation, activation and differentiation
4. B cell generation, activation and differentiation
5. Vaccine mechanism and types of Vaccines
6. **Immune deficiencies:** Introduction, primary and secondary deficiencies.
   6.1. Immunodeficiency diseases ex. AIDS
   6.2. Recent developments in Immunotherapy against various diseases

Reference Books:

1. Kuby lmmunology – RA Goldshy. Kinot. TJ. Osborne. BA.4th Ed W.H Freeman and Copany. New York
2. 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: SAD41602 3T - APPLIED BIOTECHNOLOGY - I

Contact Hours: 45 **Credit: 3**

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.
- Explain biofuels, biotransformation of reclaimant metabolites and green technologies.
- State principles and applications of various diagnostic techniques.
- Learn about the marine biotechnology and nano-biotechnology in detail.

Unit I: Biotechnology in Agriculture & Environment **15 hrs**

1. **Waste Management & Recycling**

   Composting: Definition, Advantages and limitations of composting, Types of waste suitable and unsuitable for composting, Mechanism of composting, Stages (Mesophilic → Thermophilic → Cooling → Maturation)

   Types of composting: Windrow Composting, Static Pile Composting, In-Vessel Vermicomposting.

   Vermicomposting: Definition, Process, Types of worms used, Advantages.

   Factors affecting composting: Temperature, moisture, aeration, pH, microbial diversity

   Biochemistry of composting: Role of enzymes, C:N ratio optimization, Chemical contents.

   Role of microbes in waste degradation: Key microorganisms and examples, mechanisms used by microbes
2. **Biofuels:** Definition, Generations of biofuels: First generation, Second generation, Third generation, Fourth generation – Definitions, examples, application and production process.
3. **Green technology**: Concepts and sustainable applications.
4. **Biotransformation**: Definition, Biotransformation of reclaimant metabolite, examples, Ecological impact of microbes (Bioremediation benefits vs. risks of GM microbes)

Unit II: Molecular Diagnostics & Genomics **15 hrs**

1. **Diagnostic Techniques**

   Molecular diagnosis: Definition, Scope, significance, role and examples.

   Biomarkers in disease diagnostics: Definition, types (Genomic, Proteomic, metabolic), applications

   Immunodiagnostics: Definition, Types and mechanisms: DNA reporter, fluorogenic

reporters, electro-chemiluminescent tags, label-free assays.

PCR-based diagnostics: Types - qPCR, RT-PCR, mechanism, advantages/Limitations

2. **Sequencing Technologies**

Protein Sequencing: Principles - Edman degradation, mass spectrometry; and applications

DNA Sequencing: Principles **–** Sanger, Maxam-Gilbert; and application

CRISPR-CAS technology: Definition, Mechanism, Application

Third generation sequencing (3GS): Principles and application - PacBio Single Molecule Real Time (SMRT) sequencing and Oxford Nanopore Technologies (ONT)

NGS platforms: Illumina, Nanopore – Principle and applications in disease diagnostics.

Unit III: Marine & Nanobiotechnology **15 hrs**

1. **Marine Biotechnology**

Marine derived pharmaceuticals: Bioactive compounds – Definition, examples, mechanism of action, application

Marine bioremediation: Definition, advantages and limitations.

Seaweeds – definition, application in metal removal by biosorption

Barophilic organisms – definition, examples and applications

Fluorescent Proteins: Definition, Types: GFP, RFP – definitions, components, mechanism, applications

2. **Nano biotechnology:** Definition, History

Nanoparticle synthesis (biological methods): Definition, types and mechanisms, characterization techniques.

Morphological forms: Nanospheres, Nano-capsules, Dendrimers – definitions, structure, mechanism of action, examples

Applications in drug delivery and nanomedicine, Advantages and limitations

References

1. Dubey, R. C. (2014). *A textbook of biotechnology* (5th ed.). S. Chand Publishing.
2. Satyanarayana, U. (2017). *Biotechnology*. Elsevier.
3. Glick, B. R., & Patten, C. L. (2017). *Molecular biotechnology: Principles and applications of recombinant DNA* (5th ed.). ASM Press.
4. Brown, T. A. (2016). *Gene cloning and DNA analysis: An introduction* (7th ed.). Wiley-Blackwell.
5. Primrose, S. B., & Twyman, R. M. (2013). *Principles of gene manipulation and genomics* (7th ed.). Wiley-Blackwell.
6. Kim, S. K. (Ed.). (2013). *Handbook of marine biotechnology*. Springer.
7. Rai, M., & Duran, N. (Eds.). (2011). *Nanotechnology for environmental remediation*. Springer.
8. Pechenik, J. A. (2021). *Biology of the invertebrates* (8th ed.). McGraw-Hill Education.
9. Singh, B. D., & Gautam, S. K. (2022). *Biotechnology: Expanding horizons* (5th ed.). Kalyani Publishers.
10. Kulkarni, S. K. (2015). *Nanotechnology: Principles and practices* (3rd ed.). Springer.

