

Department of Zoology

**Veer Bahadur Singh Purvanchal
University, Jaunpur**

**Syllabus of Zoology for two Years P.G.
Programme**

**To be Implemented from the Academic year
2022-23**



Submitted By :

Convener / Member of Board of Studies

Semester Courses of M.Sc. Zoology Based on CBCS

The course of M.Sc. Zoology will be spread in two years previous and final. Each of which will have two semester examinations and therefore will be four semester examinations.

Semester-I :20 Credits		
Course Code	Course Title	Credits
B050 701T	Non Chordata	4
B050 702T	Tool & Techniques in Biological Science	4
B050 703T	Comparative Animal Physiology	4
B050 704T	Biological Chemistry	4
B050 705 P/R	Practical	4

Semester-II : 20 Credits		
Course Code	Course Title	Credits
B050 801	Chordata	4
B050 802	Systematics, Biodiversity and Evolution	4
B050 803	Genetics and Cytogenetic	4
B050 804	Developmental Biology	4
B050 805	Practical	4

Semester-III : 20 Credits		
Course Code	Course Title	Credits
B050 901T	Principles of Ecology Theory	4
B050 902T	Biostatistics and Computational Biology	4
B050 903T	Biology of Parasitism	4
B050 904T	Applied Zoology	4
B050 905T	Epigenetic & Chromatin Biology Theory	4
B050 906T	Structure & Function of Genes	4
B050 907T	Animal Behaviour	4
B050 908T	Molecular Endocrinology	4
B050 909 P/R	Practical	4

Semester-IV : 20 Credits		
Stream- 1 Entomology		
Course Code	Course Title	Credits
B050 1001T	Insect Morphology Physiology & Development	4
B050 1002T	Ecology, Evolution & Taxonomy	4
B050 1003T	Economic Entomology	4
B050 1004 P/R	Dissertation	4
B050 1005 P/R	Practical	4

Stream- 2 Fish Biology		
Course Code	Course Title	Credits
B050 1101T	Morphology, Physiology & Development of Fishes	4
B050 1102T	Taxonomy & Ecology of Pisces (Theory)	4
B050 1103T	Applied Ichthyology	4
B050 1104P/R	Dissertation	4
B050 1105 P/R	Practical	4

Stream- 3 Cell Biology		
Course Code	Course Title	Credits
B050 1201T	Cytological Techniques	4
B050 1202T	Cellular Organization & Fundamental Processes: Cell Structure	4
B050 1203T	Cell Regulation-Cell Communication & Differentiation	4
B050 1204P/R	Dissertation	4
B050 1205P/R	Practical	4

Stream- 4 Environmental Biology and Toxicology		
Course Code	Course Title	Credits
B050 1301T	Wild Life Biology	4
B050 1302T	Environmental Chemistry	4
B050 1303T	Environmental Monitoring & Toxicology	4
B050 1304 P/R	Dissertation	4
B050 1305 P/R	Practical	4

Programme Specific Outcomes of Zoology

1. Developing deeper understanding of key concepts of biology at biochemical, molecular and cellular level, physiology and reproduction at organism level, and ecological impact on animal Behavior.
2. Developing the concept of animal adaptation by exploring the diversity of functional characteristics of various kinds of organisms which is closely related to evolutionary processes and environmental changes.
3. Understanding of Mendel's principle, its extension and chromosomal basis; chromosomal anomalies and associated diseases; developing concepts of regulation of gene activity in prokaryotes and eukaryotes of transcriptional and post transcriptional level.
4. Development of an understanding of animal science for its application in entomology, apiculture, aquaculture, agriculture and modern medicine.
5. Develop an information about and basic concept of developmental biology elucidation of early embryonic development and organogenesis of invertebrates and vertebrates, explanation of embryonic stem cells and their application.
6. To understand the basic components of computers, software (operating system) and application of software used in biological and statistical studies.
7. Development of theoretical and practical knowledge in handling the animals and using them as model organism.
8. By the theoretical project work is aimed to in calculate ability to develop a research question, organize relevant available literature and development of technical writing skill.
9. To understand the impact of chemicals on biodiversity of microbes, animals and plants; Bio indicators and biomarkers of environmental health. Biodegradation and bioremediation of chemicals; competition and existence; intraspecific and inter specific interactions.
10. Maintenance of high standards of learning in animal sciences.

M.Sc. (Zoology)

The M.Sc. Previous (Zoology) examination will consist of two semesters, called as first and second semesters. Their examinations will be held in the months of December and May respectively. In each semester examinations, there will be four compulsory papers and one practical. Each theory paper will be of three hours duration and 4 credit, and six hours duration practical with 4 credits. (Total 20 credits) (maximum marks 75), except where stated otherwise. There will be 25% internal evaluation in each paper based on:

- | | |
|--------------------------|----------|
| 1. Attendance | 10 Marks |
| 2. Class Test/Assignment | 05 Marks |
| 3. Seminar | 10 Marks |

Format of the Question Paper:

There will be one compulsory question consisting of 4 parts of short answer type question based on the whole course, out of which all parts will have to be answered. Besides this, there will be 8 questions from four units (two from each unit), out of which 4 questions will have to be answered (one from each unit). Thus in all 5 questions will have to be attempted and 9 questions will have to be set. All questions will carry equal marks, except stated otherwise.

