RAIGANJ UNIVERSITY

DEPARTMENT OF ZOOLOGY

P.O.: Raiganj, Dist.: Uttar Dinajpur, West Bengal, Pin: 733134



Meaning of the Courses and their Abbreviations

Discipline Specific Course (DSC): A course, which may be offered by the main discipline/subject of study.

MINOR Course: An elective course, chosen from an unrelated discipline/subject of study, with an intention to seek exposure beyond discipline/s of choice

IDC/MDC: An elective course, chosen from an unrelated discipline/subject of study, with an intention to seek exposure beyond discipline/s of choice

Ability Enhancement Compulsory (AEC) Course: The course designed for knowledge enhancement consisting of Environmental Studies, English Communication/ Modern Indian Language (**MIL**) communication.

Skill Enhancement Course (SEC): The course designed to provide value-based and/or skill-based knowledge relating to the main discipline.

Value Added Course (VAC): The objective of the value added course is to supplement the curriculum, to make students develop their own interest and aptitude andto offer placement education, skill enhancing to the student community enabling for future employment.

Internship/Apprenticeship/Project/Community (IAPC): Assist the students to acquaint to design research objective and to develop skills to solve the problem by hands-on experiment on different disciplines.

SEM-1 DSC-1 Non-Chordates, Essential Structures and Functions Spin (0) 10 (0) 60 4 MINCR-1 Biosystematics and Animal Diversity Spin (0) 0 45 3 AEC Centralized 0 45 3 VAC1 Centralized 0 45 3 Ward With/Centrificat Converse the end of semester-II Structures 35:10.01 60 4 SMC2 Chordates: Essential Structures and Functions 35:10.01 60 4 MinoR P2 Human Physiology, Nutriture Biology & Sports Biomechanics 35:10.01 60 4 MINOR P2 Human Physiology, Nutriture Biology & Sports Biomechanics 35:10.01 60 4 MINOR P2 Pundamentals of Hiochemistry & Biodownistly Register (PBR)Bes 60 4 3 VAC2 Centralized Drojet related to: Peoples Biodiversity Register (PBR)Bes 60 4 MINOR PA Human Physiology: Centrolling and Coordination 35:10.01 60 4 MINOR PA Human Physiology: Centrolling and Coordination 5:10.01	Semester	Paper Code	Contents	Theory	Practical	Total	Credit
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IDC LMDC1 Fundamentals of Ecology 59:10 90:0 95:0 90:0		MINOR-1	Biosystematics and Animal Diversity	35+10 (3)	15 (1)	60	4
AEC Centralized Join (1) 45 3 VAC1 Centralized 30 (2) 15 (1) 45 3 May exit with Certificate Course at the and of semester:II 55:10 (3) 15 (1) 60 4 MINOR3.2 Human Physiology, Nurther Biology & Sports Biowechanics 35:40 (3) 15 (1) 60 4 MINOR3.2 Fundamentals of Biochemistry & Biochemistry & Biodycental Pharmacology 36:40 (3) 0 45 3 AEC-2 Centralized Fundamentals of Biochemistry & Biochemical Pharmacology 30 (2) 45 (1) 45 3 SEC-3 Public Health Entomology & Vector Biology 30 (2) 15 (1) 45 3 VAC-2 Centralized Project related to: Peoples Biodiversity Register (PBR/Beccee)		IDC 1/MDC1	Fundamentals of Ecology	35+10 (3)	0	45	3
SEC1 Advances in Aquaculture 30 (2) 15 (1) 45 3 May exit with Certificate Course at the end of senester-II Status St		AEC	Centralized				
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SEM_2 DSC 2 Chordales: Essential Structure and Functions 39-10.91 15 (1) 60 4 MINOR2 Human Physiology: Nutrition Biology: & Sports Biomechanics 38-10.91 15 (1) 60 4 IDC-2MIDC2 Centralized Incl. 2010 45 3 AEC2 Centralized Incl. 2010 45 3 VAC2 Centralized Incl. 2010 45 3 VAC2 Centralized Incl. 2010 45 3 APC Neeping/Fish Fram Management/ Sericulture/Animal Human Huma	May exit wi	th Certificate Cou	rse at the end of semester-II				
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IndexInstance </td <td>SEM-5</td> <td>DSC-8</td> <td>Essentials of Endocrinology & Metabolic Disorders</td> <td>35+10 (3)</td> <td>15 (1)</td> <td>60</td> <td>4</td>	SEM-5	DSC-8	Essentials of Endocrinology & Metabolic Disorders	35+10 (3)	15 (1)	60	4
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Students will be awarded 4 years graduate degree		MINOR-8	Elementary knowledge to Immunology	35+10 (3)	15 (1)	60	4
	Students w	ill be awarded 4 ye	ars graduate degree				

Gross Outline of Undergraduate-Zoology Syllabus

Programme Outcome

- 1. To promote holistic development of students having the world view of a truly global citizen.
- 2. To provide flexibility to students so that learners have the ability to choose their learning trajectories and programmes, and thereby choose their paths in life according to their talents and interests.
- 3. To eliminate harmful hierarchies among disciplines/fields of study and silos between different areas of learning.
- 4. Multidisciplinary and holistic education to ensure the unity and integrity of all knowledge.
- 5. To promote creativity and critical thinking and to encourage logical decision-making and innovation.
- 6. To promote ethics and human & Constitutional values.
- 7. To impart life skills such as communication, cooperation, teamwork, and resilience.
- 8. To promote outstanding research as a co-requisite for outstanding education and development.
- 9. To incorporate Indian Knowledge System relevant for a particular discipline or field of studies.
- 10. Impart quality life science education to women students and to develop young women as outstanding scholars/ teachers/ career women/ entrepreneurs and responsible citizens.
- **11.** Appreciate the complexities of biological organization and address scientifically controversial issues in a rational way.
- 12. Assess the scope of animal biology and select particular areas for further study.
- 13. Inculcate transformational impact on the quality of education and to inspire the students to adopt scientific temper and live with scientific values.
- 14. Make the students aware of applications of Zoology and to highlight the potential of various branches to become an entrepreneur.
- 15. Be familiar with human population growth on a global scale. Understand the ways that organisms interact with each other in the natural environment. Understand how factors such as size and location of habitat influence the number of species found in a given area.

SEMESTER-I

Course title: Non-Chordate Structure and Functions Course code: DSC1 Course type: Major Credit: 4 (Theory + Practical) Full marks: 60 [Theory: 45 (Credit: 3) + Practical:15 (credit 1)]

1. Objectives of learning:

- 1.1 To learn the mechanism of classification of living animals
- 1.2 To understand and identify the faunal diversity in the planet
- 1.3 To comprehend the variety of organ systems in different phylum in animal kingdom
- 1.4 Develop insights to compare the evolution of organ systems through the animal kingdom

2. Learning outcome:

- **2.1** The students will be able to appreciate the variety of life forms existing in earth.
- **2.2** They will be able to identify existing faunal diversity in their surroundings.
- **2.3** They will be developing concepts regarding the developmental hierarchy in living organisms.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Outline sketch of topics:

4.1 Theory: [Marks: 45 (End term examination: 35, Internal assessment: 10), Credit: 3]:

Units	Description of the topics	No. of lectures
Ι	Basics of Animal Classification: Definition: Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types; Codes of Zoological Nomenclature; Synonymy and Homonymy; Six kingdom concept of classification (Card woese)	1
II	Protista: Classification up to class (according to Levine et. al., 1981) and General characters of Protozoa; Locomotion in Amoeba; Evolution of symmetry and segmentation of Metazoa	3
III	Porifera: General characters and Classification up to class, Water canal system in Porifera, Spicules in sponges	2
IV	Radiata: General characteristics and Classification up to classes in Cnidaria, Polymorphism in Cnidaria, Corals and coral reef diversity, General characteristics of Ctenophora.	3
V	Platyhelminthes and Nematoda: General characters of Helminthes, Parasitic adaptations, Life cycle of <i>Taenia solium</i> and <i>Ascaris lumbricoides</i>	2
VI	Annelida: Evolution of coelom and metamerism, General characters and Classification up to classes of Annelida, Metamerism, Excretion in Annelida through nephridia.	2
VII	Arthropoda: General characteristics and Classification up to classes, Respiration in Arthropoda (Gills in prawn and trachea in cockroach),	3
VIII	Onycophora: General characteristics and Evolutionary significance	1
IX	Mollusca: General characteristics and Classification up to classes, Nervous system and torsion in Gastropoda	3
X	Echinodermata : General characteristics and Classification up to classes, Water Vascular system in Starfish, larval forms and their affinities with chordates	3
XI	Hemichordata: General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	1

Note: Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th edition.

4.2 Practical (Marks:15, Credit:1):

Units	Description of the topics	No. of Lectures
Ι	Identification of Amoeba, Euglena, Entamoeba, <i>Paramecium</i> (from the prepared slides)	1

II	Identification of Sycon, Obelia, Physalia, Millepora, Aurelia, Gorgonia, Metridium, Pennatula, adult Fasciola hepatica, Taenia solium and Ascaris lumbricoides	1
Ш	Identification of Annelids - Aphrodite, Nereis, Pheretima, Hirudinaria	1
IV	Identification of Arthropods - <i>Limulus, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Julus.</i> Onychophora - <i>Peripatus</i>	1
V	Molluscs - Chiton, Dentalium, Pila, Unio, Pinctada, Sepia, Octopus, Loligo.	1
VI	Echinodermates - Asterias, Ophiura, Echinus.	1
VII	Dissect and display mouth parts, salivary gland, digestive system, nervous system, reproductive system, straited muscles of <i>Periplaneta americana</i> (cockroach)	2
VIII	Dissect and display gills and nervous system of prawn	1

5. Suggested reading:

5.1 For theory:

- **5.1.1 Ruppert and Barnes, R.D. (2006).** Invertebrate Zoology. 8th Edition. Holt Saunders International Edition.
- **5.1.2** Brusca and Brusca (2022). Invertebrates. 3rd edition, Sinauer Associates.
- **5.1.3 Kotpal, R.L. (2020).** Modern textbook of Zoology (Invertebrates). 12th Edition. Rastogi Publication.
- **5.1.4** Jordan and Verma (2009). Invertebrate Zoology. 15th Edition, S. Chand publishers.
- **5.1.5** Brusca, R. C. and Brusca, G. J. (2002). Invertebrates. 4th Edition. Sinauer Associates. Sunderland. Massachusetts 01375.
- **5.1.6 Chatterjee and Chatterjee (2014). Advanced** Practical Zoology. Books and Allied Publishers.
- **5.1.7** Ruppert and Barnes, R.D. (2006). Invertebrate Zoology. 8th Edition. Holt Saunders International Edition.
- **5.1.8** Sinha, K. S., Adhikari, S., and Ganguly, B. B. (2018). Biology of Animals. Vol. I. New Central Book Agency. Kolkata.

5.2 For practical:

- **5.2.1** Ghosh, K.C. and Manna, B. (2015). Practical Zoology. New Central Book Agency. Kolkata.
- 5.2.2 Lal, S.S (2016). Practical Zoology Invertebrate. Rastogi Publication. Lucknow.
- **5.2.3** Singh, S (2016). Zoology Practical Handbook. 1st edition. Vishal Publishing.

Course title: Biosystematics & Animal Diversity Course code: MINOR-1 Course type: Minor Credit: 4 (Theory + Practical) Full Marks: 60 [Theory: 45 (Credit 3) + Practical: 15(Credit 1)

1. Objectives of learning:

- **1.1** To understand the animal diversity around us
- **1.2** To understand the underlying principles of classification of animals
- 1.3 To understand the terminology needed in classification
- 1.4 To understand the differences and similarities in the various aspects of classification
- **1.5** To classify invertebrates and to be able to understand the possible group of the invertebrate observed in nature
- 1.6 To understand our role as a caretaker and promoter of life
- **1.7** Understand the constraints that animals deal with on a regular basis and ways in which they deal with those constraints
- **1.8** Understand how biologists study populations

2. Learning outcomes:

- 2.1 The student will be able to understand classify and identify the diversity of animals.
- 2.2 The student understands the importance of classification of animals and classifies them effectively using the six levels of classification.
- 2.3 The student knows his role in nature as a protector, preserver and promoter of life which he has achieved by learning, observing and understanding life.
- 2.4 The students will be able to analyze interactions within the context of specific habitats and judge how the habitat shapes the distribution and abundance of species. Key factors that influence the habitat include climate, energy input, spatial/temporal complexity, and resource availability.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practical requiring field study will be assisted by the faculty concerned.