Practical Paper No. SAD41600 3P (Practical based on SAD41600 3T)

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. SAD41601 3P (Practical based on SAD41601 3T)

Immunology

1. RBC Total WBC count WBC Differential count
2. Erythrocyte Sedimentation Rate (ESR).
3. Packed Cell Volume (PCV).
4. Estimation of Haemoglobin (Hb).
5. Mean Cell Haemoglobin and Mean Cell RBC volume.
6. Colour Index and Volume Index of RBC.
7. Osmotic fragility of RBC.
8. Immunodiffusion.
9. Single Radial Immunodiffusion.
10. Rocket immunoelectrophoroesis.
11. Cross over Immunoelectrophoresis.
12. Graber and Williams Immunoelectrophoresis.
13. Detection of HCG by latex agglutination inhibition test.
14. Haemeagglutination tests for identification of human blood groups.
15. Detection by viral fever by slide agglutination tests.
16. Isolation and purification of IgG from serum
17. Precipitation reaction by double immunodiffusion (Ouchterlony method) and radial immunodiffusion (Mancini's method)
18. Detection of antigens or antibodies by ELISA – Indirect and Sandwich ELISA
19. Blood typing – A, B, AB and O
20. Immunoblotting assay for protein detection
21. Immunoprecipitation assay

Practical Paper No. SAD41602 3P (Practical based on SAD41602 3T)

Applied Biotechnology -I

1. Techniques for isolation of pure cultures.
2. 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

Practical Paper No. SAD41603 3P

Practical Skill/advanced technique

Laboratory techniques

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. Estimation of blood lipids.
10. Study of cell viability by Trypan blue exclusion
11. Isolation of DNA from *E. coli.*
12. Isolation of plasmid from bacteria
13. To observe Bacteriophage growth.
14. To isolate DNA from Bacteriophage.
15. Bacterial DNA amplification using PCR
16. Restriction digestion of DNA using nuclease.
17. Transformation of DNA in bacteria.

Cockroach Culture

18. Establishment and Maintenance of Cockroach (*Periplaneta americana*) Culture.

Sericulture

19. Chawki Rearing of Mulberry Silkworms Using DFL Sheets to I^{st} instar stage.
20. Rearing silkworm for coccon production
21. Extraction of Silk from Cocoons and Evaluation of Silk Quality

Vermicomposting

22. Identification of different species of earthworms used in Vermicomposting.
23. Study the protocol for successful rearing of earthworms for vermicomposting.
24. Extraction of compost from vermicomposting bed.
25. Chemical analysis of vermicompost.

Pearl Culture

26. Identification of different species of pearl oyster and its rearing and maintenance.
27. Method of insertion of nucleus.

Butterfly gardening

28. Identification of Common Butterfly Species and Their Host Plants
29. Establishment and Layout Design of a Butterfly Garden.
30. Rearing and Observation of Butterfly Life Cycle under Controlled Conditions

Marketing skills

31. Packaging and Labelling Standards for Animal-Based Products (FSSAI Guidelines)
32. Digital Marketing Tools for Promoting Animal-Based Products
33. Visit to local market/cooperative or processing unit.

Paper No. SBD41604 3T - APPLIED PARASITOLOGY - I

Contact Hours: 45 **Credits- 3**

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, Systematics and taxonomy. 15 hrs

1. Scope and historical landmarks in Parasitology, Inter-specific biological relationships: Phoresis, Symbiosis, Commensalism and Parasitism.
2. Parasitism: Definition and concept, Origin and evolution of parasites.
3. Adaptation in parasites. Advantages and disadvantages in parasitic life.
4. Types of hosts: Definitive and intermediate, Primary and secondary, Specific host, Paratenic, Carrier, Susceptible, Resistant, Accidental, Vectors.
5. Systematics and taxonomy of parasite, Basic principles and nomenclature aspects of parasites.
6. Protozoan parasites of medical & veterinary importance: Parasitism in Phylum Apicomplexa: General organization of Haemosporina, transmission, treatment and control of malaria, Gregarina, Eimeria, Toxoplasma, Babesia and Theilaria species.
7. Morphology, Pathogenicity and Control of *Entamoeba sp., Trypanosoma, Trichomonas and Giardia sp.*

Unit - II: Immunology, Biochemistry and Molecular biology. 15 hrs

1. Susceptibility and resistance.
2. Innate defense mechanisms pathogen associated molecular pattern (PAMPs), complement, alternative pathways and classical pathways.
3. Adaptive immune receptors: Self and non-self-recognition in adaptive responses, antibodies, functions of antibody in host-defense, Hypersensitivity and allergic reactions in parasitic infections inflammation.
4. Energy metabolism in parasitic protozoa and Helminthes, lipid metabolism, metabolism of nitrogenous compound, Amino acid metabolism.
5. Transfection success in kinetoplastid flagellates. Genetic exchange in malarial parasites and trypanosomes.

Unit - III: Habitat and Environment. 15 hrs

1. Habitat and environment of different parasites. Host parasite system.

2. Host reaction to parasites, pathogenicity of Endo and Ectoparasites.
3. General control of Endo and Ectoparasites: Chemical, Biological, Physical, Mechanical, Cultural and Legislative.
4. Economic importance of parasites, direct or indirect effect on human, animal, farm animals and Agriculture, poultry and fisheries pathogenicity.
5. Factors influencing parasitism; influence of season, host age and other phonological factor on parasitic population (prevalence and intensity).
6. Parasitic populations, parasites ecological niche, Host as an environment, Infectious site.
7. Adaptations for transmission: parasitic reproduction, behavioral adaptations, Epidemiology.