M.Sc Final Zoology

The M.Sc Final Zoology will consist of two semesters, called as third and fourth semesters. Their examinations will be held in the months of December and May respectively. In 3rd semester examinations there will be two compulsory papers and one practical beside the two elective theory papers. Each paper will be of three hours duration and of 4 credit and sixth hours duration practical with 4 credit. (Total 20 credits) .4th semester have four stream, student select one stream .Each stream have four paper. Each paper will be three hour duration and of 4 credit and sixth hour duration practical with 4 credit (Total 20 credits) .(maximum marks 75), except where stated otherwise. There will be 25% internal evaluation in each paper based on:

- | | |
|--------------------------|----------|
| 1. Attendance | 10 Marks |
| 2. Class Test/Assignment | 05 Marks |
| 3. Seminar | 10 Marks |

Format of the Question Paper:

There will be one compulsory question consisting of 4 parts of short answer type question based on the whole course, out of which all parts will have to be answered. Besides this, there will be 8 questions from four units (two from each unit), out of which 4 questions will have to be answered (one from each unit). Thus in all 5 questions will have to be

attempted and 9 questions will have to be set. All questions will carry equal marks, except stated otherwise.

(ZOOLOGY)
TWO-YEAR FULL-TIME PROGRAMME
AFFILIATION

The proposed programme shall be governed by the V.B.S.P.U. Jaunpur.

PROGRAMME STRUCTURE

The M.Sc. Programme is divided into two parts as under. Each part will consist of two semesters as given below

Semester-odd Semester-Even

Part-I First Year Semester-1 Semester-2

Part-II Second Year Semester-3 Semester-4

Each semester would consist of four papers (course) and one practical course (based on all four papers, two credits for each paper). Semesters I and II (Part I) would have core papers (courses) to be studied by all students of the M.Sc.Zoology programme. Semesters III and IV (Part II) would comprise optional papers from which each student would have to select four papers in Semester III and three papers of his/her choice in Semester IV. Selection of papers in Semester III and IV would be based on choice and other specific guidelines as outlined below. It is mandatory for each student to complete a dissertation, assigned at the end of semester II and goes on until Semester IV. It would be theoretical and not involve any laboratory components. The schedule of papers prescribed for various semesters shall be as follows.

Part-I Semester-1

1. B050 701T Non- Chordata
2. B050 702T Tool and Techniques in Biological Science
3. B050 703T Comparative Animal Physiology
4. B050 704T Biological Chemistry
5. B050 705 P/R Practical

Part-I Semester-2

1. B050 801T Chordates-Origin and Evolution
2. B050 802 T Systematics, Biodiversity and Evolution
3. B050 803T Genetics and Cytogenetic
4. B050 804T Developmental Biology
5. B050 805 P/R Practical

Part-II: Semester-3

- Two papers B050 902T and B050 907T (Interdisciplinary) are compulsory.
 - Two optional papers are to be selected by each student
 - One paper from B050 901, B050 903 or B050 904.
 - One paper from B050 905, B050 906 or B050 908.
1. B050 901T Principles of Ecology Open Elective
 2. B050 902T Biostatistics and Computational Biology
 3. B050 903T Biology of Parasitism Elective Course
 4. B050 904T Applied Zoology
 5. B050 905T Epigenetic and Chromatin Biology
 6. B050 906T Structure and Function of Genes Elective Course
 7. B050 907T Animal Behavior
 8. B050 908T Molecular Endocrinology
 9. B050 909 P/R Practical

Part-II: Semester-4

Student will select any one of the four streams, each stream consisting of three papers (courses). Besides this, each student will complete a dissertation, which would be theoretical and not involve any laboratory components.

Stream 1: Entomology

1. B050 1001T Insect Morphology, Physiology & Development
2. B050 1002T Ecology, Evolution & Taxonomy
3. B050 1003T Economic Entomology
4. B050 1004T Dissertation
5. B050 1005 P/R Practical

Stream 2: Fish Biology

1. B050 1101T Morphology, Physiology & Development of Fishes
2. B050 1102T Taxonomy & Ecology of Pisces
3. B050 1103T Applied Ichthyology
4. B050 1104T Dissertation
5. B050 1105 P/R Practical

Stream 3: Cell Biology

1. B050 1201T Cytological Techniques
2. B050 1202T Cellular organization & Fundamental Processes
3. B050 1203T Cell Regulation-Cell communication
4. B050 1204 P/R Dissertation
5. B050 1205 P/R Practical

Stream 4: Environmental Biology & Toxicology

1. B050 1301T Wild Life Biology
2. B050 1302T Environmental Chemistry

3. B050 1303T Environmental Monitoring & Toxicology
4. B050 1304 P/R Dissertation
5. B050 1305 P/R Practical

Semester 1

- B050 701T Non Chordata (4 credit)
- B050 702T Tool & Techniques in Biological Science (4 credit)
- B050 703T Comparative Animal Physiology (4 credit)
- B050 704T Biological Chemistry (4 credit)
- B050 705 P/R Practical (4 credit)

Semester 2

- B050 801T Chordates-Origin and Evolution(4credit)
- B050 802T Systematics, Biodiversity and Evolution(4 credit)
- B050 803T Genetics and Cytogenetics (4credit)
- B050 804T Developmental Biology (4 credit)
- B050 805 Practical(4 credit)