4. Outline sketch of topics:

4.1 Theory [Marks:45 (end term examination:35, internal assessment:10), Credit:3]:

Units	Description of the topics	No. of Lectures
Ι	<i>Taxonomy & Systematics:</i> Taxonomy: Basic terminology and Introduction. Alpha, Beta and Gamma levels of taxonomy, Micro-taxonomy, Macro taxonomy: Phenetics (numerical taxonomy, Cladistics (Phylogenetic systematics), Evolutionary taxonomy (evolutionary systematics) Classical taxonomy and experimental or neo taxonomy (biochemical taxonomy and Cytotaxonomy), Significance of Taxonomy, Systematics: definition introduction	
II	<i>Linnaean system of classification</i> (Six level classification: Phylum, class, order, family, genus, species), Concept of Species: Biological & Evolutionary Introduction to Binomial Nomenclature. Introduction to Five kingdom system.	2
III	Protista - Protozoa General Characters of Protozoa; Locomotion in Amoeba	1
IV	Porifera -General characters and Water canal system in Porifera	1
V	Radiata - General characters of Cnidarians, Polymorphism	1
VI	Pseudocoelomates - General characters of Nematoda; Parasitic adaptations	1
VII	Annelida - General characters of Annelida; Metamerism	1
VIII	Arthropoda - General characters, Metamorphosis	1
IX	Mollusca- General characters of mollusc; Nervous system.	1
X	Echinodermata - General characters of Echinodermata, Water Vascular system in Starfish	1
XI	Protochordata - Salient features	1
XII	Pisces - General Characters, Osmoregulation	1
XIII	Amphibia - General characters, Adaptations for terrestrial life, Parental care	1
XIV	Reptilia - General Characters Amniotes; Biting mechanism, types of skulls.	1
XV	Aves -General Characters The origin of birds; Flight adaptations	
XVI	Mammalia - General Characters of mammals; Primates; Dentition in mammals	1

4.2 Practical (Marks: 15, Credit:1):

Units	Description of the topics	No. of Lectures
I	Identification of Non-Chordates: Euglena, Amoeba, Paramecium, Sycon, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Chiton, Dentalium, Octopus, Asterias, Sepia, Loligo and Antedon.	2
II	Identification of Chordates: <i>Balanoglossus, Amphioxus, Petromyzon,</i> <i>Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus, Draco,</i> <i>Naja, Viper</i>	2
III	Dissections of Digestive and nervous system of Cockroach	2
IV	Mounting of different types of Fish scales	2
V	Dissecting out pecten from chick eye	2

5. Suggested reading:

5.1 For theory:

- **5.1.1 Ruppert and Barnes, R.D. (2006).** Invertebrate Zoology. 8th Edition. Holt Saunders International Edition.
- **5.1.2** Brusca and Brusca (2022). Invertebrates. 3rd edition. Sinauer Associates.
- **5.1.3 Kotpal, R.L.** (2020). Modern textbook of Zoology (Invertebrates). 12th Edition. Rastogi Publication.
- **5.1.4** Jordan and Verma (2009). Invertebrate Zoology.15th edition. S. Chand publishers.
- **5.1.5** Brusca, R. C. and Brusca, G. J. (2002). Invertebrates. 4th Edition. Sinauer Associates. Sunderland. Massachusetts 01375.
- **5.1.6 Chatterjee and Chatterjee (2014). Advanced** Practical Zoology. Books and Allied Publishers.
- **5.1.7 Ruppert and Barnes, R.D. (2006).** Invertebrate Zoology, 8th Edition. Holt Saunders International Edition.
- **5.1.8** Sinha, K. S., Adhikari, S., and Ganguly, B. B. (2018). Biology of Animals. Vol. I. New Central Book Agency. Kolkata.

5.2 For practical:

- **5.2.1** Ghosh, K.C. and Manna, B. (2015). Practical Zoology. New Central Book Agency. Kolkata
- **5.2.2 Lal, S. S. (2016).** Practical Zoology Invertebrate. Rastogi Publication. Lucknow.

5.2.3 Singh, S (2016). Zoology Practical Handbook, 1st edition. Vishal Publishing.

Course title: Fundamentals of Ecology Course code: IDC1/MDC1 Course Type: Minor Credit: 3 Full Marks: 45 [Semester examination: 35 + Continuous evaluation: 10]

1. Objectives of learning:

- **1.1** They will be able demonstrate a broad understanding of the processes that shape the distribution and abundance of organisms from the micro-habitat to the globe.
- **1.2** They will be able to recognize that the distribution of organisms is a product of positive and negative interactions within and across trophic levels, including competition, mutualism, predation, and parasitism.
- **1.3** Can evaluate the relationships among ecological interactions, habitat context and the evolution of organism form and function. Distinguish how the evolution of organism form and function influences ecological interactions and habitat tolerance and judge how ecological processes in turn shape the evolution of organism form and function.
- **1.4** Judge how organism function, habitat context and interactions within and across trophic levels influence the flow of energy and the movement and recycling of matter in communities and ecosystems.
- **1.5** Judge how ecological processes across all scales are affected by human activities, and apply basic ecological principles to meet societal resource management and conservation goals.

2. Learning outcomes:

- **2.1** The learners will be able to identify and critically evaluate their own beliefs, values and actions in relation to professional and societal standards of ethics and its impact on ecosystem and biosphere due to the dynamics in population.
- **2.2** To understand anticipate, analyse and evaluate natural resource issues and act on a lifestyle that conserves nature. The Learner understands and appreciates the diversity of ecosystems and applies beyond the syllabi to understand the local lifestyle and problems of the community.
- **2.3** The learner will be able to link the intricacies of food chains, food webs and link it with human life for its betterment and for non-exploitation of the biotic and abiotic components.
- **2.4** The working in nature to save environment will help development of leadership skills to promote betterment of environment.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Outline sketch of topics:

4.1 Theory [Marks: 45 (End term examination: 35, Internal assessment:10), Credit: 3]:

Units	Description of the topics	No. of Lectures
I	<i>Introduction to Ecology:</i> Definition of ecology, Autecology and Synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, Habitat and niche.	2
п	Ecosystem types: Types of ecosystems with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Aquatic (Freshwater, estuarine, Marine and terrestrial (Forest, Grassland and Desert)	3
III	Population: Unitary and Modular populations, Demographic factors, Survivorship curves, dispersal and dispersion, exponential and logistic growth, equation and patterns, r and K strategies Population, regulation - density- dependent and independent factors, Population Interactions, Gause's Principle, Lotka-Volterra equation for competition, concept of meta-population – demes and dispersal, interdemic extinctions, age structured populations. Density, Natality, Mortality, Fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. Exponential and logistic growth, Population regulation – density-dependent and independent	5
IV	Community -Community characteristics: species diversity, abundance, dominance, richness, Ecotone and edge effect. Ecological succession in detail with examples, species interaction.	2
V	Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with an example of Nitrogen cycle. Major terrestrial biomes; theory of island biogeography.	2
VI	Beneficial Associations: Commensalism (remora fish on shark, Cattle egrets on livestock), Mutualism (Termite and Trichonympha, bees and flowers, cleaning symbiosis in fish by prawns. Antagonistic associations: Parasitism (Ascaris and man, lice and humans), Prey predation (Lion and deer).	4

VII	Ecological modelling: History of ecological modelling, Principle of ecological	3
	modelling, Application of ecological modelling.	5

5. Suggested reading:

5.1 For theory:

- 5.1.1 **P**.D. Sharma (2014). Ecology and Environment. 13th edition. Rastogi Publications.
- 5.1.2 Bowman, Hacker and Cain (2020). Ecology. 5th edition. Sinauer associates.
- 5.1.3 Peter, S. (2002). Ecology: Theories & Application. 4th edition. Prentice Hall India Learning.
- 5.1.4 Kumar, P. and Mina, U. (2021). Fundamentals of Ecology and Environment. 3rd edition. Pathfinder publications.
- 5.1.5 C. J. Krebs (2001). Ecology. The Experimental Analysis of Distribution and Abundance. Harper-Collins. NY.
- 5.1.6 Odum, E. P. (2017). Fundamentals of Ecology. 5th edition Cengage Learning India.
- 5.1.7 Desharnais, R., Bell, J, and Palladino, M. A. (2000). Ecology Student Lab Manual. Biology Labs'. Addison Wesley Longman. University of California.
- 5.1.8 Smith, T. M. and Smith, R. L. (2015). Elements of Ecology. 9th edition. Pearson Education.

Course title: Advances in Aquaculture Course code: SEC1 Course type: Major Credit: 3 (Theory + Practical) Full marks: 45 [Theory: 30 (Credit 2) + Practical: 15(Credit 1)]

1. Objectives of learning:

- **1.1** To understand the techniques involved in aquaculture practices.
- **1.2** To get a detailed information about aquaculture.

- **1.3** To provide a basic idea about the importance of live feed in culture systems. To know the basis of technologies of fisheries and aquaculture, to understand the principles of its importance, purpose and application.
- **1.4** To know the conditions of development of aquatic organisms and its habitat conditions, formation and change patterns of yielding in relate with the environmental changes of anthropogenic influence.
- **1.5** To know the fisheries and aquaculture schemes used in breeding, rearing and feeding technologies in farms, their purpose and principles of application, be aware of the fisheries and aquaculture design and construction principles, taking into account the legislation and directives.
- **1.6** Describe the fisheries and aquaculture business management features, methods, and strategies for aquaculture business development, operational funding, fisheries and aquaculture production innovation and marketing issues and strategies.
- **1.7** Apply traditional research methods, scientific literature, information technologies and statistical methods of calculation to perform and summarize the research and creative use results of analysis by preparation of the final thesis and oral presentations.
- **1.8** Apply modern equipment in laboratories, special computer programs for design of fisheries and aquaculture farms by implementation of innovative ideas for management of farms.
- **1.9** Describe the fisheries and aquaculture technological processes, identify problems and solve them, relate agriculture activity and aquaculture productivity and safety, analyze and evaluate effects of the fisheries and aquaculture on the environment, to provide the preventive safety measures.
- **1.10** Apply methods and techniques used in fisheries and aquaculture design and construction, their management methods and quality assurance principles.
- **1.11** Solve the technological challenges related to management of fisheries and aquaculture farms; organize activities to ensure their entrepreneurship and competitiveness.
- **1.12** To critically and logically contemplate, to have a reasoned opinion and be able to defend it, to gather and present scientific information to different audiences.

2. Learning outcomes:

- **2.1** The learners will be aware of all the techniques involved in aquaculture.
- 2.2 At the end of the course, student can able to gain the knowledge on the aquaculture practices.
- 2.3 Will be able to define the basic features of aquaculture.
- 2.4 Express the importance of aquaculture.
- 2.5 Recognize the fish farming technology and equipment.
- 2.6 Will be able to express the problems in aquaculture.

- 2.7 Explain the problems in aquaculture farm construction and water for aquaculture.
- 2.8 Explain the diseases and the parasite problems in aquaculture.
- **2.9** Will be able to recognize the culture methods of some aquatic animals.
- **2.10** Explain the culture of plankton for the feeding aquatic animals.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Outline sketch of topics:

4.1 Theory [(Marks: 30 (end term examination: 20, internal assessment: 10), Credit:2]:

Units	Description of the topics	
Ι	Introduction to aquaculture: Definition, scope and importance of	
_	aquaculture.	4
	Sustainable Aquaculture System: Sustainable Aquaculture Culture System:	
	Extensive, Semi intensive, Intensive, Water quality in culture ponds and	
	factors controlling water quality. Preparation and Management of Fish	
II	Culture Ponds, Polyculture or Composite fish culture, integrated fish farming,	3
	pen and cage culture, and • raceway culture. Flow through system. Biofloc.	
	Cold water fishery, Sewage fed fishery (Basic concept), Induced Breeding of	
	Carps. Synthetic Hormones in Hypophysation.	
	Recent Advancement of Aquaculture: Ornamental Fisheries, Preparation and	
III	Management of Fish Aquarium. Common characters and sexual dimorphism	2
	of fresh water and marine aquarium fish: Guppy, Molly, Sword tail, Gold fish,	3
	Angel fish, Blue morph, Anemone fish, Butterfly fish.	
	Fish Nutritional requirements: Feed Formulations and Preparation of	
IV	Compound Diets. Capture Fishery: Fishing Crafts and Gears, Fish	4
	Preservation and By-products.	
v	Fin Fish pathology: Name of Infective Diseases. Causative Agents, Symptoms	
	and Control. Fungal (Saprolegniasis), Bacterial (Dropsy, Fin and Tail rot),	5
	Protozoan (White Spot Disease) and Parasitic (Gyrodactylosis,	3
	Dactylogyrosis)	

VI	Applied Aquaculture :Prawn Farming and Pearl Culture: Species of commercial prawn; types of prawn farming; methods of prawn farming, Pearl producing molluscs, pearl formation, methods of pearl culture.	2
VII	Fish Biotechnology: Transgenic Fish, Aquaponics	3

4.2 Practical (Marks: 15, Credit:1):

Units	Description of the topics	No. of Lectures
Ι	Spot identification: Identification of different fish species using Meristic characters. (Systematic position, specimen characters), <i>Labeo rohita, Catla catla, Cirrhinus mrigala, Cyprinus carpio, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Clarias batrachus, Heteropneustes fossilis, Channa punctatus, Anabas testudineus. Macrobrachium rosenbergii, Penaeus monodon</i>	4
II	Aquarium management: Setting of aquaria; Fabrication; Maintenance.	
III	Water quality criteria for Aquaculture: Assessment of Water temperature, pH, conductivity, Total dissolved Solids	2
IV	Field visit to an Aquaculture farm/ Hatchery: Project report on a visit to an Aquaculture farm/ Hatchery	2

