

UNIVERSITY OF NORTH BENGAL

**M.Sc. SYLLABUS IN ZOOLOGY
Choice Based Credit System
(Implemented from Session 2022-23)**

2022

PG Syllabus in Zoology

FIRST SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and PRACTICAL)	CC-101	Functional Biology of Non-chordates	42+8=50	02
	CC-102	Functional Biology of Chordates	42+8=50	02
	CC-103	Cell Biology and Genetics	42+8=50	02
	CC-104	Ecological Principles and Applications	42+8=50	02
	CC-105	Insect Biology & Pest Management	42+8=50	02
	CC-106	Practical Related to CC-101 & CC-102	50	02
	CC-107	Practical Related to CC-103	50	02
	CC-108	Practical Related to CC-104 & CC-105	50	02
DSE (Discipline Specific Elective)	DSE-101	A- Seminar Presentation OR B- Poster Presentation	50	02
AEC	AEC-101	University prescribed course	50	02
FULL MARKS AND CREDIT			500	20

SECOND SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and PRACTICAL)	CC-201	Immunology: Organization and Function of Immune System	42+8=50	02
	CC-202	Animal Biotechnology: Tools-Techniques & Applications	42+8=50	02
	CC-203	Biochemistry	42+8=50	02
	CC-204	Fish Biology, Fisheries and Aquaculture	42+8=50	02
	CC-205	Biosystematics	42+8=50	02
	CC-206	Practical Related to CC-201 & CC-202	50	02
	CC-207	Practical Related to CC-203 & CC-204	50	02
	CC-208	Critical analysis of published original research article and review paper (one each)	25+25	01+01
DSE (Discipline Specific Elective)	DSE-201	A- Field Based Biodiversity Study OR B- Preparation and presentation of a research project proposal	50	02
SEC (Skill Enhancement Course)	SEC-201	University prescribed course	50	02
FULL MARKS and CREDIT			500	20

THIRD SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and PRACTICAL)	CC-301	Animal Physiology and Endocrinology	42+8=50	02
	CC-302	Practical Related to CC-301	50	02
	CC-303	Seminar Presentation	50	02
	CC-304	Institutional Visit/Field Studies	50	02
DSE (Discipline Specific Elective) (DSE -301-305)	DSE-301A	Cellular Immunology	A. 60+15=75	03
	DSE-301B	Molecular Immunology		
	DSE-302A	Environment and Chemical Ecology		
	DSE-302B	Environmental Toxicology & Environmental Assessment		
	DSE-303A	Insect Physiology and Communication & Coordination	B. 60+15=75	03
	DSE-303B	Industrial Entomology		
	DSE-304A	Fish Biology and Applied Ichthyology		
	DSE-304B	Fisheries and Hydrobiology		
	DSE-305A	Molecular Cell Biology		
	DSE-305B	Molecular Genetics		
Generic Elective (GE)	GE-301	Wildlife Conservation, Biodiversity & Taxonomy	42+8=50	02
	GE-302	Biophysics and Biostatistics	42+8=50	02
AEC	AEC-301	University prescribed course	50	02
Full Marks and Credit			500	20

N.B.- Student will have to choose any one pair (A+B) course among DSE-301 - DSE-305

FOURTH SEMESTER:

Course Type	Course Code		Marks (Theoretical + Class Test)	Credit
CORE (THEORY and Practical)	CC-401	Gamete Biology and Developmental Biology	42+8=50	02
	CC-402	Evolution & Population Genetics	42+8=50	02
	CC-403	Practical related to CC-401	50	02
	CC-404	Comprehensive Viva Voce	25	01
	CC-405	Dissertation/Review	50	02
DSE (Discipline Specific Elective) (DSE -301-305)	DSE-401	Clinical Immunology and Immunotechnology	60+15=75	03
	DSE-402	Chronobiology, Behavioural Ecology & Biotechnology		
	DSE-403	Insect Pests & Insect Pest Management		
	DSE-404	Fish Technology		
	DSE-405	Molecular Cell Biology & Genetics	50	02
	DSE-406 (A to E)	DSE Related Practical Courses		
Generic Elective (GE)	GE-401	Environment & Public Health	42+8=50	02
	GE-402	Techniques in Molecular Biology, Biochemical & Biophysical Methods	42+8=50	02
SEC (Skill Enhancement Course)	SEC-401	University prescribed course	50	02
Full Marks and Credit			500	20

N.B.- Student will have to choose any one course among DSE-401 - DSE-405

Question Pattern:**Two Units for Each Theoretical Paper. Each Unit will have following Pattern.**

1. Objective/MCQ Type: $1 \times 3 = 03$ (Answer any Three out of Five)
 2. Short Answer Type: $2 \times 3 = 06$ (Answer any Three out of Five)
 3. Descriptive Answer Type: $6 \times 2 = 12$ (Answer any Two out of Four)
- Total Marks: 21**

Two Units for Each Theoretical Paper of DSE course in 3rd and 4th Semester. Each Unit will have following Pattern.

1. Objective/MCQ Type: $1 \times 4 = 04$ (Answer any Four out of Six)
 2. Short Answer Type: $2.5 \times 4 = 10$ (Answer any Four out of Six)
 3. Descriptive Answer Type: $8 \times 2 = 16$ (Answer any Two out of Four)
- Total Marks: 30**

M.Sc. in Zoology Programme: FIRST SEMESTER

CORE COURSE THEORY

CC-101: Functional Biology of Non-chordates

Course credit: 02

Course objectives:

This topic endeavoured to provide a critical look at the different functional systems of non-chordates. Further, there is an evolutionary approach to portray invertebrate diversity and function against the selective pressure of nature.