Semester 3

Two Papers – B050 902T And B050 907T are compulsory

Two optional papers are to be selected by each student

One paper from B050 901T or B050 903T or B050 904T

One paper from B050 905T or B050 906T or B050 908T

- B050 901T Principles of Ecology (4 credit)
- B050 902T Biostatistics and Computational Biology (4 credit)
- B050 903T Biology of Parasitism (4 credit)
- B050 904T Applied Zoology(4 credit)
- B050 905T Epigenetic & Chromatin Biology(4 credit)
- B050 906T Structure & Function of Genes(4credit)
- B050 907T Animal Behaviour (4 credit)
- B050 908T Molecular Endocrinology (4 credit)
- B050 909 P/R Practical(4 credit)

Semester 4 (Any one stream from 1-4)

Stream 1 Entomology

- B050 1001T Insect Morphology Physiology & Development (4 credit)
- B050 1002T Ecology, Evolution & Taxonomy(4 credit)

B050 1003T Economic Entomology(4 credit)

B050 1004 P/R Dissertation (4 credit)

B050 1005 P/R Practical (4 credit)

Stream 2 Fish Biology

B050 1101T Morphology, Physiology & Development of Fishes (4 credit)

B050 1102T Taxonomy & Ecology of Pisces (4 credit)

B050 1103T Applied Ichthyology (4credit)

B050 1104 P/R Dissertation (4 credit)

B050 1105 P/R Practical (4 credit)

Stream 3 Cell Biology

B050 1201T Cytological Techniques (4credit)

B050 1202T Cellular Organization & Fundamental Process (4 credit)

B050 1203T Cell Regulation-Cell Communication & Differentiation (4 credit)

B050 1204 P/R Dissertation (4 credit)

B050 1205 P/R Practical (4credit)

Stream 4 Environmental Biology & Toxicology

B050 1301T Wild Life Biology (4 credit)

B050 1302T Environmental Chemistry (4 credit)

B050 1303T Environmental Monitoring & Toxicology (4 credit)

B050 1304 P/R Dissertation (4 credit)

B050 1305T Practical (4 credit)

Semester 1

Course Code	Course Title	Credits
B050 701T	Non Chordata	4

Unit-1: Organization of Coelome, types of Coelome, Protostomia and deuterostomia, Nutrition and reproduction in protozoa: origin of Metazoa: organization and affinities of Porifera; Polymorphism and Coral reefs.

Unit-2: Patterns of life cycle and defferent larval forms of helminthes parasities: metameric segmentation in Annelida; Adaptive radiation in Annelida.

Unit-3: Organization and affinities of Onychophora; Larval forms in Crustacea; Torsion in gastropods, its effect and significance.

Unit-4: Larval forms in Echinodermata; Affinities of Echinodermata and Hemichordata; Brief outlines of the structure and affinities of minor phyla with special reference to ctenophore, Rotifera.

Suggested Literature:

1. A life of invertebrates by W.D. Russel-Hunter, MacMillan Publishing Co. inc.,New York.
2. Advances in invertebrates' reproduction by K.G. Adiyodi and R.G. Adiyodi, Peralam- KenothKerivellur, Kerala.
3. Biology of the invertebrates by Jan Pechenik, William C. Brown Publishers, Dubuque, Iowa.
4. Invertebrates zoology by A. Kaestner, Interscience Publishers.
5. Invertebrates zoology by Alfred Kaestner, H.W.Levi & L.R. Levi, John Wiley & Sons Inc.
6. Invertebrates (Protozoa to Echinodermata) by Ashok Verma, Narosa Publishing house, New Delhi.
7. Invertebrates Learning by W.C. Corning and J.A. Dayal.
8. Invertebrates Structure and Function by E.J.W. Barrington, The Camolet Press, Great Britain.
9. Invertebrates Zoology by P.A. Meglitsch & F.R. Schram; Oxford University Press.
10. Invertebrates Zoology by R.D. Barnes, V Edition. Holt Saunders International edition.

11. Principles of Comparative Anatomy of Invertebrates by W.N. Bekiemishev, University of Chicago Press.
12. Principles of Comparative Anatomy of Invertebrates by Dr J.M. Mac Lennon; Z. Kabata, Oliver and Boyd Edinburgh.
13. Textbook of Invertebrate Zoology by G.S. Sandher; H. Bhaskar, Campus book International.
14. The Invertebrates by L.H. Hymen, McGraw-Hill Book Company.
15. The Invertebrates: A New Synthesis by R.S.K Barnes, P. Calow, P.J.W. Olive, D.W. Golding, and Spicer, J.I, III Edition, Blackwell Science.
16. Invertebrate Zoology by Jordon and Verma.

Course Outcomes-After the course the students will be able to understand the basics of this course. Larval forms in Echinodermata; Affinities of Echinodermata and Hemichordata; Brief outlines of the structure and affinities of minor phyla. Get benefit of this course in various competitive examinations.

Course Code	Course Title	Credits
B050 702T	Tool & Techniques in Biological Science	4

UNIT-1: Principles and uses of analytical Instruments; Flame Photometry, Spectrophotometer.

UNIT-2: Microbial technique:- Media preparation, sterilization, Inoculation, growth monitoring, use of fermentation and Microbial Assays.

UNIT-3: Separation and identification of biomolecules by Paper and thin layer Chromatography.

UNIT-4: Separation of Biomolecule by electrophoresis : GEL and SDS page.