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. SBD41605 3T- ANIMAL PHYSIOLOGY -I

Contact Hours: 45 Credits- 3

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.

Part A: Physiology of Arthropods

Unit I **8 hrs**

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 **12 hrs**

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 **25 hrs**

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.

Mollusca

4. Osmotic equilibrium, osmotic and ionic regulation in freshwater and Marine forms.
5. Respiratory organs, structural properties and functions of respiratory pigments.

6. Nitrogenous end products, urine formation and excretion.
7. Reproduction pattern (Gonochorium, Hermaphroditism, self-fertilization, parthenogenesis).
8. Factors influencing reproduction, formation control of reproduction, sex reversal.

Echinodermata

9. Coelomic fluids and coelomocytes.
10. Respiratory organs, role of Perivisceral coelomic fluid in respiration, factors affecting respiration.
11. 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. SBD41606 3T - MOLECULAR BIOLOGY - I

Contact Hours: 45 **Credit: 3**

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: DNA & RNA, Genome Organization **15 hrs**

1. **Central Dogma & Nucleic Acids:** Definition and concept
   DNA: Definition, Composition and properties –Structure: Anti-parallel strands, Watson-Crick model, Chemical properties: Neighbor frequency, Forms of DNA, Chargaff's rule.
   RNA: Definition, Composition, Classification.
2. **Genome Complexity:** Size and shape of genomes, C-value paradox, organelle genomes.
3. **Repetitive DNA**: Definition, Types of clusters and repeats –
   Tandem repeats – Satellite, Minisatellite, Microsatellite (Definitions, composition and examples)
   Interspersed repeats - Transposons, Pseudogenes (Definitions, composition and examples)
4. **Gene Evolution**: Definition, Gene duplication (mechanism), gene conversion, codon usage bias.
5. **Case study:** Globin gene clusters.

Unit II: Prokaryotic DNA Replication **15 hrs**

1. **Initiation of Replication**
   Replicon: Definition, Types (with examples): Single/multi-copy, linear/circular
   Origin Recognition: oriC structure and mechanism (DnaA boxes, AT-rich region).
   Regulation: Sequestration of origins, helicase loading (DnaB-DnaC complex).
2. **Enzymology & Elongation**
   Unwinding the Helix: Helicases: Mechanism, assay (gel-based unwinding), Topoisomerases: Types (I/II), role in relieving supercoiling, gyrase assay.
   Priming DNA Synthesis: Primosome Components (DnaG + DnaB), RNA primer

synthesis - mechanism

3. **Polymerization:** DNA Polymerases: Hand-palm structure, Pol I, Pol III (Trombone model), processivity, fidelity, Nucleotide Polymerisation, in vitro assay (radioactive dNTPs).
4. **Termination & Connection to Cell Cycle**
   Termination: Tus-ter complex (Function), decatenation by topoisomerase IV.
   Cell Cycle Coordination: Replication timing vs. cell division (SeqA protein role).

Unit III: Prokaryotic Transcription & Translation 15 hrs

1. **Transcription in Prokaryotes**
   Transcriptome, Prokaryotic RNA polymerase: molecular composition and function
   Initiation: Bacterial promoters: -10/-35 elements, Sigma factor: Function in promoter binding , DNA melting, promoter clearance.
   Elongation: β-subunit's catalytic role.
   Termination: Rho-dependent/independent mechanisms.
2. **Translation in Prokaryotes**
   Genetic code: Triplet codon, Properties of genetic code, Wobble hypothesis
   Ribosome structure: A, P, E sites
   Translation Stages: Activation of amino acids
   Initiation: Shine-Dalgarno complex, initiation factors, GTP hydrolysis by IF2
   Elongation: elongation factors, peptide bond formation
   Termination: release factors

3. Gene Structure and Regulation: Fine structure of gene, One gene-one enzyme/polypeptide concepts; Complementation test, intragenic complementation; Cistron, recon, muton; Split genes, jumping genes, overlapping genes; Operon concepts and regulation: lac, arabinose, tryptophan operons

References

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. SBD41607 3T – 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: Diversity, Identification, and Ecology of Fishes **15 hrs**

General characters and classification of freshwater 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, Phylogeny of fish.

Aquatic ecosystems: freshwater, brackish, and marine ecosystems, Productivity of ponds and nutrient circulation, Identification of plankton, nekton, and benthos, Role of plankton in fish culture

Unit II: Fish Culture and Hatchery Techniques **15 hrs**

Culture techniques of major carps, Breeding techniques: natural, induced, 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, Types of fish-ponds in freshwater fish culture, Layout and construction of ponds, Fertilization and management of ponds

Unit III: Fisheries, Health Management, and Ornamental Fish Keeping **15 hrs**

Major fisheries in India, Important inland, cold water, brackish, estuarine, and marine fisheries, Conventional and non-conventional fishing methods, Fish diseases and their control measures Setting up and maintenance of home aquariums, Aquarium fish care and management

Reference

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. SBD41604 3P (Practical based on SBD41604 3T)

Applied Parasitology - I

1. Study of different types of animal associations with suitable examples.
2. Study of different types of parasites (Protozoa, Helminthes and Insect) using permanent slides.
3. Collection and preservation methods of scolex or segments for taxonomic or molecular studies.
4. Preservation, staining, mounting and identification of Helminth parasite.
5. Study of different important Ectoparasites of various vertebrate hosts.
6. Study of different important endoparasites of various vertebrate hosts.
7. Study of hemoflagellates from vertebrate blood.
8. Preparation of blood smear, staining and identification of Haemosporina.
9. Study of different mosquito vectors of protozoan parasites.
10. Submission of permanent slides at the time of examination.
11. Estimation of protein/Amino acid from cestodes/trematodes/nematode.
12. Detection of human related disease by using different
Immunological kit.