Course Learning outcomes:

The knowledge of basic Invertebrate Biology can be helpful to yield valuable shreds of evidence regarding the diversity of life. Besides, the information regarding the arena of non-chordates in components of food webs to fulfil many ecosystems services, such as pollination, decomposition and nutrient release can be treated as the major avenues of the topic.

CC-102: Functional Biology of Chordates

Course credit: 02

Course objectives:

The course aims to teach the students the fundamental zoology of chordate, emphasizing the functional aspect. The topics like basic vertebrate body plan and its movement provide vital ideas on the evolution of chordate's life under ectothermic and endothermic modes. Detailed knowledge and understanding of the aerodynamics and energetics of flying and gliding provide immense knowledge of aerial life. The auditory and olfaction system provides the external queue to specialized chordates like mammals, which helps them explore the land. The respiration, circulation, and digestion associated with feeding behaviours in different groups of chordates make the students recognize various physiological evolution in the chordates groups. The study of cranial kinesis in fish, reptiles, and birds helps understand intracranial mobility in feeding mechanisms. The functional association of CNS and information processing, the evolution of the cerebrum, cerebellum, and vertebrate brain, particularly the structure and function of the limbic system and reticular formation, helps the students to comprehend the idea about the neuronal mechanism and information processing by the vertebrate brain.

Course Learning outcomes:

- ❖ The student will gather immense knowledge on the basic vertebrate body plan and its movement, which can explore fundamental thought on the evolution of chordate's life under ectothermic and endothermic modes.
- ❖ The students will gain knowledge of the aerodynamics and energetics of flying and gliding.
- ❖ The students will open the knowledge of respiration, circulation, and digestion within the chordates groups.
- ❖ The students will understand the different feeding mechanisms by understanding cranial kinesis and associated skull morphology and its development.
- ❖ The students will achieve the facts about the vertebrate brain's neuronal mechanism and information processing.

CC-103: Insect Biology and Pest Management

Course credit: 02

Course objectives:

Insect Biology and Pest Management attempt to introduce students to the insect morphology, classification of Class Hexapoda with characters and examples of major orders which form the basis of entomology. Insect Biology is the study of the properties, processes, and functions of insect maintenance

systems including the basic insect biology, such of nutritional, reproductive, growth and developmental biology. The course emphasizes on the role of climate change and different physical ecological factors on insect biology. This is followed by understanding insect ecology in respect to prey-predator, host-parasite/parasitoid relationship and defense mechanism of insects for survival fitness in challenging environment. Concept of pest status with agricultural, medical and veterinary importance, different types of insecticides, various methods of pest control. It also includes various aspect of pest management like assessing of crop damage, pest forecasting and the concept of IPM & IRM.

Course Learning outcomes:

A student in this course should be able to:

- ❖ Know different orders of class Hexapoda, characteristics of major order.
- ❖ Become familiar with the various physiological systems operating in insects.
- ❖ Identify the influence/control (neural and/or hormonal) within each system.
- ❖ Know the role of abiotic factors on the insect physiology and development.
- ❖ Develop a concept of pest designation, pest management tactics and prediction of pest attack.
- ❖ This knowledge will help to gain a comprehensive understating about common pests and their management aspects.

CC-104: Cell Biology and Genetics

Course credit: 02

Course objectives:

The course of Cell Biology and Genetics has been designed to offer as CORE COURSE at Semester-I of Master's level to impart basic and advance concepts genome organization in prokaryotes and eukaryotes, gene, cell cycle, genetic recombination, gene mapping and gene regulation, apoptosis and transposons and cytogenetic techniques and knowledge of molecular biology, which are the components of speciation, evolution and diseases.

Course Learning outcomes:

- ❖ This course will help students to understand basic and some advance aspects of cell biology and genetics required for most researches.
- ❖ Students will gain knowledge of chromosome structure and function and hands on training on chromosome preparation. It will also help students to gain knowledge of applications of some core topics in gene analysis.
- ❖ It will empower students to get employ in academic and research institutions.

CC-105: Ecological Principles and Applications

Course credit: 02

Course objectives:

This course aims to create awareness amongst students about the basic concepts pertaining to ecology. This course will focus on the different types of ecosystems and will help students to learn strategizing for healthy environment. This course will be helpful in assessing the impact of environmental factors on plants and animals which is required for maintaining a healthy earth.

Course Learning outcomes:

- ❖ Students will be able to articulate the basic structure, functions and processes of systems influencing the ecology of an organism.
- ❖ Students will gain knowledge about environmental factors and its impact on life systems.
- ❖ Students will also gain basic knowledge about biological interactions in an environment.

CORE COURSE PRACTICAL

CC-106: Non-chordate and Chordate

Course credit: 02

Course objectives: This course is directed towards identification of protozoan and nematode parasites of cockroach, fish and toad. This course also aims at in-depth study of important arthropods related to ecosystem energy transmission. The course is also designed for developing binary keys for taxonomical identification of Non-chordate and Chordate specimens. The students will get hands-on training for *in situ* localization of pituitary gland of a carp, accessory air-breathing organs of market-available fish specimen and cranial nerves in *Gallus* head.

Course Learning outcomes:

- ❖ Students will learn the methods of mounting of protozoan gut parasites from cockroach/fish/toad.
- ❖ Students will understand the usefulness of different economically important arthropods and will learn to identify them.
- ❖ Students will gain knowledge to identify Non-chordate and Chordate specimens using taxonomic keys.
- ❖ Students will gain knowledge of locating different organs and systems *in situ* and get trained for incorporating experimental set-up.