Suggested Literature:

1. Essential Laboratory Techniques by S.R. Gallagher, E.A. Wiley.
2. An introduction to Practical Biochemistry by D.T. Plummer.
3. Techniques in Live Sciences by D.B. Tembhare.
4. Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition by Keith Wilson and John Walker, Cambridge University Press.
5. Light Microscopy in Biology: A practical Approach, 2nd Edition by Alan J. Lacey, Oxford University Press.
6. Electron Microscopy: Principles and Techniques of Biologist by John J. Bozzola, Lonnie D. Russell, Jones & Bartlett Publ.
7. Tools and Techniques of Biotechnology by Mousumi Debnath, Pointer Publishers.

8. Tools and techniques in Biological Science by Dr. Dev, Vats and Vijeta.

Course outcomes- To get the ideas of the media preparations and sterilization, Inoculation and growth monitoring, use of fermentation, microbial Assays and separation and identification of biomolecules by Chromatography: Paper and thin layer Chromatography, Gel exclusion Chromatography. This course is useful in various competitive exams like CSIR-NET etc.

Course Code	Course Title	Credits
B050 703T	Comparative Animal Physiology	4

UNIT -1: Modes of nutrition, types of digestion and absorption of food; Neurons, Mechanism of conduction and transmission of nerve impulses; Nernst equation, electrical potential, types of synapse and synaptic transmission.

UNIT-2: Osmotic conformity and regulation: Stenohaline, Euryhaline animals, Hypo, Hyper environment and terrestrial life; General characteristics of stimulus and response reaction: Chemoreceptors, photoreceptors, phonoreceptors, mechanoreceptors, equilibrium reception;

UNIT-3: Thermoregulation in animals: Temperature relationship in poikilotherms, endotherms, thermal acclimatization; Circulation: Types of circulation, physiological categories of heart, conduction system, cardiac cycle, electrocardiogram; Types of muscles, its composition, muscle contraction.

UNIT-4: Pattern of nitrogen excretion in different animals: Types of excretory products, Biosynthesis of urea and uric acids; Comparative study of endocrine organs and their hormonal secretion in non chordates and chordates.

Suggested Literature:

1. Animal Physiology by M. Brown, Apple Academic Press.
2. Animal Physiology by R.C. Sobte, Narosa Publishing House.
3. Animal Physiology by F.R. Haninworth
4. Comparative Animal Physiology by C.L. Prosser, W.B. Saunders Company.
5. Comparative Physiology of Animal by R.W.Hill; P.D. Sturke.
6. Environmental Physiology of Animals by P. Willmer; G. Stone, Blackwell Science Ltd.
7. General and Comparative Physiology by W.S. Hoar, Prentice Hall of India Pvt. Ltd.
8. Marshall's Physiology of Reproduction by G.E. Lamming, Churchill Livingstone.
9. Neural and Integrative Animal Physiology by C.L. Prosser, Wiley India Pvt. Ltd.
10. Principles of Animal Physiology by J.A. Wilson.

Course outcomes- To study the osmotic conformity and role of membranes in ionic regulation: Stenohaline, Euryhaline animals, Hypo and Hyper environment and terrestrial life and pattern of excretion in different animals. After the course the students get able to get benefit of this course in various national and international competitive examinations.

Course Code	Course Title	Credits
B050 704T	Biological Chemistry	4

Unit I: Elementary thermodynamic system; Acid base buffer amphoteric, Zwitter ions.

Unit II: Kinetics of enzyme reaction; order of enzyme reaction, rate equations, two substrate reactions; Enzyme Inhibition, Competitive and non competitive inhibitors in biological system, Applications of enzyme inhibition techniques in pest control, Allosteric Enzyme.

Unit III: Structure and function of vitamins and coenzymes; metabolic pathway.

Unit IV: Biosynthesis of amino acids, Nucleotides , glycogen and urea.

Suggested Literature

1. Biochemistry by J.M berg J.L. Tymoczko, W.H. Freedman Plagraue Macmillon
2. Biochemistry by Zubey; Styrrer
3. Self physiology and Biochemistry by W.D. McElory , Prentice Hall of INDIA Pvt. LTD
4. Comparative biochemistry by K.A Munday, Pergmon Press Oxford London
5. Essentials of Biochemistry by Srivastva; Lal; N.Singh, Rekha Publications
6. Essentials of Biological chemistry by Fairley Kilgour, Affiliated east -west Press
7. Harper's Biochemistry by R.K. Murray, D.K Granner, A long medical book.
8. Introduction to biochemistry by J. Awapra, Printice Hall of INDIA Pvt. LTD
9. Lehninger Principles of biochemistry D.L Nelson, M.M .Cox W.H. Freedman Company

Course outcomes- To study the Kinetics of enzyme of reaction and kinetic of enzyme catalyzed reactions, order of enzyme reaction, rate equations, two substrate reactions; Temperature Coefficient, Activation Energy; Enzyme Inhibition, Competitive and non competitive inhibitors ; Applications of enzyme inhibition techniques in pest control, Allosteric Enzyme. This course is useful in various competitive exams.

Course Code	Course Title	Credits
B050 705P/R	Practical	4

Max. Marks: 75

Time: 6 hours

Distribution of Marks:

Major dissection	10
Minor dissection	05
Technique/ Instrumentations	10
Biochemistry Exercise	10
Physiology Exercise	10
Spotting (10 spots)	20

Viva voice and seminar 10
Total Mark: 75

Course B050 701P/R: General Survey and classification of the non- chordates phyla (Protozoa to Echinodermata) with the help of museum specimens and slides.