5. Suggested reading:

5.1 For theory:

- 5.1.1 Chaudhuri, S. (2017). Economic Zoology. NCBS.
- 5.1.2 Das, M.K. and Das, R.K. (1997). Fish and Prawn Diseases in India- Diagnosis and Control. InlandFisheries Society in India, Barrackpore, West Bengal.
- 5.1.3 Das, S. (2022). Aquarium Fishery.
- 5.1.4 Dunham, R.A. (1985). Aquaculture and Fisheries Biotechnology. Genetic Approaches. CABI.
- 5.1.5 Govindan, T.K. (2008). Fish Processing Technology. Oxford and IBH Publishing Co. Pvt. Ltd. Kolkata.
- 5.1.6 Jhingran, V.G. (2007). Hindustan Publishing Corporation. 3rd Edition.
- 5.1.7 Khanna, S.S. and Singh, H.R. (2017). A Text Book of Fish Biology and Fisheries. Narendra Publishing House.
- 5.1.8 Lutz. C.G. (2001). Practical Genetics for Aquaculture. Fishing News Book. Oxford.
- 5.1.9 Menon, A.G.K. (1999). The Freshwater Fishes of India, A Handbook. Z.S.I

- 5.1.10 Pierre Boundry, Andy Beaumont, Kathryn Hoare. (2010). Biotechnology and Genetics in Fisheries and Aquaculture. Wiley Blackwell.
- 5.1.11 Pillai, T.V.R. and Kutty. (2007). Fishing News Book. 2nd Edition.
- 5.1.12 Sarkar, S., Kundu, G. Chaki, K.C. (2017). Introduction to Economic Zoology. NCBA
- 5.1.13 Pillay, T.V.R . (1990). Aquaculture Principles & Practices. Fishing News (Books) Limited, London.
- 5.1.14 Bardach, John.E. (1997). Sustainable Aquaculture. John Wiley and Sons.
- 5.1.15 Chapman, V.J. (1980). Seaweeds and theirs uses Chapman and Hall London.
- 5.1.16 Wheaton, F.W. (1977). Aquaculture Engineering. John Wiley and Sons. New York.
- 5.1.17 Stickney (1995). Principles of Aquaculture, John Wiley & Sons.
- 5.1.18 Santhanam R. N. Ramanathan and G. Jegatheesan (1990). Coastal Aquaculture in India. CBS publishers and Distributors.
- 5.1.19 Joachim W., Hertrampft and Pascal, F.P. (2000). Handbook on Ingredients for Aquaculture feeds. Kluwer Academic Publishers. London.
- 5.2. For practical:
- 5.2.1. Chaudhuri, S. (2017). Economic Zoology. NCBS.
- 5.2.2. Das, M.K. and Das, R.K. (1997). Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Society in India. Barrackpore. West Bengal..
- 5.2.3. Das, S. (2022). Aquarium Fishery.

SEMESTER-II

DSC-2 Course title: Chordates: Essential Structure and Functions Credit: 4 (Theory + Practical)

1. Objectives of learning:

- 1.1 To learn the mechanism of classification of living animals.
- 1.2 To understand and identify the faunal diversity in the planet.

- 1.3 To comprehend the variety of organ systems in different phylum in animal kingdom.
- 1.4 Develop insights to compare the evolution of organ systems through the animal kingdom.

2. Learning outcome:

- 2.1 The students will be able to appreciate the variety of life forms existing in earth.
- 2.2 They will be able to identify existing faunal diversity in their surroundings.
- 2.3 They will be developing concepts regarding the developmental hierarchy in living organisms.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. Morefocus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field studywill be assisted by the faculty concerned.

4. Outline sketch of topics:

4.1 Theory: [(Marks: 45 (end term examination: 35, internal assessment: 10), Credit:3]:

Units	Description of the topics	No. of Lectures
Ι	Introduction to Chordates: General characteristics and outline classification of Phylum Chordata	1
II	Protochordata: General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in Ascidia. Chordate Features and Feeding in Branchiostoma	2
III	Origin of Chordata: Dipleurula concept and the Echinoderm theory of origin of chordates. Advanced features of vertebrates over Protochordata	3
IV	Agnatha: General characteristics and classification of cyclostomes up to order. Type study of Petromyzon sp.	2
V	Pisces: General characteristics and classification of Chondrichthyes and Osteichthyes up to order. Accessory respiratory organ, migration and parental care infishes.Sdder in fishes (Clasification up to Sub- Type study of Scoliodon sp.	3
VI	Amphibia: General characteristics and classification up to living Orders.Metamorphosis and parental care in Amphibia.	3
VII	Reptilia: General characteristics and classification up to living order. Poison apparatus and Biting mechanism in Snake.	
VIII	Aves: General characteristics and classification up to Sub-Classes. Exoskeleton and migration in Birds.Principles and aerodynamics of flight.	2

VIII	Mammals: General characters and classification up to living orders.	3
	Affinities of Prototheria Exoskeleton derivatives of mammals. Adaptive	
	radiation in mammals with reference to locomotory appendages.	
	Echolocation in Micro chiropterans and Cetaceans.	

4.2 Practical (Marks: 15, Credit:1):

Units	Description of the topics	
Ι	Protochordata- Balanoglossus, Herdmania, Branchiostoma	3
II	Agnatha- Petromyzon, Myxine	3
III	Fishes- Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Raja, Trygon, Mystus, Clarias, Notopterus, Wallago, Heteropneustes, Labeo, Catla, Cirrhinus, Puntius, Exocoetus, Echeneis, Anguilla, Hippocampus, Syngnathus, Tetradon/ Diodon, Anabas, Flat fish	3
IV	Amphibia- Necturus, Bufo, Hyla, Alytes, Axolotl, Tylototriton	2
V	Reptilia- Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus. Key for Identification pf poisonous and non-poisonous snakes	2
VI	Mammalia- Bat (Insectivorous and Frugivorous), Funambulus	3
VII	Pecten from Fowl head	2
VIII	Dissection of brain and pituitary of Tilapia	2
IX	Power point presentation on study of any two animals from two different classes by students (only demonstration)	

5. Suggested reading:

5.1 For theory:

- 5.1.1 **Young, J. Z. (2004).** The Life of Vertebrates. 3rd Edition. Oxford university press. Pough H. Vertebrate life. 8th Edition. Pearson International.
- **5.1.2** Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. 4th Edition. Jones and Bartlett Publishers Inc.
- **5.1.3 Parker, T. J. and Haswell, W. (1972).** Text Book of Zoology, Volume II: Marshall and Willam (Eds.)7th Edition. Macmillan Press. London.

- **5.1.4 Kardong, K. V. (2002).** Vertebrates: Comparative anatomy, function evolution. Tata McGrawHill.
- **5.1.5** Kent, G. C. and Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Edition. McGraw Hill.
- 5.1.6 Nelson, J.S., (2006). Fishes of the World. 4th Edition. Wiley.
- **5.1.7** Romer, A. S. and Parsons, T. S. (1986). The vertebrate body. 6th Edition. Saunders College Publishing.
- **5.1.8** Jordan, E.L. and Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
- **5.1.9** Sinha, K. S., Adhikari, S., Ganguly, B. B. and Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd

5.2 For practical:

- 5.2.1 Ghose, K.C. and Manna, B. (2015) Practical Zoology. New Central Book Agency. Kolkata.
- 5.2.2 Lal, S.S. (2016). Practical Zoology Invertebrate. Rastogi Publication. Lucknow.
- **5.2.3** Singh, S. (2016). Zoology Practical Handbook, 1st edition. Vishal Publishing.

Course title: Human Physiology, Nutr	ition biology & Sports Biomechanics
Course code: MINOR-2	
Course type: Minor	
Credit: 4 (Theory + Practical)	
Full marks: 60 [Theory: 45 (Credit 3) +	Practical: 15(Credit 1)

1. Objectives of learning

- **1.1** To understand the structure of the different organ systems in man/mammals. To understand and identify the faunal diversity in the planet.
- 1.2 To comprehend the variety of organ systems in different phylum in animal kingdom
- **1.3** Develop insights to compare the evolution of organ systems through the animal kingdom.

2. Learning outcome:

- **2.1** The students will be able to appreciate the variety of life forms existing in earth.
- **2.2** They will be able to identify existing faunal diversity in their surroundings.
- **2.3** They will be developing concepts regarding the developmental hierarchy in living organisms.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the concerned faculty.

4. Outline sketch of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Units	Description of the topics	No. of
т	Digestion and Absorption of Food: Structure and function of digestive	3
1	glands; Digestion and absorption of carbohydrates, fats and proteins	0
П	Functioning of Excitable Tissue (Nerve and Muscle): Propagation of	3
	nerve impulse (myelinated and non-myelinated nerve fibre); Mechanism	
	of muscle contraction (Sliding filament theory).	
III	Respiratory Physiology: External and internal Respiration, Transport of	3
	oxygen and carbon dioxide in blood, Factors affecting transport of gases.	
IV	Renal Physiology: Mechanism and regulation of urine formation.	2
V	Cardiovascular Physiology: Structure of heart, Coordination of	2
	heartbeat, Cardiac cycle, ECG.	
X / T	Endocrine and Reproductive Physiology: Structure and function of	3
VI	endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal,	
	ovaries, and testes), Brief account of spermatogenesis and oogenesis,	
	Menstrual cycle. Mechanism of steroidal and peptide hormone action.	
	Sports Biomechanics: Principles and Methods of Sports Training,	4
VII	Fatigue, Injuries and Rehabilitation, Biomechanics on Biological Systems,	
	Statistical Methods in Sports& Computer Application.	

4.2 Practical (Marks: 15, Credit: 1):

Units	Description of the topics			No. of Lectures			
Ι	Sports video analysis using Kinovea or similar software.			2			
II	Demonstration	of	common	yoga	postures	-	2

	Adho Mukha Svanasana, Virabhadrasana, Utthita Parvakonasana,	
	Uttanasana, ViparitaVirabhadrasana.	
III	Preparation of haemin and haemochromogen crystals.	2
IV	Preparation of temporary mount of Blood film.	2
V	Examination of permanent histological sections of mammalian	4
	oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid,	
	pancreas, adrenal, testis, ovary.	

5. Suggested reading:

5.1 For Theory

5.1. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology. 12th

Edition. John Wiley and Sons, Inc.

5.2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology. 11th Edition. McGraw Hill.

5.3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology. 12th Edition. Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.

5.4. Marieb, E. (1998). Human Anatomy and Physiology. 4th Edition, Addison-Wesley.

5.5. Kesar, S. and Vashisht, N. (2007). Experimental Physiology. Heritage Publishers.

5.6. Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand and Company Ltd.

5.2 For Practical

5.2.1 Ghose, K.C. and Manna, B. (2015). Practical Zoology. 2nd Edition. New Central Book Agency.

5.2.1 Poddar, T., Mukhopadhyay, S., and Das, S. K. (2015). 1st Edition. An Advance Laboratory Manual of Zoology. Trinity Press.

Course Title: Fundamentals of Biochemistry & Biochemical Pharmacology Course Code: IDC2/MDC2 Course Type: Minor Credit: 3 Full Marks: 45 [Semester end examination: 35 + Continuous evaluation: 10]

1. Objectives of learning

- 1.1 To understand the structure and function of biomolecules
- 1.2 To explore the pathways of metabolism and energy production
- **1.3** To get practical skills in biochemical techniques.
- 1.4 To apply biochemistry to understand diseases and develop treatments.