CC-107: Cell Biology & Genetics

Course credit: 02

Course objectives:

This course is directed towards identification of different cell cycle stages through the study of chromosome structure and alignment; preparation and study of human karyotype. This course also aims at in-depth study of Barr body preparation, study of polytene chromosome from the salivary glands of *Drosophila* etc. The students will get hands-on training for sophisticated techniques for Genomic DNA extraction, Quantification of DNA by UV-spectrophotometer, Electrophoretic separation of Proteins and DNA.

Course Learning outcomes:

- ❖ Students will learn the methods of staining and identification of different cell cycle stages.
- ❖ Students will understand the usefulness of human karyotype study.
- ❖ Students will gain knowledge to identify giant chromosomes.
- ❖ Students will gain knowledge of genomic DNA extraction, quantification of DNA by UV-spectrophotometer, electrophoretic separation of protein and DNA and get trained for incorporating experimental set-up.

CC-108: Insect Biology and Ecology

Course credit: 02

Course objectives:

This course has been designed to provide students a hands-on experience about various aspects of insect biology and ecology. The course is designed to study the insect morphology, developmental stages to have a practical knowledge. The study of insect diversity/richness/abundance is intended to have a practical experience about vast diversity of insects. The course also includes the determination of lethal doses/concentration of natural (plant/animal based) or synthetic against insect pests/ vector to gain knowledge about the efficacy of insect control agents. The later portion of the course is designed to provide students in-depth practical knowledge about the analysis of

water and soil samples, estimation of planktons, basics of community analysis and identification of ecological specimen.

Course Learning outcomes:

- ❖ Students will be able to learn about insect's morphological characteristics that will make their understanding flawless about insect classification.
- ❖ Students will be able to understand insect biodiversity and will make them aware about richness and abundance of insects.
- ❖ Students will be able to determine lethal doses that will help in insect pest/ vector control programmes and about judicious use of insecticides.
- ❖ Students will obtain in-depth knowledge about the analytics related to water and soil sample.
- ❖ Students will be able to estimate and identify ecological specimen better that will help in understanding the ecological problems better.

SECOND SEMESTER

CORE COURSE THEORY

CC-201: Immunology: Organization and Function of Immune System**Course credit: 02****Course objectives:**

This course will help students develop skills necessary for critical analysis of contemporary literature on topics related to various diseases and role of immune system. The topics have been selected with the aim to teach students the basics of Immunology so as to develop understanding of the subject. They will learn Properties and overview of Immune Responses, Cells, Organs, and Microenvironments of the Immune System, Immunogen characteristics. Students will develop concept of inappropriate or dysfunctional immune responses along with tolerance and autoimmunity. They will be able to relate antibody, Complement, Lymphocyte activation, Cytokines.

Course learning outcomes:

After going through this course, students should be able to:

- ❖ Identify the cellular and molecular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens.
- ❖ Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
- ❖ Learn to review the literature to determine the strengths and weaknesses of the data published in immunology and its novelty.

CC-202: Animal Biotechnology**Course credit: 02****Course objectives:**

Animal Biotechnology course has been designed in a graded manner to introduce the students to the basic tools and techniques of recombinant DNA technology and then to the application parts of the course which initiates some of the hallmarks of human achievements in combating human diseases, both pathogen-mediated as well as genetic diseases. The course also deals with biotechnological approach towards novel product development for human and animals. This course will provide basic grasps and current techniques required for biotechnological revolution.

Course Learning outcomes:

- ❖ This course will help the students to understand basic as well as advanced concepts of animal biotechnology.
- ❖ It will empower the students to take up higher researches in the advanced field of biotechnology research, drug and pharmaceutical research in future.
- ❖ It will provide employability in biotechnological and pharmaceutical industries and higher studies.

CC-203: Biochemistry**Course credit: 02****Course objectives:**

This course has been designed to provide students an overall knowledge in the field of biochemistry. The course will help students to acquaint with basic concepts about the various aspects of the structure and function of proteins, lipids, carbohydrates and other essential biomolecules. In addition, this course will enable students to understand the basic principles and applications of bioenergetics and metabolism.

Course Learning outcomes:

- ❖ Students will acquire in-depth knowledge about biochemistry and will have the ability to apply the acquired knowledge to provide cost effective solutions in biochemistry.
- ❖ Students will acquire the ability to translate knowledge about biochemistry to address environmental and ethical issues through case studies presented in the class.
- ❖ Students will acquire the ability to critically analyze biochemical data, draw conclusions and apply this knowledge for general welfare.

CC-204: Fish Biology, Fisheries and Aquaculture

Course credit: 02

Course objectives:

This topic emphasized basic in-hand acquaintance regarding the handling of fish and dealing with various limnological apparatus and parameters.

Course Learning outcomes:

Students will learn the identification of Pisces using the classical morphological methods and basic titrimetric methods for calculating different water parameters.

CC-205 BIOSYSTEMATICS

Course credit: 02

Course objectives:

The course of Biosystematics has been designed to offer as core course at Semester-II of Master's level to impart basic and advance concepts of taxonomy and systematic encompassing species, Linnaean hierarchy, zoological nomenclature, classification and, taxidermy and molecular systematics, which are the essential components of population genetics, speciation, biodiversity and evolution.

Course Learning outcomes:

- ❖ This course will help students to understand basic and some advance aspects of taxonomy and systematic required for animal science. It will also help student to understand epidemic/endemic diseases.
- ❖ Students will gain knowledge of application of cytogenetic and molecular techniques in systematic and use of bioinformatics.
- ❖ It will empower students to get employ in academic institutions as well as institutions associated with animal survey, wild and biodiversity assessment.