Practical Paper No. SBD41605 3P – (Practical based on SBD41605 3T)

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. SBD41606 3P (Practical based on SBD41606 3T)

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. SBD41607 3P (Practical based on SBD41607 3T)

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.

Practical Paper no. SRD416073P - Research Project –I

(Credits – 4)

As per NEP 2020 Credit distribution structure for Two Years PG Program with Multiple Entry and Exit Options

Class: M.Sc. Second Year Semester: IVth 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	**SAD416504T**	Evolution And Behavior	3	-	3	-	12
	SAD416514T	General and Comparative Physiology	3	-	3		
	SAD416524T	Applied Biotechnology II	3		3		
	SAD416504P	Practical based on SAD416504T		2	-	1	
	SAD416514P	Practical based on SAD416514T	-	2	-	1	
	SAD416524P	Practical based on SAD416524T	-	2	-	1	
DSE (Choose any one from pool)	**SBD416534T**	Applied Parasitology- II	3	-	3	-	04
	SBD416544T	Animal physiology – II	3	-	3		
	SBD416554T	Molecular biology – II	3	-	3		
	SBD416564T	Fishery Science – II	3	-	3		
	SBD416534P	Practical based on SBD416534T	-	2	-	1	
	SBD416544P	Practical based on SBD416544T	-	2	-	1	
	SBD416554P	Practical based on SBD416554T	-	2	-	1	
	SBD416564P	Practical based on SBD416564T	-	2	-	1	
RM	**SRD416574P**	Research Project	-	6	-	6	06
			12	**14**	**12**	**10**	**Total credits 22**

Paper No. SAD41650 4T – EVOLUTION AND BEHAVIOUR

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 – Concept of Evolution, Theories of evolution & evolutionary forces 15 hrs

1. Origin of basic biological molecules: Abiotic synthesis of organic monomers and polymers;
2. Concept of Oparin and Haldane; Experiment of Miller (1953);
3. The first cell and Evolution of prokaryotes;
4. Origin of eukaryotic cells and Sex
5. Geological time scale. Major events in the evolutionary time scale
6. Origins of Major groups of animals (Amphibia, Reptilia, Birds and Mammals)
7. Stages in primate evolution including Homo, Recent findings on human evolution.
8. Concept of evolution and theories of organic evolution, Lamarckism, Darwinism,.
9. New concepts regarding Lamarckism and Darwinism, Neo-Darwinism and Modern Synthetic Theory.
10. Hardy-Weinberg law of genetic equilibrium and Evolutionary forces
    (i) Natural selection
    (ii) Mutation
    (iii) Isolation and its role in species formation
    (iv) Genetic drift
    (v) Migration
    (vi) Meiotic drive

Unit II – Characteristics of evolution 15 hrs

1. Speciation: patterns and mechanism of reproductive isolation, models of speciation (Allopatric, Sympatric, Parapatric). Evolutionary species concept, Phylogenetic species concept.
2. 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.

3. Characteristics of evolution, Extinction, replacement, irreversibility of specialization, etc. Adaptive diversity and nature of adaptation; Adaptive radiations, occupation of new environment and niche, mimicry and coloration.

Unit III – Animal Behavior (Ethology, social and reproductive behaviour) 15 hrs

1. Introduction to ethology: scope & significance
2. Learning: habituation, conditioning (classical & operant), insight learning, Fixed action patterns & innate behaviours
3. Biological rhythms: circadian, circannual, tidal
4. Methods of studying animal behaviour (field & lab techniques, ethograms)
5. Communication: visual, auditory, chemical, tactile signals
6. Sexual selection, mate choice, courtship behaviour (insects), Parental care strategies
7. Territoriality, Social organization: dominance hierarchies, altruism, kin selection, eusociality (insects, mammals)

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 & J.M. Valentine.
4. Futuyama, D.J. Evolution. Subject 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 5th ed. Cambridge Univ Press. By Manning

Paper No. SAD41651 4T - 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 **15 hrs**

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 **15 hrs**

Exchange of gases

1. Integumentary, Bronchial respiration, Aquatic to aerial breathing (Lungs, Trachea and Respiratory mechanisms).
2. Transporting of oxygen, CO_2, Regulation of fluid volume, the reticulo-endothelial system, coagulation of blood, energy-producing reactions and energy utilizing reactions,

Excretory system

3. 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.

Cardiovascular system

4. Comparative anatomy of heart structure, myogenic heart, specialized tissue, neural and chemical regulation of all above.

Sensory mechanisms

5. 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.

Unit III **15 hrs**

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.