2. Learning outcomes:

- 2.1 Students will understand the molecular basis of life process.
- 2.2 Students will be able to apply biochemical knowledge to solve problems in medicine, agriculture and environmental science.
- 2.3 Students can pursue further education or careers in areas such as medicine, pharmacology, biotechnology and academia.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. Morefocus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Description of topics:

4.1 Theory Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Units	Description of the topics	No. of Lectures
	Carbohydrate: Structure and Biological importance: Monosaccharides,	3
Ι	Disaccharides, Polysaccharides; Derivatives of Monosachharides. Carbohydrate	1
	metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway,	1
	Gluconeogenesis.	L

п	Lipid: Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids. Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis.	3
III	Proteins : Amino acids- Structure, Classification, General and Electro chemical properties of α -amino acids; Physiological importance of essential and non-essential amino acids. Proteins-Bonds stabilizing protein structure; Levels of organization. Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic, amino acids.	4
IV	<i>Nucleic Acids:</i> Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids. Types of DNA and RNA, Complementarity of DNA, Hpyo-Hyperchromaticity of DNA, Basic concept of nucleotide metabolism.	4
V	<i>Enzymes:</i> Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanismof enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk, plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)	6

5. Suggested reading:

5.1 For theory:

- 5.1.1 Campbell and Farrell. (2012). Biochemistry. 7th Edition. Brooks and Cole.
- 5.1.2 Das, D. (2010). Biochemistry. Central Book Agency, Kolkata
- **5.1.3 Devlin, T.M. (1992).** Text Book of Biochemistry with clinical correlation, Wiley Liss,. New York.
- **5.1.4** Elliot, W.H. and D.C. Elliot, (1994). Biochemistry and molecular Biology, 2nd Ed., Oxford UniversityPress.
- **5.1.5** Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry. 2nd Edition, BIOSScientific Publishers Ltd. U.K.
- **5.1.6** Jain, J.L., Jain m S and N. Jain. (2005). Fundamentals of Biochemistry. 6th Ed. S. Chand Pub. N. Delhi.
- 5.1.7 Maheswari, N. (2008). Clinical Biochemistry. Jaypee Pub. NewDelhi.
- **5.1.8** Metzler D.E., (2001). The chemical reactions of living cells –2nd edition, 2001, AcademicPress.
- **5.1.9** Nelson, D.L. and Cox, M.M. (2017). Lehninger's Principle of Biochemistry. 7th Ed. Worth Publishers. New York.
- 5.1.10 Sathyanarayana U. and Chakrapani. (2002). Biochemistry –Books & Allied (P) Ltd. Kolkata.
- 5.1.11 Stryer, L. (2002). Biochemistry. 7th Edition. W.H. Freeman and Company. New York.

5.1.12 Voet. D and Voet. J.G. (2004). Biochemistry. 3rd edition. John Wiley & Sons, Inc.

Course Title: Public Health Entomology & Vector Biology Course Code: SEC2 Course Type: Major Credit: 3 (Theory + Practical) Full Marks: 45 [Theory: 30 (Credit 2) + Practical: 15 (1)]

1. Objectives of learning:

- 1.1 To know the general morphology and anatomy of Arthropod which is very essential for learning insect.
- 1.2 To know the huge diversity of insects detailed description of classification of insec classification is very important.
- 1.3 To understand the life-history, bionomics of the various vectors causing transmissable diseases
- 1.4 To identify the various larval instars of mosquito species of anopheline and culicine mosquitoes.
- 1.5 To identify the sand fly adult and identifying the major species.
- 1.6 To be acquainted with the control measures of insect vectors with special emphasis on mosquitoes.
- 1.7 To be familiar with the insecticides generally used to control pests ,their classification, dose, mode of action.
- 1.8 To know the various alternative control measures for vector control.

2. Learning outcomes:

- 2.1 The learners will be able to appreciate major features of morphology and anatomy of Arthropods and insects.
- 2.2 The huge diversity of insect is very to study and therefore knowing the major orders will give students overall idea regarding the insect world to a great extent.
- 2.3 In depth bionomics, life-history and identification study will help students to identify the larval and adult stages of the anopheline and culicine vector life- stages which are very indispensable for vector diversity study and vector profiling of any particular region.
- 2.4 Students will be able to understand major vector of Kala-Azar and many areas of Uttar Dinajpur district contains ample amount of this vector. Therefore, idea regarding this vector bionomics, life-history and control measures of this vector is crucial.

- 2.5 The learners will be able to work out the control measures of vector control.
- 2.6 Nowadays major focus on vector control encompasses around alternative control and therefore learning the biological, pheromonal, hormonal control measures of mosquito control will help students immensely to understand the environment –friendly vector control.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practical requiring field study will be assisted by the faculty concerned.

4. Description of topics:

4.1 Theory Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Units	Description of the topics	No. of Lectures
Ι	Arthropods: General Classification with characters.	2
Π	Arthropods of Public Health importance: Taxanomy, classification – order- family – general characters.	2
III	Insects: Morphology–General structure and metamorphosis. Digestive System and Nervous System. Reproductive System. Circulatory System. Excretory System.	3
IV	Morphology, Life History, Bionomics, and identification of anophelines.	2
V	Morphology, Life History, Bionomics, and identification of culicines (Filaria Vectors).	2
VI	Morphology, Life History, Bionomics, and identification of phlebotomine sandflies.	2
VII	Control of Arthropod Vectors: Source Reduction, Chemical control, Biological Control, Genetic Control, Personal Protection and other Measures.	3
VIII	Pheromones and Insect Growth Regulators.	2
IX	Integrated Pest Management (IPM).	2

X	Integrated Vector Control (IVC) and Comprehensive Vector Control.	2
XI	Insecticides: types, formulations, dosages, uses, mode of action, precaution and antidotes.	3

4.2 Practical (Marks: 15, Credit: 1):

Units	Description of the topics	No. of Lectures
Ι	Techniques for collection, transportation, preservation and mounting of insects.	2
П	Mounting of wings and antennae.	5
III	Identification of Anophelines, Culicines -larvae and adult.	2
IV	Susceptibility test of mosquitoes against some frequently used insecticides.	4
V	Dissection of mosquito mouth parts, gut and Salivary glands.	2
VI	Dissection of spermatheca of sand fly for species identification.	2
VII	Different types of haemocyte study from the haemolymph of cockroach.	2
VIII	Identification of predators of Mosquitoes and bio-control agents.	4
IX	Demonstration of spray equipments –parts, operations, discharge rates, maintenance.	2
X	Demonstration of fogging instruments-parts, operations, maintenance.	2
XI	Identification of medically important insects other than mosquitoes and house flies (flea, sand fly, black fly, biting midge, lice, bed-bug).	4

5. Suggested reading:

5.1 For theory:

- **5.1.1** Ananthakrishnan, T.N. (1996). Biotechnological perspectives in Chemical ecology of Insects (EditedBook) Oxford & IBH.
- 5.1.2 Atwal. (1976). Agricultural pests of India and South-East Asia Kalyani Publishers.
- **5.1.3** Chapman. R.F. (2000). The Insects: Structure and Function. 4th Edition. Cambridge Univ. Press
- **5.1.4** Chatterjee, P.B. (1997). Plant protection techniques, Bharati Bhawan.
- 5.1.5 D. De Sarkar (1998). The Silkworm: Biology, Genetics and Breeding. Vikas. New Delhi.
- **5.1.6** Gullan, P.J. and Cranston, P.S. (1994). The Insects, An outline of Entomology. Chapman & Hall.
- **5.1.7** Gupta, A.P. (2017). Immunology of Insects and other arthropods. Taylor & Francis Group.
- **5.1.8** Hill, D.S. (1987). Agricultural Insect pests of the tropics and their control Cambridge University Press. Cambridge (Rept. Ed.).
- **5.1.9** Kerkut, G.A. and Gilbert, L.I. (1985). Comprehensive Insect Physiology. Biochemistry and Pharmacology. Vols. 1-12. Edition. Pergamon Press, Oxford. Kettle.

- 5.1.10 Morohoshi. S. (2000). Development Physiology of Silkworms, Oxford & IBH. New Delhi.
- **5.1.11** Persley, G.J. (1996). Biotechnology and Integrated pest management. CAB International.
- **5.1.12** Pfadt, R.E. (1985). Fundamentals of Applied Entomology, Macmillan Publishing Company.
- **5.1.13** Price, P.W. (1997). Insect Ecology.3rd Ed. John Wiley & Sons Inc. Singh, S. 1982.Bee Keeping in India, I.C.A.R. New Delhi.
- **5.1.14** Speight, M.R. Hunter, M.D. and Watt, A.K. (1998). Ecology of Insects. Concepts and Application. Blackwell Science.

5.2 For practical:

- **5.2.1** Atwal, A.S. and Balraj, S. (1989). Pest population and assessment of crop loss. Publication & Information division. Indian Council of Agricultural Research.
- 5.2.2 Pedigo, L.P. (1996). Entomology and pest management. Prentice-Hall of India Pvt. Ltd.
- 5.2.3 Medical and veterinary entomology, CAB International Manuals on Sericulture. (1976). Vol. 1-4. EAO of the United Nations, Rome Mc Gavin, G. C. 2001.
- **5.2.4** Essential Entomology An order-by-order introduction.1st Edition. Oxford Universitypress.

SEMESTER-III

Course title: Cell biology Course code: DSC 3 Course type: Major Credit: 3 (Theory + Practical) Full marks: 60 [Theory: 45 (Credit 3) + Practical: 15 (Credit 1)]

1. Objectives of learning:

- **1.1** This course introduces the students to the basics of cell and its components. This gives them a strong foundation on the basic unit of life.
- **1.2** Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- **1.3** Students will understand how these cellular components are used to generate and utilize energy in cells. Students will understand the cellular components underlying mitotic cell division.

- **1.4** Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
- **1.5** The learners will be able understand the process of cellular response mediated by the external stimulus and the molecular components associated with the cell response.

2. Learning Outcome:

- **2.1** Describe the evolution, diversity and replication of cells;
 - 2.2 Explain the role of compartmentalization and signalling in cellular biology;
 - 2.3. Interpret and explain key experiments in the history of cell biology;
 - 2.4. Evaluate and apply knowledge of modern techniques in cellular biology.
 - 2.5. Interpret, analyse, describe and present new experimental data.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Description of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Units	Description of the topics	No. of Lectures
Ι	Overview of Cells Basic structure of Prokaryotic and Eukaryotic cells,	4
	Viruses, Viroid, Prion and Mycoplasma.	
II	Plasma Membrane Ultra structure and composition of Plasma	
	membrane: Fluid mosaic model Transport across membrane: Active	5
	and Passive	
	transport, Facilitated transport Cell junctions: Tight junctions, Gap	
	junctions, Desmosomes.	
III	Cytoplasmic organelles I Structure and Functions: Endoplasmic	
	Reticulum, Golgi Apparatus, Lysosomes Protein sorting and	4
	mechanisms of vesicular transport,	
IV	Cytoskeleton Type, structure and functions of cytoskeleton, Accessory	4
	proteins of microfilament & microtubule A brief idea about molecular	
	motors	
V	Nucleus Structure of Nucleus: Nuclear envelope, Nuclear pore	
	complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and	4
	packaging (nucleosome)	

VI	Cell Division: Cell cycle and its regulation, Cancer (Concept of	3
	oncogenes and tumor suppressor genes with special reference to p53,	
	Retinoblastoma and Ras and APC.	
VII	Cell Signaling. Mitosis and Meiosis: Basic process and their	
	significance. Cell signalling transduction pathways; Types of signaling	4
	molecules and receptors GPCR and Role of second messenger (cAMP),	
	Extracellular matrix-Cell interactions Apoptosis and Necrosis.	

4.2 Practical (Marks: 15, Credit: 1):

Unit	Description of the topics	No. of lectures
Ι	Preparation of permanent slide to show the presence of Barr body in	3
	human female blood cells/cheek cells.	
II	Preparation of temporary stained squash of onion root tip to study	4
	various stages of mitosis	
III	Study of various stages of meiosis.	4
IV	Preparation of permanent slide to demonstrate: (i)DNA by Feulgen	4
	reaction, (ii) Cell viability study by Trypan Blue staining	

5.Suggested reading:

5.1 For theory

- **5.1.1** Albert, B., Dennis, B., Julian, L., Martin, R., Keith, R., and James, W. (2008). Molecular Biology of the Cell. 5th Edition. Garland publishing Inc. New York and London.
- **5.1.2** Cooper, G.M. (2018). The Cell: A Molecular Approach. 8th Edition. Oxford University Press. 816 pages.
- **5.1.3** Karp, G. (2015). Cell and Molecular biology: Concepts and Application. 8th Edition. Wiley.
- 5.1.4 Lodish, H. (2016). Molecular Cell Biology. 8th Edition New York: W.H. Freeman.
- **5.1.5 Plopper, G, D. Sharp and Siroski, E (2013). Lewin's** Cell 3rdEdition—Johns & Bartlett Publishers.
- 5.1.6 Green, D.R. (2011). Apoptosis: Physiology and Pathology. Cambridge Univ. Press.
- **5.1.7** Verma and Agarwal. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Pub. Meerut. U.P.
- **5.1.8 Weinberg R.A. (2014).** Biology of Cancer. 2ndedition. Garland Science. Taylor and Francis.
- 5.2 For practical:
 - 5.2.1 Ghose, K.C. and Manna, B. (2015). Practical Zoology. 2nd Edition. New Central Book Agency

5.2.1 Poddar, T., Mukhopadhyay, S., and Das, S. K. (2015). 1st Edition. An Advance Laboratory Manual of Zoology. Trinity Press

Course Title: Animal Physiology: Controlling & Coordinating Systems Course Code: DSC 4 Course Type: Major Credit: 3 (Theory + Practical) Full Marks: 60 [Theory: 45 (Credit 3) + Practical: 15 (Credit 1)]

1. Objectives of learning

- **1.1** To understand the fundamental principals of animal physiology including homeostatis and cell signaling.
- **1.2** To describe the structure and function of major organ systems in animals, such as the nervous, muscular and circulatory systems.
- **1.3** To explain the mechanism of animal behavior in response to internal and external stimuli.
- **1.4** To analyze the physiological adaptation of animals to their environments.
- **1.5** To conduct basic experiments to investigate physiological processes in animals

2. Learning Outcome:

- 2.1 The students will develop a deep understanding of the principals governing the functioning of animal bodies.
- **2.2** The enhancement of critical thinking and analytical skill of complex physiological processes will be developed among students.
- **2.3** A holistic view will be developed about animals as integrated systems linking form to function and behavior.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the well-equipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Description of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

:		
Unit	Description of the topics	No. of lectures
	Tissues Structure, location, classification and functions of epithelial tissue,	
Ι	connective tissue, muscular tissue and nervous tissue.	4
	Bone and Cartilage Structure and types of bones and cartilages, Ossification.	
II		3
III	Nervous System: Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and Neuromuscular junction; Reflex action and its types	4
IV	Muscular system: Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre.	5
v	Respiratory and circulatory system - Structure and function of hemoglobin and myoglobin. Oxygen and carbon dioxide transport, Oxygen dissociation curve. Structure of vertebrate hearts, comparative study of artery, vein and capillary.	3

4.2 Practical:

Unit	Description of the topics	No. of
		lectures
Ι	Blood-Hb, TC and DC (own blood).	1
II	Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells	3
III	Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid	4
IV	Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues	4

5.Suggested reading:

- 4.3 For theory:
- **5.1.1.** Hill,W.R., Wyse,G.A. and Anderson, M.A. (2016). Animal Physioloby. 4th Edition. Sinauer Associates.
- 5.1.2. Verma, P.S., Tyagi, B.S. and Agarwal, V.K. (2000). Animal Physiology, S. Chand Limited.