Protozoa: Vital staining and staining preparation of *Paramecium* ;Study of cyclosis and trichocysts in *Paramecium*; Permanent preparation of ,*Paramecium*, *Vorticella*, Study of prepared slides: *Balantidium*, *Opalina*.*Paramecium* conjugation / binary fission,*Entamoeba histolytica* ,*Giardia*, *Trypanosoma*, *Leishmania*.

Porifera: Permanent preparation of gemmules, sponging fibres and different kinds of spicules, Study of museum specimens specimens/models; *Lecuosolania* , *Sycon* , *Grantia*, *Euplectella*, *Hyalonema*, *Chondrilla*, *Chliona*, *Spongilla*, *Spongia*, *Hippospongia*.

Cnidaria and Ctenophora: Study of nematocysts of *Hydra*,Permanent preparation of *Hydra*; *Obelia* and other hydrozoan colonies and *Obelia* Medusa ; Study of museum specimens/ models : *Tubularia* , *Sertularia*, *Campanularia*, *Millepora*, *Stylaster*, *Physalia*, *Porpita*, *Varella*, *Aurelia*, *Tubipora*, *Alcyonium*, *Gorgonia*, *Pennatula*, *Metridium*, *Fungia*, *Madrepora*.

Helminths: Permanent preparation of selected soil and plant nematodes , cestode and trematode parasites of cattle and poultry , and different larval stages of liver fluke, Study of museum specimens/ whole mounts : *Fasciola*, *Taenia*, *Echinococcus*, *Trichuris*, *Ascaris*, *Ancylostoma*, *Wuchereria*;study of prepared slides :*Scolex* of tape worm ,mature and gravid proglottid of tape worm;Study of *cysticercus* larva, larval stage of *Fasciola* .

Annelida:Study of museum specimens/models:*Aphrodite*, *Glycera*, *Chaetopterus*, *Arenicola* ,*Sabella*, *Serpula*, *Tubifex* ,:Study of prepared slides:T.S. of body of leech passing through various places.

Arthropoda: Study of museum specimen: *Limulus*, *Palamnaeus*, *Apus*, *Argulus*,*Balanus*, *Sacculina*, *Mysis*, *Squilla*, Prawn, Lobster, true crab, hermit crab, *Julus*, *Scolopendra*,, *Lepisma*, stick insect, grass hopper, *termites*, *Pediculus*, butterfly, wasp, *Xenopsylla*, life history of honey bee, lac insect and silk moth; Study of prepared slides: Mouth parts of mosquitoes, house fly, honey bee, butterfly, *Cimex*, *Daphnia*, *Cypris*, *Cyclops*, *Pediculus*.

Mollusca : Study of museum specimen/models : *Chiton*, *Dentalium*, *Pila*, *Aplysia*, *Doris*, *Lymnaea*, *Mytilus*, *Patella*, *Limax*, pearl oyster, *Teredo*, *Nautilus*, *Loligo*, *Sepia*, *Octopus*. Study of prepared slide: Radula, T.S of shell of *Unio*, T.S of gill lamina of *Unio*, T.S of body of *Unio* passing through middle region; Larvae of mollusca.

Echinodermata: Study of museums specimen/ models: *Asterias*, *Ophiothrix*, *Echinus*, *Thyone*, *Holothuria*, *Antedon*; Study of prepared slides: Larvae of echinoderms: Aristotle's lantern.

Hemichordata :Study of museum specimens: *Balanoglossus*, *Tornaria* larva,

Minor phyla: Representative specimens of Onychophora (*Peripatus*), Sipunculida (*Sipunculus*), Echiurida (*Bonelia*)

Course B050 702 P/R : Basic principles and functioning of Spectrophotometry, Paper and thin layer chromatography.

Course B050 703 P/R: Comparative study of total count of erythrocyte and leukocytes of fish and mammals. estimation of haemoglobin content of the blood, Determination of haematocrit in fish, bird and rat. Determination of respiratory rate of rat in relations to size and sex.

Course B050 704 P/R: Quantitative estimation of total free amino acid by paper chromatography in tissues of cockroach. paration of these amino acids; Kinetic assay of salivary amylase and study of effects of time, temperature and pH.

SEMESTER -2

Course Code	Course Title	Credits
B050801 T	Chordates-organ and Evolution	4

Unit–1: Study the famous Biologist and their contribution:Charles Darvin,C.R.Narayan Rao,R.Mishra, Dr.Lalji Singh and Salim Ali.

Origin of chordates: Interrelationship of Ostractoderms and placodermi.

Unit–2: General organization of Dipnoi and crossopterygii ; origin of paired fins in teleosts.

Unit–3:Rhynchocephalia, origin and evolution of reptiles, Birds and mammals.

Unit–4:Comparative study of heart in different classes of vertebrates , e.g. fish , amphibians reptiles, birds and mammals. comparative study of urinogenital system in different group , e.g amphibians , reptiles, birds and mammals .

Suggested Literature:

1. Comparative Anatomy of vertebrates by Herbert W. Rand ,Harverd University Press
2. Comparative Anatomy of Vertebrates by M.D.L. Srivastava
3. Evolution of the vertebrates, E.H.Colbert.
4. Introduction to vertebrates by T.C.Majupuria , s. Nagin Company
5. Text book of Comparative Anatomy of Vertebrate by Saurav Singh , Centrum Press
6. Text book of Zoology: Vertebrates by T.J. Parker &W.Haswell , modified by A . J . Marshal.
7. The life of vertebrates: J. Z .Young.
8. The origin of vertebrates by N.J.Berrill , Oxford at The clarendon Press
9. The vertebrates Body, A.S. Romer.
10. Vertebrate life by McFaland; Pough ; code ; Heiser, Macmillian and Collier Publisher
11. Vertebrate Palenotology .A.S.Romer.