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. SAD41652 4T - APPLIED BIOTECHNOLOGY - II

Contact Hours: 45 **Credit: 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:

- Describe principles and applications of DNA finger printing, Human genome project etc.
- Understand stem cells, policies, storage and applications.

Unit I: Biotechnology in Human Welfare **15 hrs**

1. **Forensic & Medical Applications**
   DNA fingerprinting: Principles (VNTRs, STRs), applications in crime and paternity cases.
   Wildlife forensics (case study)
   Human Genome Project: Implications in health and diseases.
2. **GM Crops & Food Safety**
   Benefits vs. controversies, safety assessments.
   Health Concerns: Allergenicity, antibiotic resistance markers

Unit II: Advanced Genomics, Bioinformatics and Transgenics **15 hrs**

1. **NGS Data Analysis:** Variant calling (WGS, WES), GWAS, ethical challenges. Cloud-based bioinformatics tools (brief overview), Targeted Sequencing: Panel genes vs. WES/WGS (cost/accuracy tradeoffs).
2. **Transgenic and Genetically Engineered Animals:** Transgenic Mouse, Creation of Gene knockout Mice.
3. **Transgenic Livestock**: Sheep, Poultry, Fish (with applications)
   Non- breeding strategies: Gene Transfer Methods (Microinjection, CRISPR-Cas9, viral vectors), Somatic cell nuclear transfer (e.g., Dolly the sheep).
   Breeding strategies: Embryo Technologies **(**Embryo transfer, in vitro fertilization (IVF), cloning**),** Sex selection

Unit III: Advanced Biotechnological Applications **15 hrs**

1. **Synthetic & Systems Biology**
   Systems Biology: Principles, Modeling (Computer simulation), applications in drug discovery.
   Synthetic Biology: Principle and applications, scope for the production of bioactive metabolite
2. **Pharmaceutical Biotechnology:** Use of Microbes in pharmaceutical industries,

Microbial Drug Discovery

Drug Design Strategies: Molecular screening (e.g. High-throughput screening), Rational Design (e.g. *in silico* docking)

Toxicity & Trials: LD50 and ED50, clinical phases.

3. **Stem Cells & Therapeutics**

   Stem cells: Types, Storage, Therapeutic applications in human degenerative diseases; Ethics & Policies of stem cells, Cord blood banking.

References

1. Brown, T. A. (2016). *Gene cloning and DNA analysis: An introduction* (7th ed.). Wiley-Blackwell.
2. Glick, B. R., & Patten, C. L. (2017). *Molecular biotechnology: Principles and applications of recombinant DNA* (5th ed.). ASM Press.
3. Karp, G. (2013). *Cell and molecular biology: Concepts and experiments* (7th ed.). Wiley.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular biology of the gene* (7th ed.). Pearson Education.
5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular biology of the cell* (6th ed.). Garland Science.
6. Campbell, M. A., & Heyer, L. J. (2013). *Discovering genomics, proteomics, and bioinformatics* (2nd ed.). Benjamin Cummings.
7. Primrose, S. B., & Twyman, R. M. (2013). *Principles of gene manipulation and genomics* (7th ed.). Wiley-Blackwell.
8. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Scott, M. P. (2021). *Molecular cell biology* (9th ed.). W.H. Freeman.
9. Chawla, H. S. (2011). *Introduction to plant biotechnology* (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
10. Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomson, J., & West, M. (2009). *Essentials of stem cell biology* (2nd ed.). Academic Press.

Practical Paper No. SAD41650 4P (Practical based on SAD41650 4T)

Evolution and Behavior

1. Practical based on Hardy-Weinberg law.
2. Lederberg experiment.
3. Courtship behavior in *Drosophila*.
4. Observation & recording of bird calls, courtship, feeding
5. Reading behavior of praying Mantis.
6. Preparation of ethograms for birds, mammals or insects (local species).
7. Schooling behavior of fish.
8. Phototaxis / geotaxis / chemotaxis experiments
9. Field visit to an animal husbandry centre.
10. Visits to museums / natural history collections / field surveys

Practical Paper No. SAD41651 4P (Practical based on SAD41651 4T)

General and Comparative Physiology

1. Qualitative survey of digestive enzymes in any vertebrate.
2. Estimation of salivary amylase activity.
3. Determination of abnormal and normal constituents of urine.
4. Estimation of chloride from haemolymph/ urine of cow.
5. Estimation of uric acid from serum.
6. Total count of R.B.C from human blood.
7. Differential count of W.B.C from human blood.
8. Estimation of Haemoglobin and carrying capacity of blood.
9. Measurement of blood pressure.
10. Hematin crystal formation.
11. Effect of temperature on the heart beat and Q10 measurement.
12. Effect of temperature on the rate of oxygen consumption
13. Measurement of respiratory quotients.

Practical Paper No. SAD41652 4P (Practical based on SAD41652 4T)

Applied Biotechnology -II

1. Use of biological database from Expasy and NCBI.
2. Retrieval of Nucleotide sequence from GenBank.
3. Retrieval of Protein sequence from GenBank.
4. Sequence similarity search by using BLASTN.
5. Sequence similarity search by using BLASTP.
6. Accessing structural database and download the protein structure.
7. Multiple Sequence Alignment.
8. Protein modelling based on DNA sequencing database/RNA sequencing database.
9. Protein modelling based on Amino acid sequencing database.
10. Green synthesis of nanoparticles.
11. Characterization of nanoparticles with the help of UV Spectroscopy/FTIR.
12. Size identification of nanoparticles with the help of SEM.
13. Antibacterial activity of nanoparticles on E. Coli.
14. Calculation of LD50 of given organism.