- **5.1.3. Cui, Naftel, Daley, Lynch, Haines, Yang and Fratkun (2011)**. Atlas of Histology with Functional and Clinical Correlations. Lippincoat. Williams and Wilkins.
- 5.1.4. Randall, D., and Burggren, W. (2002). Eckert Animal Physiology. 5th Edition. W. H. Freeman.
- **5.1.5.** Ross and Pawlina. (2010). Histology: A Text and Atlas. 6th Edition. Lippincott Williams & Wilkins.
- **5.1.6.** Sembulingam and Sembulingam. (2012). Essentials of Medical Physiology. 6th Edition. Jaypee Pub. New Delhi.
- **5.1.7.** Vasudeva and Mishra. (2014). Inderbir Singh's Text book Of Human Histlogy. 7th Edition. Jaypee Publisher N. Delhi

4.4 For Practical:

5.2.1 Ghose, K.C. and Manna, B. (2015). Practical Zoology. 2nd Edition. New Central Book Agency.

5.2.1 Poddar, T., Mukhopadhyay, S., and Das, S. K. (2015). 1st Edition. An Advance

Laboratory Manual of Zoology. Trinity Press.

Course Title: Human Health, Community hygiene and Immunization Course Code: Minor 3 Course Type: Minor Credit: 4 (Theory + Practical) Full Marks: 60 [Theory: 45 (Credit 3) + Practical: 15 (Credit 1)]

1. **Objectives of learning:**

1.1 To monitor health status to identify community health problems.

- **1.2** To diagnose and investigate health problems and health hazards in the community.
- **1.3** To Inform, educate, and empower people about health issues.
- **1.4** To mobilize community partnerships to identify and solve health problems.
- **1.5** To develop policies and plans that support individual and community health efforts.
- **1.6** To enforce laws and regulations that protect health and ensure safety.

1.7 To Link people to needed personal health services and assure the provision of health care when otherwise unavailable.

1.8 To assure a competent public health and personal healthcare workforce.

1.9 To evaluate effectiveness, accessibility, and quality of personal and population-based health services.

2. Learning outcome:

- 2.1 After completing the programme, the students shall be familiar with the concepts of, and knowledge related to, the global distribution of illness and access to health care services, and be able to critically analyse health burdens, policies and initiatives. o understand and identify the faunal diversity in the planet.
- 2.2 The students' competencies are acquired through emphasising on multidisciplinary and multi-sectoral approaches and bringing together the understanding of a wide range of players in improving community health. Develop insights to compare the evolution of organ systems through the animal kingdom.
- 2.3 The students will also have acquired and demonstrated the skills necessary to plan and conduct a research project of relevance to community health and global health.

3. Teaching learning approach:

Theoretical classes will be conducted using traditional teaching tools such as chalk and board, as well as modern visual aids like overhead or LED projectors. Emphasis has been placed on practical learning rather than theory. Students will have the opportunity to demonstrate and perform practical experiments in the well-equipped department laboratory. For practicals that involve field study, the faculty members will provide assistance and guidance.

4.Outline sketch of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Unit	Description of the topics	No. of
		lectures
Ι	Health: (i) Introduction to health- Definition, concept of health and disease,(ii)	7
	Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor	
	and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine	
	deficiency disorders- their causes, symptoms, treatment, prevention and	
	government programmes, if any. (iii) Life style related diseases- hypertension,	
	diabetes mellitus, and obesity- their causes and prevention through dietary and	
	lifestyle modifications, (iv) Social health problems- smoking, alcoholism, drug	
	dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes,	
	treatment and prevention. (v) Common ailments- cold, cough, and fevers, their	
	causes and treatment, (vi) Concepts of Nutrigenomics and health informatics	

II	Food hygiene and Community health: (i) Potable water- sources and methods of	4
	purification at domestic level, Food and Water borne infections: Bacterial infection:	
	cholera, typhoid fever, dysentery; Viral infection: hepatitis, poliomyelitis,	
	Protozoan infection: Amoebiasis, Giardiasis; Helminths infection: Taeniasis,	
	Ascariasis, Vector borne diseases: Malaria and Dengue, their transmission,	
	causative agent, sources of infection, symptoms and prevention, Brief account of	
	food spoilage: Causes of food spoilage and their preventive measures	
III	Immunization: (i) Immunity–Types, Classification; Antigen and antibody	4
	reaction, (ii) Hypersensitivity-skin test; serological tests, (iii) Immunoprophylaxis	
	: Vaccines & sera-Types & Classification, Storage and handling cold chain.	
	Immunization for various diseases; Immunization Schedule.	

4.2 Practical:

Unit	Туре	No. of
		lectures
Ι	To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric	3
II	Methylene Blue Reductase Test (MBRT) of milk.	2
III	Gram staining of bacteria.	3
IV	Study of the stored grain pests and mosquito vectors (Anopheles, Culex and	4
	Aedes) from slides/ photograph (Sitophilus oryzae, Trogoderma granarium,	
	identification, habitat and food sources, damage caused and control.	
V	Project on community health service in a selected rural area.	3

5. Suggested reading:

5.1 For Theory

5.1.1 Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy. 5th Edition. New Age International Publishers.

5.1.2 Srilakshmi B. (2002). Nutrition Science. New Age International (P) Ltd.

5.1.3 Srilakshmi B. (2007). Food Science. 4th Edition. New Age International (P) Ltd.

5.1.4 Swaminathan M. (1986). Handbook of Foods and Nutrition. 5th Edition. BAPPCO.

5.1.5 Bamji M.S., Rao N.P., and Reddy, V. (2009). Text Book of Human Nutrition. Oxford & IBH Publishing Co. Pvt Ltd.

5.1.6 Wardlaw, G.M., Hampl, J.S. (2007). Perspectives in Nutrition. 7th Edition. McGraw Hill.

5.1.7 Lakra, P., and Singh, M.D. (2008). Textbook of Nutrition and Health. 1st Edition. Academic Excellence.

5.1.8 Manay M.S., and Shadaksharaswamy. (1998). Food-Facts and Principles. New Age International (P) Ltd.

5.1.9 Gibney et al. (2004). Public Health Nutrition. Blackwell Publishing.

5.2 For Practical:

5.2.1 Ghose, K.C. and Manna, B. (2015). Practical Zoology. 2nd Edition. New Central Book Agency.
5.2.2 Poddar, T., Mukhopadhyay, S., and Das, S. K. (2015). 1st Edition. An Advance

Laboratory Manual of Zoology. Trinity Press.

Course Title: Introduction to Immunology & Immuno-pathology Course Code: IDC 3/MDC 3 Course Type: Minor Credit: 3 (Theory) Full Marks: 45 [Theory, (Credit 3)]

1. Objectives of learning

1.1 To understand the basic principles of innate and adaptive immunity.

1.2 To describe the role of the immune system in health and disease.

1.3 To explain how immune responses are initiated, regulated, and executed.

1.4 To recognize the structure and function of key immune molecules.

1.5 To apply immunological principles to clinical scenarios.

1.6 To develop critical thinking skills in immunology.

2. Learning Outcome:

2.1 Students will be able to understand the cellular and molecular components of the immune system.

2.2 Students will be able to explain the mechanisms of innate and adaptive immune responses.

2.3. Students will be able to describe the role of immunological memory in vaccination.

2.4 Students will be able to analyze immune dysregulation in autoimmune diseases and allergies.

2.5 Students will be able to evaluate the impact of immunodeficiency on susceptibility to infections.

2.6 Students will be able to interpret experimental data from immunological studies.

2.7 Students will be able to communicate complex immunological concepts clearly.

2.8. Students will be able to apply immunological knowledge to real-world clinical scenarios.

3. Teaching learning approach:

The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practicals will be demonstrated and performed by students in the wellequipped laboratory of the department. The practicals requiring field study will be assisted by the faculty concerned.

4. Outline sketch of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Unit	Туре	No. of
		lectures
Ι	Overview of Immune System:	3
	Basic concepts of health and diseases, Historical perspective of	
	Immunology, Cells and organs of the Immune system	
		2
11	Innate and Adaptive Immunity:	3
	Anatomical barriers, Inflammation, Cell and molecules involved in	
	innate immunity, Adaptive immunity (Cell mediated and humoral).	
III	Antigens :	3
	Antigenicity and immunogenicity, Immunogens, Adjuvants and	
	haptens, Factors influencing	
	immunogenicity, B and T-Cell epitopes	
IV	Immunoglobulins	3
	Structure and functions of different classes of immunoglobulins	
V	Major Histocompatibility Complex:	3
	Structure and functions of MHC molecules, Structure of T cell	
	Receptor	
VI	Complement System	3
	Components and pathways of complement activation.	
VII	Immunopathology	5
	Gell and Coombs' classification and brief description of various	
	types of hypersensitivities. Hypersensitivity disorders.	
	Immunologic tolerance and autoimmunity. Congenital and	
	acquired immunodeficiencies.	

5.Suggested reading:

5.1 For theory:

5.1. Abbas, K.A. and Lechtman, H. (2011). Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication.

5.1.2 Bhattacharya, S., and Sinha, J. (2006). A Text Book of Immunology. Academic Publishers. Kolkata. pages. 496.

5.1.3 Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2018). Immunology. 8th Edition. W.H.

5.1.4 Freeman and Company. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. 5th Edition. Saunders Publication.

5.1.5 Mohanty, S.K., and Leela, K.S. (2014). Text book of Immunology. 2nd Edition. Jaypee Pub. N. Delhi.

5.1.6 Parija, S.C. (2012). Text book of Microbiology and Immunology. 2nd Edition. Elsevier.

5.1.7 Punt,J, Stranford, S., Jones,P., Owen,J.(2017).Immunology by Kuby 8th Edition. W.H. Freeman and Co. N.Y.

1. Objectives of learning:

- 1.1. To provide knowledge about the various scopes available in environmental microbiology.
- 1.2. To provide them a clear view about the distribution and role of microorganisms in Biosphere.
- 1.3. Introducing the student society to microbial community and to inculcate ecofriendly nature in them by exploring the relationships between microbes and nature; their roles and utilization to improve environmental quality.

2. Learning outcome:

- 2.1. Understand the diversity of microbes in environment.
- 2.2. Acquire information about biogeochemical cycle and ecosystem.
- 2.3. Collect knowledge about microbial interaction.
- 2.4. Understand the basic about bioremediation.
- **3. Teaching learning approach:** The theoretical classes will be taken using chalk and board or visual aids like overhead/LED projectors. More focus has been laid on hands on practical rather than theory. The practical will be demonstrated and performed by students in the well-equipped laboratory of the department. The practical requiring field study will be assisted by the concerned faculty.