Course outcomes- After the course the students will be able to understand the basics of this course. To understand the applications of this course in different field of Science and Technology. Think and develop new ideas in this subject, benefit of this course in various national and international competitive examinations

Course Code	Course Title	Credits
B050 802T	Systematics, Biodiversity and Evolution	4

Unit-1: Definition and basics concept of biosystematics & Taxonomy: Historical resume of systematics and its importance and application in biology; trends in biosystematics: concepts of different conventional and newer aspects – chemotaxonomy, cytotaxonomy, , molecular taxonomy.

Unit-2: Dimensions of speciation and taxonomic characters: type of species concepts – species category, different species concepts, subspecies and infraspecific categories, theories of biological classification hierarchy of categories taxonomic and nontaxonomic character.

Unit-3: Procedure in taxonomy: collection preservation. Different kinds of publications, type of concept – different zoological types, international code of zoological nomenclature (ICZN) –its operative principles, interpretation and application of important rules, zoological nomenclature, formation of scientific names of various taxa.

Unit-4 : Darwinian and pre-darwinian concepts of evolution : Birth of concept of organic evolution; Lamarckian theories , Darwin’s theory of natural selection : merits and demerits , Neodarwinian concepts and sources of variation : post – Darwinian concepts of evolution: Neo- Lamarkism , Neo – Darwinism’s synthetic theory of evolution. Isolation and speciation; Genes in population; Hardy Weinberg Law and sewell wright effect, micro evolution,macro evolution and mega evolution, Evolution in action

Suggested Literature:

1. Biology Systematics by A. Mielli, Chapman and Hall
2. Evolution by Hall and Hallgrimsson ,johnsn and Bartlett publisher
3. Evolution by mark ridley . Blackwell science
4. Evolution by bartonn. Hbriggs, D.E.G., Eisen J.A., Goldstein , A.E. Ptel , N.H., cold spring Harbor Laboratory press new York , U.S.A.
5. Evolution by futuyama , D.J. , sinauer associates inc., sunderland , USA
6. Evolution by Hall , B.K. and Hallgrimsson , B..Jones and Bartlett publisher, Sudbury, USA
7. Evolution analysis by Freeman and Herron , Person /prentice hall

8. Methods and principle of systematic Zoology by E.Mayer , E.G.Linsley , R.L. Usinger, McGraw – Hill Book Company , ICN
9. Numerical Taxonomy by Joseph Felsenstein , Springer – Verlag Berlin Heidelberg New York
10. Procedure in Taxonomy by E.T. Schenk and J.H.Mc. Masters , Standford University Press
1. Standford , California
11. Taxonomy ; A text and reference book by R.E. Blackwelder , John Wiley and Sons , INC
12. What evolution is by Mayr E. Basic Books , New York , USA

Course outcomes- The study of the DNA fingerprinting & Molecular markers for detection evaluation of polymorphism, RFLP, RAPD etc and numerical taxonomy, for useful to student for research methodology and further study of research work in different topics. This course is useful in various competitive exams like CSIR-NET etc.

Course Code	Course Title	Credits
B050 803T	Genetics and Cytogenetics	4

Unit-1 : Mendel's Law and their chromosomal basis ; extension of Mendel's principles; Allelic variation and gene function incomplete dominances and co- dominances, gene mutation for allelism ; gene action – genotype to phenotype – Interaction of gene .

Unit-2 : Cytoplasmic inheritance : environment and heredity : lethal genes; sex – linked inheritance ; chromosomal Mapping

Unit-3 : Sex chromosome : sex determination ; multiple allelism; Numerical and structure chromosome aberrations and their significance ; DNA replication.

Unit-4 : Microbial genetics : Bacterial transformation , transduction , conjugation , Bacterial chromosome , Bacteriophages; Molecular cytogenetics techniques (FISH , GISH, DNA Fingerprinting , Flow cytometry and chromosome painting)

Suggested literature:

1. Development genetics of higher organisms by George M. Malacinski ,Maxmillan
2. Embryology by M.P.Arora , Himalaya publishing house
3. Fundamantal of human genetics by Sanjaymadsal , new central book agency , Landon
4. Fundaments of genetics by G.S. Migalani , Norsa publishing house
5. Genetics by P.K gupta , Rastogi publication
6. Genetics by E. Conrad , apple academics press
7. Grenetics by ursilagoodenough, hotl-saumders international edition

8. Genetics by j. Russwll , Benjamin- cummings publishing company , san Francisco , california.
9. Modern genetics analysis : intergrating genes and genome , by Griffiths J.F.,Gelbart ,M.,
1. Lewontin, C, and Miller, W.H Freeman and company , new York , USA
10. Molecular genetics by Guther s. Stent Richard colendar .cbs publication and distributors
11. Principles of genetics by Snustad and Simmons (4th ED.2005), john willey& sons. USA
12. Cell biology and genetics Dr. Dev Brat Mishra

Course outcomes- To study the students get ideas of this course including sex chromosome, sex determination, multiple allelism, Numerical and structure chromosome aberrations and their significance, DNA replication, Transposable elements in prokaryotes and eukaryotes ; Role of transposable elements in genetic regulation Microbial genetics Imprinting of genes , chromosomes and gene , gene therapy for help in to the research work. Students get benefit to this course in various competitive examinations.