Paper No. SBD41653 4T - 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 **15 hrs**

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

Unit - II: Clinical Parasitology and Control. **15 hrs**

1. Parasitic diseases of:

a) Alimentary canal: GI tract, liver, abdominal cavity, Trematode infection: Fascioliasis, Taeniasis, Echinococcosis, strongyloidiasis, Tricho-strongyloidiasis, Oxyurid infection, Hook worm diseases.

b) Tissue and Blood system: Trichuriasis, loiasis, Hydatid disease, Cysticercosis, Coenurosis, Sparganosis, Schistosomiasis, Filariasis.

c) Nervous system: *Parastrongylus cantonensis*, *Taenia solium*.

2. 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, treatment, immunization.

3. Strategies-planning and control: Malaria, Human Schistosomiasis, Guinea worm disease, Strongyloidiasis, Filariasis, Tape worm.

Unit -III: Biology and Physiology of Parasites. **15 hrs**

1. Miracidia and Cercaria of Trematodes: Dispersal, micro-habitat selection, Host-directed orientation, Attachment remaining on the host and penetration.
2. Parasitic Hormones: Influence of parasites on the hosts endocrine systems. Importance of host hormone for parasites.
3. Study of medically and veterinary important Parasite:

Fasciola hepatica, Moniezia sp., Raillietina sp., Trichuris trichiura, *Ascaris sp.*, *Schistosoma mansoni.*

4. Morphology life history, diseases/ harm caused and the control of following:
   a) Parasitic Acanthocephala and Annelida (Any one example each).
   b) Parasitic Siphonoptera, Anupleura, Mallophaga.
   c) Parasitic Diptera, Hemiptera and Pentastomidea.
   d) Parasitic Arachnida – Tick, Mite.

Reference Books:

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 PrioritiesProject.
   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): 21-27Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Globaltrends in emerging infectious diseases. Nature 2008; 451(21): 990-993.
5. Applied parasitology - Hiware, Jadhav and Mohekar
6. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
7. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
8. Text book Medical Parasitology of Jaypee Brothers, - Panikar C.K.J (1988) Medical Publishers, New York.
9. Bio- Chemistry and physiology of protozoa -Hutner and Lwoff II Ed. Vols I and II
10. Prozoan Parasites of domestic animals and man – Levine.

Paper No. SBD41654 4T– ANIMAL PHYSIOLOGY-II

Contact Hours: 45 **Credits- 3**

Learning Objectives:

- To understand the basic mechanisms involved in physiological processes of vertebrates studied in animal, veterinary and medical sciences.

Learning Outcomes:

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

- Explain cell transport, its types, cell growth and cell regulation.
- Describe hormonal mechanism and reproductive physiology.
- Knowledge about respiratory, nervous and excretory physiology.

Unit I **10 hrs**

1. Colloidal properties of cell; the cell as a polyphasic colloidal system.
2. Active transport, principles and mechanisms involved in transport:
   a) endocytosis - Pinocytosis, Phagocytosis, Phagotrophy, Autophagy
   b) exocytosis
3. Cell growth: Measurement of cell growth and regulation of growth; cell growth in tumors.
4. Bioluminescent organs in different vertebrates, physical properties of bioluminescence; chemistry of light production and functional significance of bioluminescence.

Unit II **15 hrs**

1. Osmotic balance and ionic regulation in different vertebrates, role of hormones in osmoregulation.
2. Nitrogenous excretory products: Their detoxification, formation of ammonia, ornithine cycle, ammonia toxicity and detoxification, role of aldosterone, ADH hormone and renin-angiotensin system in Renal physiology.
3. Physiology of respiration: Structure of organs of respiration in air and water.
   Respiratory pigments and Chemistry of oxygen transport. Factors affecting respiration, role of thyroid hormones in basal metabolic rate.

Unit III **20 hrs**

1. Structure of myofibrils; protein molecules in myofibrils; mechanism of muscle contraction, force and shortening velocity, role of calcium in cross Bridge attachment.
2. Nerve cell and their classification; how resting potential is maintained; origin and development of action potential; synapses and theories of synaptic transmission.
3. Reproductive Physiology:
   a) Sex determination and differentiation, differentiation of gonads in mammals.
   b) Leydig cells, morphology, differentiation and its regulation.
   c) Spermatogenesis, composition and formation of semen.
   d) Ovarian follicular growth and differentiation, oogenesis, vitellogenesis, ovulation and ovum transport in mammals.
   e) Hormonal mechanisms of implantation, pregnancy, parturition and lactation in mammals.