4. Topics distribution:

4.1 Theory initiality: 45 i theory = 55 , comunuous evaluation = 10 , Credit: 5

Unit	Topics	Allotted class number
Unit-I	Concept and scope of environmental microbiology: Biodiversity; Distribution of	3
	micro-organisms in nature; Adaptations of microbes; Environmental problems	6

	and microbial solution; Micro-organisms inhabiting extreme environments;	
	Environmental education; Environmental organizations and conventions.	
Unit-II	Biosphere-three major ecosystems: (a) Lithosphere- Composition; Soil microbes, factors influencing their distribution; Energy flow, food chain and food web. (b) Hydrosphere- Water-microbes; Bioluminescence; Energy flow, pyramid of biomass. (c) Atmosphere- regions of atmosphere; Aero-microflora of hospitals and other houses. Air sampling and disease forecasting.	4
Unit-III	Microbial interactions: Plant-microbe interactions and Microbe-microbe interactions. Beneficial: commensalism, synergism, and symbiosis. Harmful: competition, amensalism, predation and parasitism. Solid waste management. Vermicomposting. Biogas technology.	3
Unit-IV	Microorganisms in soil processes: Distribution of microorganisms in soil, quantitative and qualitative micro-flora of different soils. Roles of micro- organism in soil fertility. Factors influencing the soil micro-flora. Carbon cycle; Organic matter decomposition, Humus formation; Nitrogen cycle; Mineralization; Ammonification; Nitrification; Denitrification; Reactions and organisms involved. Nitrogen fixation: symbiotic and non- symbiotic, process of nitrogen fixation.	6
Unit-V	Bioremediation concepts: Microbial extraction of oil. Bio-degradation of petroleum. Microbial degradation of xenobiotics.	2

4.2 Practical (Marks: 15, Credit: 1)

Units	Description of the topics	No. of lectures
Ι	Handling of microbiological laboratory instruments and Laboratory safety measures. Handling and maintenance of compound microscope.	3
II	Cleaning of glassware and preparation of cleaning solution.	2
III	Preparation of media: a. Liquid media, b. Solid media, c. Enriched Medium, d. Differential medium, e. Selective medium	3
IV	Scientific Inquiry - field visit to different ecosystem for sample collection. Enumeration of bacteria from environmental samples (soil, water and air).	4
V	Pure culture techniques: streak, spread and pour plate methods. Culture characteristics of Microorganisms- colony morphology, shape, margin.	5

5. Suggested reading:

5.1 For theory:

- **5.1.1** Daniel, J. C. (1999). Environmental aspects of Microbiology. Bright Sun Publications, Chennai.
- 5.1.2 Asthana and Asthana, M. (2005). Environmental problems and Solutions. S.

Chand and Co. Ltd, New Delhi.

- 5.1.3 Ramanathan, N (2018). Environmental Microbiology. Kalyani Publishers. New Delhi . ISBN 978-93-272-8844-5. 221 pages.
- **5.1.4** https://www.elsevier.com/books/encyclopedia-of-microbiology/schmidt/978-0-12-811736.
- 5.1.5 https://www.asmscience.org/content/book/10.1128/9781555812188.

5.2 For practical:

- 5.2.1 Goldman, E. and Green, L. H. (2008). Practical Handbook of Microbiology. 2nd Edition. CRC press.
- 5.2.2 Berkowitz, F. E., and Jerris, R. C. (2016). Practical Medical Microbiology for Clinicians. 1at Edition. John Wiley and Sons Inc.

SEMESTER-IV

Course Title: Introduction to Genetics Course Code: DSC 5 Course Type: Major Credit: 3 (Theory + Practical) Full Marks: 60 [Theory: 35+10 = 45 (Credit 3) + Practical: 15 (Credit 1)]

1. Objectives of learning:

- **1.1** To understand the fundamental principles of inheritance and gene function
- **1.2** To analyze the molecular basis of genetic variation and mutation
- **1.3** To explore the techniques and applications of genetic engineering
- **1.4** To investigate the role of genetics in health, disease and evolution

2. Learning Outcome:

- 2.1 The students will be able to apply genetic concepts in analyzing and interpreting genetic data.
- 2.2 The students will be able to utilize genetic engineering techniques in practical laboratory settings.
- 2.3 The students will have understanding of genetic basis of diseases and role of genetics in evolutionary process.
- **3. Teaching learning approach:** Theoretical classes will be conducted using traditional teaching tools such as chalk and board, as well as modern visual aids like overhead or LED projectors. Emphasis has been placed on practical learning rather than theory, allowing students to actively engage in hands-on activities. These practical sessions will take place in the department's well-equipped laboratory, where students will have the opportunity to

demonstrate and perform experiments. In cases where field study is necessary, the faculty members will provide assistance and guidance.

4. Description of topics:

4.1Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Unit	Description of topics	No. of							
		lectures							
I	Mendelian Genetics and its Extension: Principles of inheritance,	3							
	Incomplete dominance and co- dominance, Epistasis Multiple alleles,								
	Lethal alleles, Pleiotropy, Sex- linked, sex- influenced and sex- limited								
	inheritance, Polygenic Inheritance.								
II	Linkage, Crossing Over and Chromosomal Mapping Linkage and	5							
	Crossing Over, molecular basis of crossing over, Measuring								
	Recombination frequency and linkage intensity using three factor crosses,								
	Interference and coincidence.								
III	Mutations: Types of gene mutations (Classification), Types of	4							
	chromosomal aberrations (Classification with one suitable example of								
	each), Non-disjunction and variation in chromosome number; Molecular								
	basis of mutations in relation to UV light and chemical mutagens.								
IV	Sex Determination Mechanisms of sex determination in Drosophila Sex	4							
	determination in mammals, Dosage compensation in Drosophila &								
	Human								
v	Extra-chromosomal Inheritance: Criteria for extra chromosomal	5							
	inheritance. Antibiotic, resistance in Chlamvadomonas.Kappa particle in	0							
	Paramoecium Shell spiralling in spail								
VI	Extra-chromosomal Inheritance: Criteria for extra chromosomal	3							
VI	inhoritance Antibiotic resistance in Chlamvadomonas Kanna particle in	5							
	Deremonorium Choll enirelling in encil								
	raramoecium onen spiraning in snan.								

4.2 Practical:

Unit	Description of topics	No. of
		lectures
Ι	Chi-square analyses	3
II	Identification of chromosomal aberration in Drosophila and man	5
	from photograph	
III	Pedigree analysis of some human inherited traits	4

5. Suggested reading:

5.1 For theory:

- **5.1.1. Benjamin, A.P. (2016).** Genetics a Conceptual Approach. 6th Edition. Pearson.
- **5.1.2.** Brooker, R.J. (2012). Genetics Analysis and Principles. 4th Edition. McGraw Hill.
- **5.1.3. Dale, J.W. and Park, S. F. (2004).** Molecular Genetics of Bacteria. 4th Edition. John Wiley.
- **5.1.4.** Gardner, (2006). Principles of Genetics. 8th Edition, Wiley India Pvt. Ltd. Pages.740.
- **5.1.5.** Klug, W.S., Cummings, M.R., and Spencer, C.A. (2012). Concepts of Genetics. 10th Edition. Benjamin Cummings.
- **5.1.6. Pierce, B.A. (2013).** Genetics Essentials: Concepts abd Connections. 2nd Edition. Freeman W.H.
- **5.1.7. Russell, P.J. (2009).** Genetics-A Molecular Approach. 3rd Edition. Benjamin Cummings.
- **5.1.8.** Verma P.S., and Agarwal, V.K. (2016). Genetics. 9th Edition. S. Chand and Company Pvt. Ltd

5.2 For practical:

5.2.1 Ghose, K.C. and Manna, B. (2015). Practical Zoology. 2nd Edition. New Central Book Agency.

5.1.2 Poddar, T., Mukhopadhyay, S., and Das, S. K. (2015). 1st Edition. An Advance Laboratory Manual of Zoology. Trinity Press.

Course Title: Basic Immunology Course Code: DSC 6 Course Type: Major Credit: 3 (Theory + Practical) Full Marks: 60 [Theory: 45 (Credit 3) + Practical: 15 (Credit 1)]

1. Objectives of learning:

- **1.1** To learn the immune system components
- **1.2** To understand the basics of innate and adaptive immunity.
- **1.3** To get a clear idea of pathogenic recognition.
- **1.4** To learn different immune disorders
- **1.5** To understand the basics of vaccination
 - 2. Learning Outcome:

2.1The students will have a comprehensive knowledge of immune system and its mechanism.

2.2 They will be able to understand the mechanism of pathogenic interaction in our body

2.3 The awareness of disease and vaccination will be spread among students.

3.Teaching learning approach: Theoretical lessons will be delivered through conventional teaching techniques like chalk and board, alongside contemporary visual aids such as overhead or LED projectors. The focus has been shifted towards practical learning rather than mere theory. Students will be given the chance to showcase and conduct practical experiments in the fully equipped laboratory of the department. In case of practicals that require field study, the faculty will offer support and guidance.

4.Description of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Unit	Type	No of
Cint	Type	loctures
T	Overview of Immune System Basic concepts of health and diseases.	3
-	Historical perspective of Immunology,	0
II	Overview of Immune System Basic concepts of health and diseases, Historical perspective of Immunology	5
III	Cells and organs of the Immune system - Lymphoid cells and Antigen presenting cell . Primary and secondary lymphoid organs	4
IV	Innate and Adaptive Immunity Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).	4
V	Antigens Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity.	5
VI	Immunoglobulins Structure and functions of different lasses of immunoglobulins, Antigen- antibody interactions .	3
VII	Major Histocompatibility Complex Location and functions of MHC regions. Types and structure of MHC molecules.	4
VIII	Cytokines Types, properties and functions of cytokines.	3
IX	Complement System Components and pathways of complement activation.	3
X	Cell mediated effector responses- Brief description of destruction of target cell by CTLs, Antibody dependent cell mediated cytotoxicity and delayed type hypersensitivity.	4

4.2 Practical:

Unit	Туре				
		lectures			
Ι	Demonstration of lymphoid organs.	3			
II	Histological study of spleen, thymus and lymph nodes through slides/	5			
	photographs.				
III	Preparation of stained blood film to study various types of blood cells.	4			
IV	ABO blood group determination.	4			
V	Study of hemocyte from cockroach.	5			
VI	The experiments can be performed depending upon usage of animals in UG				
	courses.				

3. Suggested reading:

5.1 For theory:

- **5.1.1. Abbas, K.A. and Lechtman, H. (2011).** Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication.
- **5.1.2.** Bhattacharya, S., and Sinha, J. (2006). A Text Book of Immunology. Academic Publishers. Kolkata. Pages. 496.
- 5.1.3. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2018). Immunology. 8th Edition. W.H. Freeman and Company. Abbas, K. Abul and Lechtman H. Andrew (2003). Cellular and Molecular Immunology. 5th Edition. Saunders Publication.
- **5.1.4. Mohanty, S.K., and Leela, K.S. (2014).** Text book of Immunology. 2nd Edition. Jaypee Pub. N. Delhi.
- **5.1.5. Parija, S.C. (2012).** Text book of Microbiology and Immunology. 2nd Edition. Elsevier.
- **5.1.6. Punt, J, Stranford, S., Jones, P., Owen, J. (2017).** Immunology by Kuby 8th Edition W.H. Freeman and Co. N.Y.

5.2 For practical:

5.2.1	Ghose,	K.C. a	and Man	na, B.	(2015).	Practi	ical Z	Zool	ogy.	2 nd	Edit	ion. l	New	
	Centra	l Book	Agency											
	m 1	O D	10 1	O TC	(0047)	A TT	11		(D			1 01		ŀ

5.2.2 Talwar, G.P. and Gupta, S. K. (2017). A Handbook of Practical and Clinical Immunology. 2nd Edition. CBS Course Title: Advances in Biochemistry Course Code: DSC 7 Course Type: Major Credit: 4 (Theory + Practical) Full Marks: 60 [Theory: 45 (Credit 3) + Practical: 15 (Credit 1)]

1. Objectives of learning:

- **1.1** The course is designed to give students basic concepts of biochemistry and its nature of interdisciplinary importance. To let students understand the physical and chemical properties of molecules, and their status of occurrence in biological system.
- **1.2** To familiarize the students with major biomolecules namely carbohydrates, lipids, proteins and nucleic acids which are important for the structural organization and functions of the cells. The course encompasses the overall perspective on the biomolecules their characteristic properties and organization in carrying out all the living functions which constitute the life.
- **1.3** The course is designed to enable students understand enzymes, properties, mechanism of action and regulation of their activity. To acquaint students grasp the basic cascades of energy transfer system and subsequent products in biology. The course will help the students understand fundamental energetics of biochemical processes, their functionalities.

2. Learning Outcome:

- **2.1** Students will understand the basic concept of micro and macro biomolecules such as carbohydrates, proteins, lipids and nucleic acids and their significance.
- **2.2** Students will be able to perform various analytical techniques such as chromatographic, electrophoretic, spectrophotometric and other techniques.
- **2.3** Students will learn principle and procedures and their trouble shooting of various techniques in the separation of components.

3. Teaching learning approach:

Theoretical classes will be conducted using traditional teaching tools such as chalk and board, as well as modern visual aids like overhead or LED projectors. Emphasis has been

placed on practical learning rather than just theory. Students will have the opportunity to demonstrate and perform practical experiments in the well-equipped department laboratory. For practicals that involve field study, the faculty members will provide necessary assistance.