Course Code	Course Title	Credits
B050 804T	Developmental Biology	4

Unit-1: Basic concepts of developmental biology – cellular differentiation, signalling , patterning ; Determination of polarity and symmetry.

Unit-II: Early embryonic development of vertebrates and invertebrates; Gametogenesis , structure of the gametes – the sperm and eggs , its types; function of vitellogenins yolk and egg membrans ; Hormonal control of ovulation ; fertilization , mechanism and types , capacitation , acrosome formation , fertilizin and antifertilizin reactions, amphimixis, patterns of cleavages in different types of animals eggs. Role of Yolk in egg organization planes of cleavage,morulation and blastulation , types of blastulae.

Unit-III: Fate maps and cell lineages ; gastrulation ; cleavages and formation of blastula , gastrulation, neural tube formation, fate of germinal layers, notogenesis.

Unit-IV: Introduction and organizer concept ; stems cell types its biomedical application , transplantation ; ageing and cellular death ; transgenic animal methods of formation, production and biomedical application of transgenic animals.

Suggested Literature:

1. A survey of embryology by F.G. Gilchrist, McGraw-Hill Book Company
2. An introduction to embryology by B.L. Balinsky, CBS College Publishing
3. An introduction to embryology by B.L. Balinsky; Dr. Biol. Sci., Sanders College Publishing.
4. Analysis of biology development by Kathoff, McGraw-Hill Science, New Delhi, India.
5. Atlas of development embryology by Emil. S. Szebenyi, Fairleigh Dickinson University Press
6. Developmental biology by N.J. Berrill, Tata McGraw-Hill Publication
7. Developmental biology by Scott F. Gilbert, Sinauer Associates Inc. Publication
8. Developmental biology by Gilbert, Sinauer Associates Inc, Massachusetts, USA
9. Experiment embryology by Robert Rogh, Burgess Publishing Company
10. Foundation of embryology by Bradley M. Bopdwner, Holt Rinehart and Winston, INC
11. Modern embryology by Charles W. Bopdwner, Holt Rinehart and Winston, INC
12. Principle of development biology by Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz. (3rd ED., 2006), Oxford University Press.
13. Regeneration in vertebrate by C.S. Thornton, The University of Chicago Press.

Course outcomes-After studying this course the student will be able to understand the basic of this course and think and develop new ideas in this course to know introduction and organizer concept; stem cells types its biomedical application, EMB transformation, teratogenesis, neoplasia, tumorigenesis, allometric growth; nucleocytoplasmic interaction.

Course Code	Course Title	Credits
B050 805P/R	Practical	4

Max. Marks: 75

Time: 6 hour

Distribution of marks:

Exercise

Cytogenetics exercise	15
Ecology exercise	15
Embryology exercise	15
Spotting (10 spots)	20
Viva-voice and seminar	10

Total marks

75

Courses B050 801- B050 802 P/R: General character and classification of chordate phyla.

Urochordata : study of museum specimens/ whole mount : *oikopleura, Herdmania , Ascidia ,pyrosoma , doliolum, salpa.*

Cephalochordate: study of museum specimen:Branchiostoma .

Cyclostomata : study of museum specimens /models : *Petromyzon ,Myxine; Ammocoete* larva.

Pisces: study of museum specimens/ models :*sphyrna(hammer – headed shark) , Trygon,(sting –rays) , pristis , Raja (skate), Torpedo(electric –rays), chimaera, polypterus, Acipener, Amia, Lepidosteus, harpodon , notopterus, labeo, catla, cyprinus,cirrhina, arius , heteropneustes,clarias, wallago, mystus, Anguilla, exocoteus, hippocampus, channa ,amphipinous, anabas, synaptura, echeneis, protopterus, ;study of disarticulated bone of carp.*

Amphibia: Study of museum specimen /models :*Ichthyophis, ambystoma,axolotl, latrva , salamandra, amphiuma, triturus, proteus,Necturus , siren,alytes,bufo, hyla, rhacophorus, study of adisarticulated bone to frog*

Reptilia:Study of museum specimen/models *chelone, kachuga, sphenodon , hemidactylus, calotes, draco, heloderma , varanus , typhlops, python, natrrix , dendrophis, bungarus , naja , russlle’s viper, pit viper, hydrophis , crocodilus , alligator , gavialis, study of disarticulated bones of varanus*

Aves :Study of museum specimens / models :*Arhaeopteryx,Milvus(kite), Pavo(peacock), Columba (pigeon), eudynamys (koel) , psittacula (parrot) , bubo (owl), house sparrow , corvus (crow) ; study of disarticulated bones of fowl .*

Mammalians :Study of museum specimens / models : *echidna , ornithorhynchus , macropus , bat , manis , hystrix, rattus, lepus, study of disarticulated bones of rabbit .*

Course B050 803T :Study of mitosis in onion root tip and meiosis in testis of grasshopper or with the acetocarmine squash method ;study of the salivary gland chromosomes of *Drosophila* and*chironomus*.

Course B050 804T : Prepared slides of the embryology of frog , chick and mammals and mammalian placentation microtomy of embryonic stages of chick embryonic ; application of window techniques for in –situ study of chick embryo.