CORE COURSE PRACTICAL

CC-206: Immunology and Biotechnology

Course credit: 02

Course objectives:

The course is planned to give comprehensive practical knowledge on different community analysis measures involving different value indices. This course is intended to familiarize students with basic

techniques for estimating and analyzing water and soil samples which form the very base of environmental biology. This course will also provide hands-on exposure pertaining to microbial techniques and will provide an understanding about species identification with reference to North Bengal.

Course Learning outcomes:

- ❖ Students will learn the methods of community analysis and will be able to comprehend the value indices better.
- ❖ Students will understand the usefulness of different analysis techniques for studying different water and soil samples.
- ❖ Students will gain knowledge to assess functional responses in planktons.
- ❖ Students will get motivated to identify species with reference to North Bengal
- ❖ Students will have a comprehensive understanding about the different microbial techniques for identification and culture of microorganisms.

CC-207: Biochemistry, Fish Biology, Fisheries and Aquaculture

Course credit: 02

Course objectives:

This course has been designed to provide students an overall knowledge in the field of biochemistry. The course will help students to acquaint with basic concepts about the various aspects of the structure and function of proteins, lipids, carbohydrates and other essential biomolecules. In addition, this course will enable students to understand the basic principles and applications of bioenergetics and metabolism.

Course Learning outcomes:

- ❖ Students will acquire in-depth knowledge about biochemistry and will have the ability to apply the acquired knowledge to provide cost effective solutions in biochemistry.
- ❖ Students will acquire the ability to translate knowledge about biochemistry to address environmental and ethical issues through case studies presented in the class.
- ❖ Students will acquire the ability to critically analyze biochemical data, draw conclusions and apply this knowledge for general welfare.

THIRD SEMESTER

CORE COURSE THEORY

CC-301: Animal Physiology and Endocrinology

Course credit: 02

Course objectives:

The course aims to teach the students advanced animal physiology topics like respiration, excretion,

osmoregulation, adaptation, thermoregulation, circulation, neurotransmitters, and synaptic transmission. The endocrinology portion focuses on the mechanism of hormone action, neuro-endocrine integration, structure, function and evolution of different vertebrate endocrine glands, i.e., pituitary gland, thyroid gland, adrenal gland, pineal gland, gonads, etc.

Course Learning outcomes:

- ❖ The students will have a good understanding of how animal physiology is influenced by the different environments queues.
- ❖ The students will be able to explore an original query in animal physiology.
- ❖ The students will appreciate evolutionary changes and environmental adaptations in different taxa of vertebrates.
- ❖ It will help to understand the neuroendocrine regulation of physiological processes.
- ❖ This course will help in advancing the knowledge of endocrinology.
- ❖ The course will allow the student to understand different pathological conditions developed by endocrine disorders in animals and humans.
- ❖ It will open the idea of how the external stimuli are perceived by an animal/human and transmitted to endocrine signals to regulate various physiological behaviours.

CORE COURSE PRACTICAL

CC-302: Animal Physiology and Endocrinology

Course credit: 02

Course objectives:

The practical course on “Animal Physiology and Endocrinology” will help students understand the knowledge as a hands-on experience. The activities with the different haematological practical experiments, estimation of amino acids, ascorbic acid, *in situ* demonstration of endocrine organs, and histology will provide the students with substantial practical experience.

Course Learning outcomes:

- ❖ The students will gather practical knowledge of animal physiology and endocrinology.
- ❖ The students will get hands-on training and thorough ideas on measuring different haematological parameters.
- ❖ The students will be able to understand the actual appearance of endocrine glands externally by macroscopic observation and internally by microscopic observation.

Disciple Specific Elective (DSE)

Student will have to choose any one pair (A+B) course among DSE-301 - DSE-305

DSE-301A: Cellular Immunology

Course credit: 03

Course objectives:

The topics like innate Lymphoid Cells, Cellular Innate Response Receptors and Signalling, Differentiation and maturation of T and B cells, Neuro-Immunology etc. will help students to learn the advanced knowledge of Immunology so as to develop understanding of the subject. Topics like hypersensitivity, tolerance and autoimmunity will develop concept of inappropriate or dysfunctional immune responses in the learners. This comprehensive course will enable the student to explore and understand the structure and function of immune system. Upon completion of the course students have a sound understanding of the essential elements of the immune system, preparing them to engage further in this rapidly evolving field.

Course Learning outcomes:

After going through this course, students should be able to:

- ❖ Examine and question prior assumptions related to immunology and categorize features unique to the immune system.
- ❖ The students will be able to comprehensively understand the cellular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens.
- ❖ Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions autoimmune diseases.
- ❖ Learn to review the literature to determine the strengths and weaknesses of the data published in immunology and its novelty.

DSE-301B: Molecular Immunology

Course credit: 03

Course objectives:

The primary objective of this course is to help students develop skills necessary for critical understanding on topics related to antigenic determinants, structural and chemical basis of antigen binding, binding forces of antigen and antibody, function and regulation of complement activity, receptors and signaling of cytokines, organization of MHC, transplantation immunology etc. Hence, the course aims that students are taught the thorough knowledge of immunology so as to develop understand clearly the molecular basis of immune system function. Upon completion of the course students have a sound understanding of the essential elements of the immune system, preparing them to engage further in this rapidly evolving field.