Reference Books:

1. EckertN Animal Physiology by David Randall.
2. Comparative animal physiology by Prosser C.L.
3. General and comparative physiology by - Florey W.A.
4. General and comparative physiology by Hoar W.B.
5. Animal physiology by Neilsen K.S.
6. Cell physiology by Giese A.C.
7. General physiology by Giese A.C.
8. A textbook of Biochemistry by West E.S. and Told W.R.
9. Cell Biology by Ambrose and Fastly.
10. Principle of animal physiology by Wilson J.A.
11. Animal physiology by Gordon G.S.
12. Modern physiology by Strang F.L.
13. Comparative physiology of animals by Hill R.W.
14. Medical physiology Guyton.
15. General endocrinology C.D. Turner
16. Endocrinology, Hadley, M.E. Pearson education (Singapore).

Paper no. SBD41655 4T - MOLECULAR BIOLOGY -II

Contact Hours: 45 **Credits- 3**

Learning Objectives:

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

Learning Outcomes:

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

- Explain gene, heredity and DNA, RNA as a genetic material.
- Describe about DNA damage and types of repairs.
- Have knowledge about genomic organization, cot and rot values, gene families etc.

Unit I **15 hrs**

1. **Extra chromosomal replication:** Replication of phage DNA φX174, T7, SV-40, rolling circle model of replication. Linear DNA-ends, terminal proteins, replication of plasmid DNA .Replication of RNA viruses and variations in them.
2. Structure and mechanism of reverse transcriptase and integrase (HIV), replication of tumor virus (RSV).
3. **Eukaryotic DNA replication:** Replicative and repair enzymes of eukaryotes. Initiation, elongation by eukaryotic DNA polymerases.
4. Isolation of ARS of yeast, ORC, Licensing factors and control of eukaryotic DNA replication, role of MCM proteins.
5. Replication of organelle genomes, maintenance of ends of linear DNAs; telomeric DNA and telomerase. Regulation of eukaryotic DNA replication and inhibitors of DNA replication.

Unit II **15 hrs**

1. **Eukaryotic promoters:** Class-II core promoter, modular organization, SV40 early promoter. Linker-scanning mutagenesis, TATA Box, downstream promoter elements, proximal promoter elements, TATA-less promoters and initiators. Class-I and Class-III promoters, Enhancers and silencers. Class-II pre-initiation complex, foot-printing DAB. Structure and function of TFIID, TBP and associated factors (TAFs). Phosphorylation of CTD of RNA pol-II, Mediator complex and RNA polymerase.
2. Transcription in eukaryotes: Separation of nuclear RNA polymerases- rat liver RNA pol. Roles of the RNA polymerases. Sensitivity to α-amanitin. Subunits of RNA pol-II (yeast pol-II).
3. Heterogeneity of Rpb1 subunit. Formation and maintenance of transcription bubble. Elongation factors: Effect of TFIIS, reversal of transcription arrest, proof reading of transcripts. Composition and working of transcription units at class-I and class-III promoters.

Unit III **15 hrs**

1. **Eukaryotic translation:** Eukaryotic translation initiation-scanning model, eukaryotic initiation factors, role of eIF4E, F, and G.
2. Formation of stable 48S initiation complex, role of eIF1 and eIF1A, toeprinting assay, direction of polypeptide synthesis and mRNA translation. Control of translation in bacteria and eukaryotes.
3. Amino acyl-tRNA synthetases, formation of ternary complex among amino- acyl tRNA, EF-T, and GTP,
4. Three site model of ribosome, peptide bond formation, G- protein and translation, stop codon suppression, release factors, aberrant termination, non-stop mRNAs, termination of transcription, termination codon, no-go-decay of mRNA.
5. Inhibitors of prokaryotic and eukaryotic translation.
6. Post-translational modifications of proteins.
7. Mechanism of translational control.

References

1. Cooper G. M. 1996. The Cell A Molecular Approach, Sinauer Associates, Inc.,
2. Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing, New York and London.
3. Harvy F. Lodish (Editor) Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger,Matthew P. Scott, S. Lawrence Zipursky, James Darnell: Authors. Molecular Cell Biology. W. H. Freeman and Co., Publishers
4. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. Molecular biology of cell. Garland Publishing Inc., New York.
5. Freifelder D. Molecular Biology. A Comprehensive Introduction to Prokaryotes and Eukaryotes. Jones and Bartlett, USA.
6. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
7. Voet D, Voet JG. Biochemistry. Ed. John Wiley & Sons. New York.
8. Benjamin Lewin. Gene VIII
9. E.D. and P.D. DeRobertis Cell and Molecular Biology

Paper No. SBD41656 4T – FISHERY SCIENCE -II

Contact Hours: 45 Credits- 3

Learning Objectives:

- To provide knowledge to the students about the recent trends and techniques of fishery.
- To impart knowledge about various physiological processes of fish.
- To inculcate knowledge about adaptations, migration, feeding etc. in fish.

Learning Outcomes:

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

- Explain physiological processes including respiration, reproduction, digestion etc.
- Describe coloration, feeding habits, migration and bioluminescence.
- Develop knowledge about structure and functioning of endocrine glands of fish.
- Explain the hormonal control and mechanisms in physiological processes.