4. Description of topics:

4.1 Theory [Marks: 45 [Theory =35, continuous evaluation = 10], Credit: 3]

Unit	Туре	No. of
		lectures
I	Amino acids and Proteins : Structure and physico-chemical properties of amino acids, Role of non-protein amino acids, peptides, peptides of physiological significance, peptide bond, peptide synthesis. Structural features of proteins and their biological functions.	4
II	Nucleotides and Nucleic acids : Structure and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thiamine, Uracil) bases. Structural features of nucleic acids (DNA & RNA) and their biological functions.	4
III	Carbohydrates: Structure, stereochemistry and functions of monosaccharides, oligosaccharides and polysaccharides.	8
IV	Lipids : Lipids and their classification, Structure, nomenclature and functions of fatty acids (PUFA), triacylglycerols (TAG), Waxes, phospholipids (Phospotidylserine, Lecithin, Cardiolipin, Plasmalogen and PAF), Sphingolipids (Cerebrosides, Globosides and Gangliosides) lipoproteins, glycolipids, steriods, prostaglandins and bile acids.	8
V	Chromatography : Chromatography - History, Principle, Partition coefficient- Nature of partition forces, Types of chromatography- Planar chromatography -Paper chromatography, Thin Layer chromatography.	4
VI	Spectrophotometry: UV and Visible spectroscopy - Principle, Instrumentation and Applications. Centrifugation : Principle of centrifugation, Concepts of Relative Centrifugal Force (RCF) and Swedberg constant. Types of centrifuges and rotors. Differential and density gradient (Zonal and Isopycnic) centrifugation. Preparative and Analytical ultracentrifugation, Subcellular fractionation.	3

4.2 Practical (Marks: 15, Credit 1)

Unit	Туре	No. of
		lectures
Ι	Qualitative analysis of carbohydrates-monosaccharides, disaccharides,	3
	polysaccharides.	
II	Qualitative analysis of lipids	5

III	Separation of amino acids by paper chromatography.	4
IV	Thin Layer chromatography of amino acids.	4
V	Separation of leaf pigments by adsorption chromatography	5
VI	Cell disruption and preparation of cell free extracts by centrifugation.	3

5. Suggested reading:

5.1 For theory:

- 5.1.1 Nelson, D. L. and Cox, M. M. (2019). Lenhinger's Principles of Biochemistry. Macmillan Worth Pub. Inc. NY.
- 5.1.2 Voet, D. and Voet, D.J. (2018). Biochemistry. John Wiley and sons.
- **5.1.3** Rodney Boyer, R. (2012). Modern experimental Biochemistry 3rd edition. Addison Wesley Longman.

5.2 For practical:



Course Title: Essentials of Biochemistry Course Code: Minor 4 Course Type: Minor Credit<mark>: 4 (Theory</mark> + Practical) Full Marks: 60 [Theory<mark>: 45 (Credit 3) + Practical: 15 (Credit 1)]</mark>

1. Objectives of learning:

- **1.1** The discipline of Biochemistry involves the study of the structure and function of biomolecules and the vital processes that occur in living organisms. It is regarded as Mother of all Biological Sciences disciplines because it unveils the chemical basis of life in all living organisms including plants, animals and microorganisms.
- **1.2** Biochemistry has contributed enormously to the growth of modern medical and health science and agriculture. Biochemistry has applications in clinical diagnosis, understanding pathology of diseases, treatment of diseases,

designing of drugs and understanding their metabolism and manufacture of various biological products like amino acids, proteins, antibiotics, hormones, enzymes, nutrients, etc.

- **1.3** Understanding the biochemical basis of vital processes of plants such as photosynthesis, respiration, hormonal regulation, nutrient assimilation has helped in developing superior varieties of crop plants with better growth attributes and yield.
- **1.4** For the estimation of pesticide residues in soil or food grain one has to rely on biochemical tests. The functions and roles of various nutrients are described only by biochemistry. The composition of food materials including the quality-milk and possible adulterations can be checked by biochemical tests. This discipline has played valuable role in farming, fishery, poultry, sericulture, bee keeping and in environmental remediation.

2. Learning Outcome:

- 2.1 On completion of the course, student will be able to understand nature of biochemistry, physical and chemical properties of molecules as a linkage of biochemistry AND concept and properties of acid-base relationship.
- 2.2 Students shall be able to assess and relate the concepts of chemistry to biology, identify the structures of amino acids, their chemical properties and their organization into polypeptides and proteins.
- 2.3 The learners will understand the structure and functions of fundamental mono, di and trisaccharide and polysaccharides and they will be able to relate the basic function of nucleotides, structure of different classes of lipids and their roles in biological systems.
- 2.4 Students will be able to understand enzyme structure and how they catalyse reactions as well as enzyme kinetics.
- 2.5 They will be able to plan and carry out simple experiments on enzymes and physiology.

3. Teaching learning approach:

Theoretical instruction will be delivered through traditional methods such as chalk and board, as well as modern visual aids like overhead/LED projectors. Emphasis is placed on practical application rather than theoretical knowledge. Students will actively participate in laboratory experiments using the department's well-equipped facilities. Faculty members will provide guidance for practicals involving field studies.

4. Description of topics:

4.1 Theory:

Unit	Туре	No. of					
		lectures					
Ι	Carbohydrate: Structure and Biological importance: Monosaccharides,	3					
	Disaccharides, Polysaccharides; Derivatives of Monosachharides.						
	Carbohydrate metabolism: Glycolysis, Citric acid cycle.						
II	Lipid: Structure and Significance: Physiologically important saturated and	5					
	unsaturated fatty acids, Triacylglycerols, Phospholipids, Sphingolipid,						
	Glycolipids, Steroids. Lipid metabolism: β -oxidation of fatty acids.						
III	Proteins: Amino acids- Structure, Classification, General and Electro chemical	4					
	properties of α -amino acids; Physiological importance of essential and non-						
	essential amino acids. Proteins-Bonds stabilizing protein structure; Levels of						
	organization. Protein metabolism: Urea cycle, Fate of C-skeleton of Glucogenic						
	and Ketogenic amino acids.						
IV	Nucleic Acids: Structure: Purines and pyrimidines, Nucleosides, Nucleotides,	4					
	Nucleic acids. Types of DNA and RNA.						
V	Enzymes: Nomenclature and classification; Mechanism of enzyme action;	5					
	Enzyme kinetics; Cofactors; Specificity of enzyme action; Mechanism of						
	enzyme action; Michaelis-Menten equation, Lineweaver-Burk plot; Factors						
	affecting rate of enzyme-catalysed reactions.						
VI	Cell disruption and preparation of cell free extracts by centrifugation.	3					
VII	Oxidative Phosphorylation: Review of mitochondrial respiratory chain,	2					
	Inhibitors and un-couplers of Electron Transport System.						

4.2 Practical: (Credit 1)

Unit	Туре	No. of
		lectures
Ι	Qualitative tests of functional groups in carbohydrates, proteins and lipids.	3
II	Quantitative estimation of Lowry Method	5

5.Suggested reading:

5.1 For theory:

5.1.1 Nelson, D. L. and Cox, M. M. (2019). Lenhinger's Principles of Biochemistry. Manmillan Worth Pub. Inc.NY

5.1.2 Voet, D. and Voet, D. J. (2018). Biochemistry. Wiley and Sons

5.1.3 Boyer, R. (2012). Modern experimental Biochemistry. 3rd Edition. Addison Wesley Longman

5.2 For practical:

5.2.1 Wilson and Walker, J. (2010). Practical Biochemistry: Principles and Techniques. 5th Edition. Cambridge University Press

5.2.2 Boyer, R. (2012). Modern experimental Biochemistry. 3rd Edition. Addison Wesley Longman

Course Title: Insect, vectors and Diseases Course Code: Mionor-5 Course Type: Minor Credit:3(Theory+ Practical) FullMarks:60[Theory: 35+10 = 45 (Credit3)+ Practical:15(Credit1)]

1. Objective of Learning:

- 1.1. To understand the biological and ecological characteristics of insect vectors.
- 1.2. To identify major insect vectors and the diseases they transmit.

1.3. To examine the life cycles and transmission mechanisms of vector-borne pathogens.

- 1.4. To evaluate the public health impact of insect-transmitted diseases.
- 1.5. To explore methods of surveillance, prevention, and control of vector populations.

2. Learning outcome

- 2.1. Students will be able to identify and classify major insect vectors responsible for disease transmission.
- 2.2. Students will be able to describe the life cycles and ecological roles of insect vectors.
- 2.3.Students will be able to explain the mechanisms of disease transmission by various vectors.
- 2.4.Students will be able to analyse the impact of vector-borne diseases on human and public health.
- 2.5.Students will be able to assess and recommend appropriate vector control and prevention strategies.
- 2.6. Students will be able to interpret surveillance data to predict and respond to vectorborne disease outbreaks.
- **3. Teaching learning approach:** Theoretical classes will be delivered using a combination of traditional teaching tools, such as chalk and board, alongside modern visual aids like overhead or LED projectors. Greater emphasis will be placed on practical learning over theoretical instruction, encouraging students to actively participate in hands-on activities. These practical sessions will be conducted in the department's well-equipped laboratory, providing students with opportunities to perform and demonstrate experiments.

4. Description of topics:

4.1.Theory [Marks:45 [Theory=35, continuous evaluation=10], Credit: 3]

Unit	Туре	No. of lectures
I	Introduction to Insects and Vectors: Basic insect biology and vector classification, the role of insects in disease transmission, Examples of major insect vectors (mosquitoes, ticks, flies).	3
II	Major Insect Vectors and Disease Transmission: Mosquito-borne diseases: Malaria, Dengue, Zika, etc., Fleas, lice, and other vectors (Plague, Typhus), life cycles and transmission methods. phosphorus,	4
III	Disease Overview: Disease causative agents, symptoms, and prevention, Focus on Malaria, Dengue, Chagas, Lyme disease, and Zoonotic diseases.	4
IV	Vector Control: Methods of controlling vectors: Chemical, biological, and environmental, Personal protection (e.g., bed nets, repellents), Role of vaccination and integrated management.	4
V	Emerging Issues in Vector Control: Climate change and vector distribution, genetically modified mosquitoes and other innovative solutions.	3
VI	Surveillance and Monitoring of Vector-Borne Diseases (2 Weeks) Techniques for monitoring vector populations, Data collection and analysis for disease control, Early warning systems and outbreak prediction.	3

4.2.Practical (Marks: 15, Credit:1):

Unit	Description of topics				
		lectures			
Ι	Identification of Vectors: Field/lab work to study insect vectors	4			
II	Observation and Analysis of the Life Cycle of Mosquito Vectors	5			
III	Dissection of an insect vector (E.g. Mosquitoes, house fly) to observe midgut and salivary Glands	3			

5.Suggested Reading

5.1. For theory

5.1.1. Service, M. W. (2012). *Medical entomology for students* (5th ed.). Cambridge University Press.

5.1.2. Marquardt, W. C., Demarcus, L. A., Black, W. C., & Roberts, L. W. (2004). *Biology of disease vectors* (2nd ed.). Elsevier Academic Press.

5.1.3. Gullan, P. J., & Cranston, P. S. (2014). *The insects: An outline of entomology* (5th ed.). Wiley-Blackwell.

5.1.4. Clements, A. N. (1992). *The biology of mosquitoes: Development, nutrition and reproduction* (Vol. 1). Chapman & Hall.

5.1.5. Lehane, M. J. (2005). *The biology of blood-sucking in insects* (2nd ed.). Cambridge University Press.

5.1.6. Kettle, D. S. (1995). Medical and veterinary entomology (2nd ed.). CABI Publishing.

5.2. For practical

5.2.1. Service, M. W. (2012). *Medical entomology for students* (5th ed.). Cambridge University Press.

5.2.2.Marquardt, W. C., Demarcus, L. A., Black, W. C., & Roberts, L. W. (2004). *Biology of disease vectors* (2nd ed.). Elsevier Academic Press.

5.2.3. Silver, J. B. (2007). *Mosquito ecology: Field sampling methods* (2nd ed.). Springer. 5.2.4. WHO. (2009). *Guidelines for efficacy testing of mosquito repellents for human skin.* World Health Organization.

5.2.5. **Panigrahi, B. K. (2014).** *A textbook of practical entomology*. Dominant Publishers & Distributors.

Course Title: Elementary Knowledge to Genetics

Course Code: Mionor-6

Course Type: Minor

Credit:3(Theory+ Practical)

FullMarks:60[Theory: 35+10 = 45 (Credit3)+ Practical:15(Credit1)]

1. Objectives of learning:

1.1 To understand the basic principles of heredity and how traits are passed from one generation to the next.

1.2 To explain the structure and role of genes, chromosomes, and DNA in inheritance.

1.3 To differentiate between dominant and recessive traits through simple examples.

1.4 To recognize the contributions of Mendel and the significance of Mendelian laws in genetics.

1.5 To identify basic patterns of inheritance using Punnett squares and simple genetic crosses.

2.Learning Outcome:

- 2.1 Students will be able to define basic genetic terms such as gene, DNA, chromosome, allele, genotype, and phenotype.
- 2.2 Students will be able to describe the structure and function of DNA and its role in the transmission of genetic information.
- 2.3 Students will be able to explain the principles of Mendelian inheritance using examples and Punnett squares.
- 2.4 Students will be able to recognize the significance of genetics in understanding heredity, genetic disorders, and modern biotechnology.