Course Learning outcomes:

After going through this course, students should be able to:

- ❖ Practice and apply some immunology-specific vocabulary, while distinguishing cells, structures, and concepts important to the field of immunology.
- ❖ The students will be able to identify the cellular and molecular basis of immune responsiveness and understand how the innate and adaptive immune responses coordinate to fight invading pathogens.
- ❖ Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
- ❖ Recognize the need for balance and regulation of immune processes and evaluate the consequences of dysregulation.

DSE-302A: Environment and Chemical Ecology

Course credit: 03

Course objectives:

In this course the students will be able to focus on the basics of environmental geology and earth processes and understand how earth's systems interact amongst themselves. This course aims to provide concepts pertaining to natural resources and reserves, and make the students understand how exploitation of these reserves affects the environment. In addition, this course will provide an in depth insight about chemical ecology and teach the students about various aspects pertaining to

chemical- environment interactions.

Course Learning outcomes:

- ❖ Students will gain in depth knowledge about the various facets of environmental geology and earth processes.
- ❖ Students will learn about the formation and classification of earth's materials.
- ❖ Students will be able to understand about the impact of exploitation of mineral resources and environment on an individual and on food chains as a whole.
- ❖ Students will also understand the importance of chemical – environment interactions and gain basic knowledge about mineral resources of India.

DSE-302B: Environmental Toxicology and Environmental Risk Assessment

Course credit: 03

Course objectives:

In this course the student will be able to focus on fate and effects of toxicants, and how they are distributed in the environment both in an individual and in food chains. Besides, the students will study the interaction between environmental toxicants and organisms, and how this impacts on populations and ecosystems. In addition, this course will also provide an insight about the different strategies pertaining to assessment and mitigation of problems arising out of environmental pollutants.

Course Learning outcomes:

- ❖ Students will gain overview knowledge about impact of environmental pollutants on an individual and on the food chain.
- ❖ Students will learn about the process of toxicant uptake and mode of action of toxicants.
- ❖ Students will be able to gather knowledge about fate and interaction of toxicants in our body and understand how defense responses work against toxicants and provide tolerance and resistance to potentially toxic substances.
- ❖ Students will have a comprehensive understanding of environmental impact assessment, auditing, policies and laws.
- ❖ Students will understand the principles of green chemistry and its advances.

DSE-303A: Insect Physiology and Communication & Coordination

Course credit: 03

Course objectives:

Insect Physiology, communication and coordination attempts to introduce students to the physiological systems of maintenance and coordination of insect, the various aspects of basic insect biology, such as nutritional, reproductive, growth and developmental biology. The course emphasizes on the immune system, detoxification and homeostasis. This is followed by perception of the external environment, coordination and intra- and interspecies chemical and physical communication, concept of symbiotic relationship and insect flight and migration.

Course Learning outcomes:

A student in this course should be able to:

- ❖ Know different orders of class Hexapoda, characteristics of major order.
- ❖ Become familiar with the various physiological systems operating in insects.
- ❖ Identify the influence/control (neural and/or hormonal) within each system.

This knowledge will help to gain a comprehensive understating about common pests and their management aspects.

DSE 303B: Industrial Entomology

Course credit: 03

Course objectives:

Industrial Entomology makes familiar with different applied aspect based on insect culture like sericulture, apiculture, lac culture and mass production insect biocontrol agents. It also discusses about use of insect based molecules in pharmacology and industry. It helps to understand uses of insect as food and feed for fish, poultry,

Course Learning outcomes:

A student in this course should be able to:

- ❖ Know the role of abiotic factors on the insect physiology and development.
- ❖ Develop a concept of pest designation, pest management tactics and prediction of pest attack.
- ❖ This knowledge will help to gain a comprehensive understating about common pests and their management aspects.

DSE 304A: Fish Biology and Applied Ichthyology

Course credit: 03

Course objectives:

Here the accentuation was incurred regarding different bodily systems viz. exoskeleton, respiratory, excretory, reproductive, nervous, endocrine and other specialized organs in Pisces along with eco-physiological aspects of fish migration, feeding, somatic growth, nutrition, disease etc.

Course Learning outcomes:

The information on this topic will equip keen interest in the young generation for the broadcast in fish biology. The students will be exposed to modern techniques like aquaponics along with controlling the disease-related problems in the field.

DSE 304B: Fisheries and Hydrobiology

Course credit: 03

Course objectives:

This paper contributes information not only about different fisheries resources viz. inland water, estuarine and marine but also provides facts regarding different systems of aquaculture practices and water management.

Course Learning outcomes:

The understanding of this study will convey detailed information regarding aquaculture management with interdisciplinary approaches because the conservation of aquatic resources is essential in the present scenario.

DSE-305A: Molecular Cell Biology**Course credit: 03****Course objectives:**

Molecular Cell Biology is offered as a DSE course that provides advanced knowledge of cell culture, chromosome structure and function, stem cell biology, aging, cell signaling and molecular genetics at the Semester III of the Masters level. This course will provide technique oriented and clinical aspects of cell biology research. Some of the most incisive analytical approaches that are now being used across the spectrum of the biological disciplines are parts of this course.

Course Learning outcomes:

- ❖ This course will help the students to understand basic as well as advanced concepts of molecular cell biology. It will empower the students to take up higher researches in the advanced field of genomics research, drug and pharmaceutical in future.
- ❖ It will provide employability in educational institutions, biotechnological and pharmaceutical industries and higher studies.