Unit I: Functional Anatomy and Physiological Systems in Fish 20 Hrs

1. Digestive system and physiology of digestion, Food and feeding habits, age and growth study, factors affecting growth
2. Structure of heart, blood vascular and peripheral circulatory system
3. Structure of kidney, ionic balance and osmoregulation, physiology of excretion
4. Reproductive system and physiology of reproduction
5. Embryological development in fish, parental care in fish
6. Respiratory organs, physiology of respiration, swim bladder.
7. Central nervous system (CNS) and cranial system, Lateral line system, sensory organs.
8. Structure of eye and image formation, Weberian ossicle.
9. Types of scales, fins, and girdles

Unit II: Ecological and Adaptive Physiology of Fish 10 Hrs

1. Coloration in fish, physiology of collaboration
2. Types of migration, adaptations of hill stream and deep-sea fishes
3. Bioluminescence and physiology of light production
4. Venom and venomous glands
5. Electric organs and their functions

Unit III: Endocrinology and Hormonal Regulation in Fish 15 Hrs

1. Structure and function of endocrine glands
2. Pituitary gland: adenohypophysis and neurohypophysis, stainable and non-stainable fibers
3. Adrenal gland: adrenocortico-steroids, corpuscles of Stannius, adrenal medullary hormones, pituitary-adrenal axis
4. Urohypophysis: Urotensin I and II
5. Thyroid gland: hormone synthesis, thyrotrophic hormones and functions
6. Pancreas: hormones, role in glucose metabolism and homeostasis
7. Hormone classification, nature, principles, and hormone receptors, Hormones and control mechanisms. Sex hormones: types, biosynthesis pathway, Gonadotropin-

releasing hormones (GnRH), role of gonadotropins, biochemical nature, Hormonal control of reproductive behavior and sex differentiation

8. Prolactin cells and their hormones, role in osmoregulation and melanogenesis
9. Calcium regulation in fish.

References Books:

1. Prosser & Brown- Comparative Physiology
2. Pillay,T.V.R.& M.A. Dill.- Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979.
3. Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.,1979.
4. Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
5. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982
6. Bardach, et. al. -Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
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.
11. Douglas P Anderson - Text Book of Fish Immunology
12. Nandini Shetty- Immunology. Introductory Textbook.
13. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi,
14. Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
15. Shang, Y.C. -Aquaculture Economic Analysis – An Introduction. 1990.
16. Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963.
17. Hoar, W.S. & D.J. Randal- Fish Physiology, Vols. 1–4, Academic Press, NY,1970.
18. Carl, B.E. Biology of Fishes- Saunders, 1979.
19. Turnor- Textbook of endocrinology
20. Day, F. -The fishes of India.

Practical Paper No. SBD41653 4P (Practical based on SBD41653 4T)

Applied Parasitology -II

1. Study of prevalence and intensity of parasites from locally available hosts.
2. Demonstrate/study the effect of season/phonological factors as the prevalence and intensity of parasites.
3. Separation of immunological protein (alpha, beta, gamma) by paper or gel electrophoresis.
4. Estimation of antigen and antibodies in samples by quantitative precipitation assay.
5. Examination of fecal sample of sheep, goat and chicken.
6. Histopathology of Caeca of chicken to study different stages of schizonts.
7. Techniques for collection, fixation, preservation, staining, mounting and identification of different nematodes from different / various hosts.
8. Collection, preservation and identification of veterinary and medically important Annelids, Acanthocephalans and Arthropods.
9. Study of different types of mouthparts of vectors.
10. Visit to veterinary and medical parasitology/ pathology laboratory and study of food and water borne parasites.
11. Submission of permanent slides at the time of examination.

Practical Paper No. SBD41654 4P (Practical based on SBD41654 4T)

Animal Physiology -II

1. Denaturation and Coagulation of egg albumen.
2.Isoelectric point of Casein.
3. Effect of temperature on Heartbeat of fish, Q 10 measurement.
4.Effect of drugs on respiration of fish.
5.Estimation of Chloride from urine
6. Estimation of Uric acid from rectum/blood of lizard/birds.
7.Determination of clotting time of blood.
8.Differential count of WBC form blood of human.
9.Effect of drugs on rate of heart beat.
10.Demonstration of Adrenalectomy and ovariectomy in rat.

Practical Paper No. SBD41655 4P (Practical based on SBD41655 4T)

Molecular Biology -II

1. Transformation of DNA in yeast /plant /animal
2. Gene expression by Gal-x.
3. Detection/ determination of Auxotroph mutant.
4. Chromatin digestion with micrococcal nuclease.
5. Isolation of DNA from animal / plant cells with help of PCR using kits.
6. Restriction digestion of DNA using nucleases.
7. DNA amplification using PCR.
8. Molecular weight determination using column chromatography and PAGE.
9. Isolation of plasmids from bacteria.
1o. Separation of DNA by gel electrophoresis
11. Separation of protein by gel electrophoresis

Practical Paper No. SBD41656 4P (Practical based on SBD41656 4T)

Fishery Science -II

1. Quantitative determination of glycogen, proteins and fats.
2. Dissections (any Bony fish)- digestive, reproductive, brain, pituitary gland and cranial Nerves.
3. Methods of food analysis with different feeding habits.
4. Study of different maturity stages and fecundity in fish.
5. Determination of growth in fish by scale or otolith method.
6. Determination of GSI and PI.
7. Histological preparation: Different glands and tissues.
8. Visiting CIFE, CIFA, FSI and CIFT etc.
9. Field work: Visit to fish production unit.

Practical Paper no. SRD41657 4P - Research Project

(Credits – 6)