3.Teaching learning approach: Theoretical classes will be delivered using a combination of traditional teaching tools, such as chalk and board, alongside modern visual aids like overhead or LED projectors. Greater emphasis will be placed on practical learning over theoretical instruction, encouraging students to actively participate in hands-on activities. These practical sessions will be conducted in the department's well-equipped laboratory, providing students with opportunities to perform and demonstrate experiments.

4. Description of topics:

4.1Theory [Marks:45 [Theory=35, continuous evaluation=10], Credit: 3]

Unit	Description of topics	No. of
		lectures
Ι	Mendelian and Non-Mendelian Genetics:	5
	Basic principles of inheritance: Mendel's laws (segregation,	
	independent assortment), Monohybrid and dihybrid crosses with	
	expected ratios. Non-Mendelian inheritance: Incomplete dominance,	
	co-dominance, multiple alleles (ABO blood group system), Sex-linked	
	inheritance: X-linked traits and examples (hemophilia, color blindness).	
	Pleiotropy: Concept and examples (e.g., sickle cell anemia,	
	phenylketonuria).	

Π	Linkage and Crossing Over: Concept of linkage: Complete and incomplete linkage, crossing over: Mechanism, molecular basis, and significance, Recombination frequency and genetic maps, Construction of linkage maps using two- and three-factor test crosses, Interference and coefficient of coincidence (basic understanding).	6
III	Sex Determination and Dosage Compensation : Chromosomal basis of sex determination: XX-XY, XX-XO, ZZ-ZW systems, Sex determination in <i>Drosophila</i> and humans, Dosage compensation: Lyon's hypothesis and X-inactivation in humans.	3
IV	Extra-Chromosomal (Cytoplasmic) Inheritance: Concept and characteristics of extra-nuclear inheritance. Examples, Kappa particles in <i>Paramecium</i> , Shell coiling in snails (<i>Limnaea</i>)	3
V	Mutation: Definition and classification: Gene (point) mutations and chromosomal mutations, Types of gene mutations: Substitutions, deletions, insertions, frameshifts, Mutagens: Physical (radiation) and chemical agents, Examples of genetic disorders due to mutations (e.g., sickle cell anemia, thalassemia).	4

4.2.Practical (Marks: 15, Credit:1):

lectures
3
2
3
3

5.Suggested reading:

5.1. For theory:

5.1.1. Benjamin, A.P. (2016). *Genetics: A Conceptual Approach* (6th Edition). Pearson. **5.1.2.** Dale, J.W., & Park, S.F. (2004). *Molecular Genetics of Bacteria* (4th Edition). John Wiley.

5.1.3. Gardner (2006). Principles of Genetics (8th Edition). Wiley India Pvt. Ltd. Pages: 740.

5.1.4. Klug, W.S., Cummings, M.R., & Spencer, C.A. (2012). *Concepts of Genetics* (10th Edition). Benjamin Cummings.

5.1.5. Russell, P.J. (2009). *Genetics: A Molecular Approach* (3rd Edition). Benjamin Cummings.

5.1.6. Verma, P.S., & Agarwal, V.K. (2016). *Genetics* (9th Edition). S. Chand and Company Pvt. Ltd.

5.2. For Practical

- **5.2.1.** Ghosh, K.C., & Manna, B. (2015). Practical Zoology, New Central Book Agency, Kolkata.
- **5.2.2.** L.S. Lal, (2016). Practical Zoology Invertebrate, Rastogi Publication, Lucknow.
- **5.2.3.** Singh, S. (2016). Zoology Practical Handbook, 1st edition, Vishal Publishing.

Course Title: Ecology and environment Course Code: Mionor-7 Course Type: Minor Credit:3(Theory+ Practical) FullMarks:60[Theory: 35+10 = 45 (Credit3)+ Practical:15(Credit1)]

1. Objectives of learning:

1.1. To explain the structure and function of ecosystems.

1.2. To analyze ecological relationships and energy flow in nature.

1.3. To identify the causes and consequences of environmental degradation.

1.4. To evaluate biodiversity and the need for its conservation.

1.5. To understand the impact of human activities on the environment.

1.6. To promote awareness and responsibility towards environmental protection and sustainable development.

2. Learning outcome:

2.1. Students will be able to explain the structure and function of ecosystems, including energy flow and nutrient cycles.

2.2. Students will be able to analyze the relationships between organisms and their physical, chemical, and biological environments.

2.3. Students will be able to identify major environmental issues such as pollution, climate change, and biodiversity loss.

2.4. Students will be able to evaluate the role of human activities in environmental degradation and resource depletion.

2.5. Students will be able to apply ecological knowledge to promote sustainable development and environmental conservation.

3.Teaching learning approach: Theoretical classes will be delivered using a combination of traditional teaching tools, such as chalk and board, alongside modern visual aids like overhead or LED projectors. Greater emphasis will be placed on practical learning over theoretical instruction, encouraging students to actively participate in hands-on activities. These practical sessions will be conducted in the department's well-equipped laboratory, providing students with opportunities to perform and demonstrate experiments.

4. Description of topics:

Unit	Туре	No. of
		lectures
Ι	Introduction to Ecology and Environment: Definition, scope, and importance of ecology and environmental science, Components of environment: biotic and abiotic, Levels of ecological organization: individual to biosphere, Human-environment interactions	3
Π	Ecosystems: Concept, types and components of ecosystems, Food chains, food webs, and ecological pyramids, Energy flow: trophic levels, primary productivity, Biogeochemical cycles: carbon, nitrogen, phosphorus,	4
III	Population and Community Ecology: Gene pool, allele frequencies, Hardy-Weinberg equilibrium, evolutionary forces (mutation, gene flow, genetic drift, natural selection), genetic bottlenecks, founder effect, and inbreeding, Exponential and logistic growth models, carrying capacity, and factors affecting population growth., Species interactions (competition, predation, mutualism), community structure, and ecological succession.	6
IV	Environmental Pollution: Air, water, soil, and noise pollution: sources, effects, control measures, Solid waste management: classification, disposal, and recycling, Environmental laws and policies in India (Air Act, Water Act, EPA)	4
V	Resources and Sustainability: Natural resources: types, overexploitation and management, Forest, water, and mineral resources, Sustainable development and Agenda 21,	3

4.1. Theory [Marks:45 [Theory=35, continuous evaluation=10], Credit: 3]

	Environmental Impact Assessment (EIA)	
VI	Global Environmental Issues: Climate change and global warming, Ozone depletion, acid rain, desertification, Role of international agreements (Kyoto, Paris Agreement, Montreal Protocol), Role of individuals and communities in environmental protection	3

4.2.Practical (Marks: 15, Credit:1):

Unit	Description of topics	No. of
		lectures
Ι	Water Quality Testing: Collect and analyze water samples for	5
	pH, turbidity, dissolved oxygen, free CO ₂ , total alkalinity	
II	Soil Quality test: Soil pH Test, Soil Moisture Content, Soil	4
	Texture (Sedimentation Test), Organic Matter (Loss on Ignition),	
	Microbial Activity (Soil Respiration)	
III	Determination of Population density in a natural community by	2
	Quadrat Sampling Method and calculation of Shannon-Wiener	
	Diversity Index.	

5.Suggested reading:

5.1.For theory:

5.1.1. P.D. Sharma (2014). Ecology and Environment, 13th edition, Rastogi Publications.

5.1.2. Bowman, Hacker & Cain (2020). Ecology, 5th edition, Sinauer associates.

5.1.3. Peter Stilling (2002). Ecology: Theories & Application, 4th edition, Prentice Hall India Learning.

5.1.3. Pranav Kumar, P., & Mina, U (2021). Fundamentals of Ecology and Environment, 3rd edition, Pathfinder publications.

5.1.4. C. J. Krebs (2001). Ecology. The Experimental Analysis of Distribution and Abundance. Harper-Collins, NY.

5.1.5.E.P. Odum (2017). Fundamentals of Ecology. 5th edition, Cengage Learning India

5.1.6. Cunningham, W. P., & Cunningham, M. A. (2017). *Environmental science: A global concern* (13th ed.). McGraw-Hill Education.

5.1.7. Cunningham, W. P., & Cunningham, M. A. (2015). *Principles of environmental science: Inquiry and applications* (7th ed.). McGraw-Hill Education.

5.1.8. **De, A. K. (2008).** *Environmental chemistry* (6th ed.). New Age International Publishers.

5.2.For practical:

5.2.1.Arora, M. P. (2012). Environmental studies: Laboratory manual. Himalaya Publishing House.
5.2.2.Kaushik, A., & Kaushik, C. P. (2015). Laboratory manual of environmental studies (3rd ed.). New Age International Publishers.
5.2.3. Trivedi, R. K., & Goel, P. K. (1986). Chemical and biological methods for water pollution studieis. Environmental Publications.
5.2.4. Mishra, D. D. (2008). Fundamental concepts in environmental studies: Including practicals. S. Chand Publishing.
5.2.5. Solomon, E. P., & Berg, L. R. (2017). Biology (10th ed.). Cengage Learning. (Chapter on Ecology and Evolution)
5.2.6. Sutherland, W. J. (2006). Ecology: A brief introduction (2nd ed.). Blackwell Publishing.

Course Title: Elementary Knowledge to Immunology Course Code: Mionor-8 Course Type: Minor Credit:3(Theory+ Practical) FullMarks:60[Theory: 35+10 = 45 (Credit3)+ Practical:15(Credit1)]

1. Objectives of learning:

1.1. To understand the structure, function, and components of the immune system in maintaining health.

1.2. To differentiate between innate and adaptive immunity, and explain key immune responses.

1.3. To study the roles of antigens, antibodies, cytokines, and the complement system in immune function.

1.4. To observe and identify immune cells and lymphoid organs through microscopy and histological slides.

1.5. To perform or demonstrate basic immunological experiments such as agglutination, ELISA, and immunodiffusion.

2. Learning outcome:

2.1. Students will be able to describe the structure and functions of the immune system and its components.

2.2. Students will be able to differentiate between innate and adaptive immunity with key examples.

2.3. Students will be able to explain the roles of antigens, antibodies, cytokines, and the complement system in immune responses.

2.4. Students will be able to identify and interpret the structure of immune cells and organs using microscopy and histological slides.

3 Teaching learning approach: Theoretical classes will be delivered using a combination of traditional teaching tools, such as chalk and board, alongside modern visual aids like overhead or LED projectors. Greater emphasis will be placed on practical learning over theoretical instruction, encouraging students to actively participate in hands-on activities. These practical sessions will be conducted in the department's well-equipped laboratory, providing students with opportunities to perform and demonstrate experiments.

4. Description of topics:

Unit	Туре	No. of
		lectures
I	Cells and Organs of the Immune System: Important immune cells: lymphoid cells and antigen-presenting cells, Main immune organs: primary (bone marrow, thymus) and secondary (lymph nodes, spleen)	3
Π	Antigens: antigens, immunogens, adjuvants, haptens, factors affecting how the body responds to antigens Immunoglobulins Different types of antibodies and their functions How antigens and antibodies interact	4
III	Cytokines: Basic types of cytokines, functions and importance in immune responses	
IV	Innate immunity: natural body barriers, inflammation, and first-line defence cells Adaptive immunity: cell-mediated and humoral immunity	4
V	Major Histocompatibility Complex (MHC) Role of MHC molecules in the body, Types and structures and functions of MHC molecules	3

4.1Theory [Marks:45 [Theory=35, continuous evaluation=10], Credit: 3]

4.2 Practical (Marks: 15, Credit:1):

Unit	Description of topics	No. of
		lectures
Ι	ABO blood group determination.	3
II	Preparation of stained blood film to study various types of blood cells	2
III	Histological study of spleen, thymus, and lymph nodes using prepared slides or photographs	3

5.Suggested reading:

5.1 For theory:

- **5.1.1. Abbas, K.Abul and Lechtman H. Andrew (2011)** Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication.
- **5.1.2. Bhattacharya,S,and Sinha,J.(2006):**ATextBookofImmunology,AcademicPu blishers, Kolkata, pages, 496.
- **5.1.3.** Kindt,T.J.,Goldsby,R.A.,Osborne,B.A.and Kuby,J(2018).Immunology,VIIIEdition.W.H. Freeman and Company. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. SaundersPublication.
- **5.1.4. Mohanty, S.K and Leela, KS (2014).** Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi.

5.2..For Practical

- **5.2.1.** Ghosh, K.C., & Manna, B. (2015). Practical Zoology, New Central Book Agency, Kolkata.
- **5.2.2. L.S. Lal, (2016).** Practical Zoology Invertebrate, Rastogi Publication, Lucknow.
- **5.2.3. Singh, S. (2016).** Zoology Practical Handbook, 1st edition, Vishal Publishing.