DSE-305B: Molecular Genetics**Course credit: 03****Course objectives:**

Molecular Genetics is offered as a DSE course that provides advanced knowledge of classical/Mendelian as well as non-Mendelian genetics, and prevalent diseases; eukaryotic gene regulation, molecular virology and genotoxicity at the Semester III of the Masters level. This course will provide technique oriented and clinical aspects of disease. Some of the most incisive analytical approaches that are now being used across the spectrum of the drug designing and pharmaceutical researches are parts of this course.

Course Learning outcomes:

- ❖ This course will help the students to understand basic as well as advanced concepts of molecular genetics, clinical genetics, viral strategies and reproduction, non-Mendelian genetics, especially related to human and animal diseases. It will empower the students to take up higher researches in the advanced field of genomics and genetic studies, drug designing and pharmaceutical research in future.
- ❖ It will provide employability in educational institutions, biotechnological and pharmaceutical industries and higher studies.

GE-301: Wildlife Conservation, Biodiversity & Taxonomy**Course credit: 02****Course objectives:**

This course not only imparts the concept of basic and molecular taxonomy essential for speciation, biodiversity and wildlife but also helps to build up scientific knowledge on wildlife resources including management of different advanced techniques appropriate in Indian conditions for both biodiversity and wildlife education.

Course Learning outcomes:

Knowledge of taxonomy will help students to understand the biodiversity and wildlife conservation of the country and to identify new species. It will empower students by providing information and advice on specific wildlife management problems and also help them to get employed in academic institutions

as well as institutions associated with the animal survey, wild and biodiversity assessment.

GE-302: Biophysics and Biostatistics

Course credit: 02

Course objectives:

The course 'Biophysics' is designed to impart basic concepts of Spectrometry, Microscopy Chromatography, Electrophoresis, Centrifugation, Crystallography and X-ray diffraction, NMR and Radioisotope techniques. Students will learn the applications of these equipments and techniques in Biology. This course 'Biostatistics' is intended to convey information to students on the essential ability for the scientific collection, presentation, and analysis of data. The course is designed so that the students get the confidence to use biostatistics for their won experimental research data in their higher studies. This course has been designed to make the students understand the principal concepts about biostatistics. This course will help the students to collect data relating to variable (s) that will be examined and calculated for descriptive statistics. In addition, this course will empower students to identify distribution form relating to variable(s) and apply hypothesis testing via statistical distributions.

Course Learning outcomes:

- ❖ Learners will be able to link basic and advanced biological experiments with the experimental set-up needed.
- ❖ Students will know the basics of data found in the applied techniques and will learn to analyze such data.
- ❖ Students studying this course will be able to perform the data analysis using the statistical tools available on any computer, such as excel.
- ❖ Students will be able to understand the subject of statistics, and its relation to other sciences.
- ❖ Students will be able to identify data related to variables and identify distribution.
- ❖ Students will acquire knowledge to apply hypothesis testing via some of the statistical distributions
- ❖ After having this course, the students may make them suitable to undertake the biostatistician jobs in the offices in the hospitals, scientific academies, funding agencies etc.

FOURTH SEMESTER

CORE COURSE THEORY

CC-401: Gamete Biology and Developmental Biology

Course credit: 02

Course objectives:

This course is designed to impart knowledge to students on fertility problems. The knowledge of sexes and their gametes will help the students to understand the process of sex determination, the development of gonads, and the development of embryo and foetus. This course will help the students to recognize the physiological changes in pregnancy. Gamete preservation and teratological effects of different xenobiotics on gametes, and in the case of an infertile partner, make it essential for assisted reproductive technologies to succeed. The main objective of the developmental biology course is to provide basic concepts on differential gene expression at the levels of transcription and RNA processing with an example of dosage compensation. It will allow the student to understand the patterns and process of early embryonic development in amphibians and *Drosophila*, which is not necessarily, shared with other biological sciences disciplines. Metamorphosis, regeneration, and aging processes will be discussed with analysis and understanding.

Course Learning outcomes:

- ❖ After attending this course, the students should understand the complex hormonal regulation of pregnancy.
- ❖ Much research is required in this area, and the students will be highly knowledgeable to take up research and teaching positions in various research or academic institutes.
- ❖ The students will also understand that cells only express a proportion of their genome and that differential gene expression underlies cell differentiation, and any alteration in the entire process of development leads to devastating diseases.
- ❖ The students studying this course will understand the structure and function of gametes like eggs and sperms and their maintenance, so the reproductive health in humans and animals is maintained in good condition.
- ❖ This course will make them suitably knowledgeable to undertake the jobs in the assisted reproductive technology clinics in the hospitals and the teaching institutions.

CC- 402: Evolution and Population genetics

Course credit: 02

Course objectives:

The course of Evolution and Population genetics has been designed to offer as CORE COURSE at Semester-IV of Master's level to impart basic and advance concepts of evolution and population genetics encompassing Species concept, speciation and genetic, mechanism of reproductive isolation, molecular evolution, RNA world, Hardy-Weinberg Law, evolutionary forces, inbreeding, QTL etc. Evolution and population genetics are core components of human genetics, clinical genetics and many other related areas in biology.

Course Learning outcomes:

- ❖ This course will help students to understand basic and some advance aspects of evolution and population genetics required for comprehensive understanding of biodiversity, population dynamics. It will also help students to understand epidemic/endemic diseases, population prevalence and inheritance of rare diseases.
- ❖ Students will gain knowledge inheritance of complex traits.
- ❖ It will empower students to get employ in academic institutions as well as institutions associated with animal survey, wild and biodiversity assessment.

CORE COURSE PRACTICAL

CC 403: Gamete Biology and Developmental Biology

Course credit: 02

Course objectives:

The practical course on “Gamete Biology and Developmental Biology” will allow the students to comprehend the knowledge as a hands-on experience. The activities with different developmental biology practical, like window preparation on the incubating egg, incubation of chick embryo for different duration, histological section preparation, will provide substantial practical experience to the students on the embryology. The surgical techniques such as adrenalectomy, castration, identifying estrous cycle stages by vaginal smear preparation, and histology of gonads will provide the students with extensive knowledge of gamete biology.

Course Learning outcomes:

- ❖ The students will gather practical knowledge of gamete biology and developmental biology.
- ❖ The students will get hands-on training and thorough ideas on the activities with different developmental biology practical, like window preparation on the incubating egg, incubation of chick embryo for different duration, histological section preparation of embryo.
- ❖ The students will understand the actual appearance of internal organs in lively conditions during the adrenalectomy and castration procedure.
- ❖ The students also will be trained in histological techniques to see the internal microscopic structure of gonads. This ability may help them to procure the job in research laboratories and hospitals in addition to the teaching institutions.

Discipline Specific Elective (DSE)

Student will have to choose any one course among DSE-401 - DSE-405

DSE-401: Clinical Immunology and Immunotechnology

Course credit: 03

Course objectives:

The primary objective of this course is to develop skills necessary for critical analysis of contemporary clinical and applied topics related to immune system. The course includes topics such as immunity to microbial infectious diseases, tumor immunology, HLA and disease association, immunodeficiency diseases, reproductive immunology, Hybridoma technology, Vaccines, Techniques and technologies For estimation of immunologically relevant molecules and substances.

This comprehensive course also emphasizes the research and development opportunities for therapeutic intervention arising from recent advances in immunology. The immunological aspects of disease will also be discussed using case-based studies.

Course Learning outcomes:

After going through this course, students should be able to:

- ❖ Understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in transplantation and cancer.
- ❖ Begin to integrate concepts from immunity into real-world issues and medical applications.
- ❖ Design new methods to improve existing vaccines and other immunotherapeutic strategies.
- ❖ Trace the study of immunology from a desire to vaccinate against infectious disease to far-reaching applications in basic research, medicine, and other fields of study.

DSE-402: Chronobiology, Behavioral Ecology and Environmental Biotechnology

Course credit: 03

Course objectives:

The course will enable students understand the importance of internal timing in regulation of daily and seasonal processes in organisms. After successful completion of this course the students will be able to understand animals' complicated behaviour, degree of inter-specific and intra-specific relationship among the animals, to know the facts behind learning and memory. This course will help in learning the role of biotechnology in sustaining a healthy earth with proper environment management.

Course Learning outcomes:

- ❖ Students should be able to conceptualize how species profitably inhabit in the environment and space out their activities at different times of the day and seasons.
- ❖ Students will understand the molecular, cellular and system levels in the generation and coordination of internal timing in both human and non-human species.
- ❖ Students will have a clear understanding about animals' complicated behaviour and focus on factors that influence animals' complicated behaviour.
- ❖ Students will understand the need of proper usage of biotechnological tools for maintaining a healthy and sustainable environment.
- ❖ Students will have a basic idea about GMO's and biotechnological approaches for waste and environmental pollution management.

DSE-403: Insect Pests & Vectors and their Management (C)

Course credit: 03

Course objectives:

Insect Pests & Vectors and their Management attempts to introduce students to the Insect pests and vectors of agricultural and medical importance. The course emphasizes on the transmission of pathogen and polyphagous pests. This also discusses about insects causing harm to livestock and insect plant interaction.

Insect Pest Management deals with the concept of economic levels and their calculation, determination, current pest control methods and about IPM and IRM.

Course Learning outcomes:

A student in this course should be able to:

- ❖ Know about pests of agricultural, forest and stored food produce/products.
- ❖ Gain knowledge about different pest control strategies.
- ❖ Biological pest control methods, its challenges and success.
- ❖ Successful pest control case stories by implementing IPM.
- ❖ Know the concept of Insecticide resistance management, host plant resistance etc.
- ❖ This knowledge will help to gain a comprehensive understating about common pests and their management aspects.

DSE 404: Fish Technology

Course credit: 03

Course objectives:

This first section of fish technology focuses on making the student understand the fish spoilage, preservation, processing technologies, and by-products associated with the fish industry. The second portion deals with fish genome and fish biotechnology, advanced technique on fish detection methods, advanced crafts and gears, etc.

Course Learning outcomes:

- ❖ The students will understand how the fish spoil and why the preservation of fish for the human society is essential.

- ❖ The students will learn the different methods of fish preservation techniques used in India and abroad.
- ❖ The students will gather knowledge about the different fish by-products, their use, their economic importance, and the associated industry.
- ❖ The students will gather on the genome and fish biotechnology, advanced techniques on fish detection methods, advanced crafts and gears, etc.

DSE-405: Molecular Cell Biology and Genetics

Course credit: 03

Course objectives:

Molecular Cell Biology and Genetics is offered as a DSE course that provides advanced knowledge of cancer genetics, pharmacogenomics, ecogenetics, personalized Medicine, molecular genetic disorders; advanced techniques in genome, transcriptomics and proteomic analyses at the Semester IV of the Masters level. This course will provide technique oriented and clinical aspects of disease.

Course Learning outcomes:

- ❖ This course will help the students to understand basic as well as advanced concepts of molecular genetics of cancer biology, clinical genetics, pharmacogenetics and genome and proteome studies.
- ❖ It will empower the students to take up higher researches in the advanced field of genomics and genetic studies, drug designing and pharmaceutical research in future.
- ❖ It will provide employability in educational institutions, biotechnological and pharmaceutical industries and higher studies.

DSE-406 (A/B/C/D/E): Discipline Specific Elective Course Practical

Marks 50

Student will have to choose any one course among DSE-406 A-E corresponding to their earlier choice of Discipline Specific Elective Course

DSE-406A: Immunology

Course credit: 02

Course objectives:

The course is designed to give comprehensive practical knowledge on different classical and modern measures for analysis of immune system function in experimental animal (mouse). This course will provide the students hands-on experience and will turn them ready to take on field based studies as well as involve in the clinical laboratories as experts.

Course Learning outcomes:

- ❖ Students will learn the methods of complement and anti-serum collection.
- ❖ Students will be able to differentiate the primary and secondary antibody response.
- ❖ Students will gain knowledge to assess cell mediated immune response.
- ❖ Students will have a comprehensive understanding of sophisticated techniques like PCR, SDS-PAGE etc.

DSE-406B: Environmental Biology:

Course credit: 02

Course objectives:

Course Objectives: The course is planned to give comprehensive practical knowledge on different community analysis measures involving different value indices. This course is intended to familiarize students with basic techniques for estimating and analyzing water and soil samples which form the very base of environmental biology. This course will also provide hands-on exposure pertaining to microbial techniques and will provide an understanding about species identification with reference to North Bengal.

Course Learning outcomes:

- ❖ Students will learn the methods of community analysis and will be able to comprehend the value indices better.

- ❖ Students will understand the usefulness of different analysis techniques for studying different water and soil samples.
- ❖ Students will gain knowledge to assess functional responses in planktons.
- ❖ Students will get motivated to identify species with reference to North Bengal
- ❖ Students will have a comprehensive understanding about the different microbial techniques for identification and culture of microorganisms.

DSE-406C: Insect Biology and Pest Management:

Course credit: 02

Course objectives:

The course is designed to study the insect's external and internal morphology, developmental stages, study of insect body parts, medical important insects. The course is intended to have a practical experience about vast diversity of insects. The course also includes the different biochemical and molecular techniques related to insect biology, physiology and biochemistry. Student will learn how to determination of lethal doses/concentration of natural (plant/animal based) or synthetic pesticides against insect pests/ vector to gain knowledge about the efficacy of insect control agents.

Course Learning outcomes:

On completion of the course students will learn about

- ❖ insect's external and internal morphology, developmental stages, study of insect body parts and medical important insects
- ❖ insect biodiversity by RTU will make them aware about richness and abundance of insects.
- ❖ different biochemical and molecular techniques related to insect biology, physiology and biochemistry.
- ❖ determination of lethal doses will help to insect pest/ vector control programmes and about judicious use of insecticides.

DSE 406D: Fish Biology, Fisheries and Aquaculture Special Paper Practical

Course credit: 02

Course objectives:

This theme emphasizes techniques related to the assessment of dietetic aspects of aquatic organisms from different aquatic resources along with identification and artificial feed preparation.

Course Learning outcomes:

The information gained here upon can impart significant acquaintance not only about the location of different internal organs in fishes but also to deal with various physico-chemical parameters of water. Demonstration of different phases of induced breeding and dietary formulation will be beneficial for students to get associated with any fisheries institute in future.

DSE-406E: Molecular Cell Biology and Genetics

Course credit: 02

Course objectives:

Molecular Cell Biology and Genetics practical is offered as a DSE course that provides basic and advanced tools and techniques related to cytogenetic studies including chromosome banding techniques, rearing of *Drosophila* and studying of salivary gland chromosomes, puff formation, DNA isolation and PCR techniques with plasmid restriction mapping, RAPD-PCR, bacterial transformation and plasmid isolation techniques. This course will provide hand-on experience to the students on basic molecular genetics and cell biology techniques.

Course Learning outcomes:

- ❖ This course will help the students to understand and learn methods of studying molecular genetics cell biology applied in most of the higher researches and biotechnological industries.

- ❖ It will empower the students to take up higher researches in the advanced field of genomics and genetic studies, drug designing and pharmaceutical research in future.
- ❖ It will provide employability in educational institutions, biotechnological and pharmaceutical industries and higher studies.

GE-401: Environment and Public Health

Course credit: 02

Course objectives:

This course is planned to provide students with an understanding of the development of the subject with an emphasis on understanding the determinants of the environment related health problems. This course will enable students to better understand the communicable disease epidemiology and gain in-depth knowledge about major environment related health problems. In addition, this course will enable students to assess environment related health problems and gain concepts related to prevention and control strategies.

Course Learning outcomes:

- ❖ Students will gain knowledge about the cause and consequences of environment related health problems
- ❖ Students will be able to evaluate the relations between environment and public health.
- ❖ Students will be able to apply management principles to anticipate, identify, evaluate and to control environment related health problems.

GE-402: Molecular Biology, Biochemical and Biophysical methods

Course credit: 02

Course objectives:

Molecular Biology, Biochemical and Biophysical Methods is offered as a GE course that provides advanced knowledge of molecular genetics techniques for analysis of genes. This course will provide technique oriented and clinical aspects of disease. It also provides concepts and handling of different sophisticated equipment used in estimation of macromolecules.

Course Learning outcomes:

- ❖ This course will help the students to understand basic as well as advanced concepts of molecular genetics, biophysical and biochemical methods.
- ❖ It will empower the students to take up higher researches in the advanced research in future.
- ❖ It will provide employability in educational institutions, biotechnological and pharmaceutical industries and higher studies.