SEMESTER – 3

Course Code	Course Title	Credits
B050 901T	Principles of Ecology Theory	4

Unit-1: Environment: meaning, definition and environmental perception. Environmental factors (Abiotic) ' medium, substrate, solid, water and humidity, light, temperature, atmospheric gases (O₂, CO₂, and N₂), pH.

Unit-II: Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere; Terrestrial and aquatic (fresh water and marine) habitat; Environmental (biotic factors; population and community ecology, parasitism and prey-predator relationship ; Ecosystem definition, type, structural components of ecosystem (pond ecosystem)- autotrophs and Hetrotrophs (producer consumers, decomposers and transformers); Ecological pyramids on numbers biome and energy.

Unit-III: Biogeochemical cycle Acclimation & acclimatization, adaptation, ecological habitats and niche, concept of limiting factors, Liebig's law of the minimum; Shelford law of tolerance; ecological succession.

Unit-IV: Ecological succession, Energy flow; First and second law of thermodynamics; population size and density, dispersion. age structure. population growth, natality, mortality, biotic potential, population interaction,; Concept of r and k selection.

Suggested Literature:

1. Basic concepts of Ecology by Clifford B. Knight, The Macmillan Company, New York
2. Basic Ecology by E.P. Odum, Oxford and IBN Publishing Co., New Delhi
3. Ecological Modeling by Grant, W.E. and Swannack , T.M.,(2008) , Blackwell.
4. Ecology and Applied Environmental Science by Kimon Hadjibros, Cro Press.
5. Ecology and Margaret Brown, Apple Academic
6. Environmental Law by Gurkiratkaur, Shree Publishers and Distributors, New Delhi
7. Field Biology and Ecology by Benton and Werner , McGraw-Hill Book Company
8. Field Sampling: Principles and Practices in Environmental Analysis by Conklin A.R. Jr(2004), CRC Press
9. Fundamental processes in Ecology: An Earth system Approach by Wilkinson, D.M.:(2007),Oxford University PRESS , UK,

10. Fundamentals of Ecology by E.P. Odum,

11. Principles and standards for Measuring Primary Production by Fahey, T.J .and Knapp, A.K., (2007),Oxford University press, UK.

Course outcomes- Demonstrated an understood of ecological relationships between organisms and their environment. A Presented an overview of diversity of life forms in an ecosystem. Explained and identified the role of the organism in energy transfers, Described the habitat ecology and resource ecology. To understood the Environmental Pollution and their management.

Course Code	Course Title	Credits
B050 902T	Biostatistics and Computational Biology	4

UNIT I

Basic components of computer- hardware (CPU, input, output, storage devices), software (operating systems). Application software:: introduction to M S EXCEL use of worksheet to enter data, edit data, copy data, move data; correlation, regression coefficients, etc, use of bar diagrams, histogram, scatter plots etc. graphical tools in excel for presentation of data; image and data handling.

UNIT II

Sampling technique: methods of sampling, choices of sampling methods, sampling and non-sampling errors: tabulation and graphic representation of data; frequency distribution, tabulation, bar diagram, histogram, pie diagram; and their significance and limitations; measures of dispersion: variance and standard variation, coefficient of variation, theorems on probability.

UNIT III

Correlation analysis, correlation of coefficient, correlation coefficient, graphical method of presentation; regression; regression analysis, regression coefficient and its properties,; standard error of a statistic, test of students' t-test: assumption for t-test, properties and application of t-distribution.

UNIT IV

The square test: degree of freedom. Properties and uses of chi-square, conditions for using the chisquare; analysis of variance – one way and two of classification, f-test; types of non-parametric tests, its advantage/disadvantage and use.

Suggested literature:

1.Biostatistics by P N Arora and P.K Malhan, Himalaya publishing house

2. Principles of Biostatistics by Pagano M. Gauvreau, K (2000), Duxbury press, USA
3. Fundamental of Biostatistics by I A Khan and A Khanam, Ukaaz publication, Hyderabad
4. Research Methodology by Devbrat Mishra

Course Outcomes- Introduction to basic components of computers, Software (operating systems) and application software used in biological and statistical studies. An overview of databank searchdata mining, data management and interpretation. An introduction and learning of Probit Log Analysis for interpretation of toxicity data.

Course Code	Course Title	Credits
B050 903T	Biology of Parasitism	4

UNIT 1: Introduction to parasitology: Animal associations and host – parasite relationship : Distribution of diseases and zoonosis caused by animal parasites, morphology, lifecycle , mode of infection of *Plasmodium*, molecular biology of *Plasmodium*-

UNIT 2: Morphology, lifecycle and mode of infection of *Leishmania*,: morphology, lifecycle , mode of infection of *Entamoeba and Giardia* , morphology, biology, lifecycle and mode of infection of gastrointestinal, nematodes (*Ascaris lumbricoides, Ancylostoma duodenale,*) and *Wuchereria bancrofti*

UNIT 3: Morphology biology, lifecycle and mode of entry of *Fasciola, Taenia and* :

UNIT 4: Pathology of helminth infections ; immune response and self defense mechanisms, immune invasion and biochemical adaptation parasites ;

Suggested Literature

- 1 Ecology of Parasites by A.P Diwan , A.K Arora , Anmol Publications , New Delhi
- 2 Foundations of Parasitology by Roberts L.S. and Janovy J; M.C. Graw – Hill Publishers, New York U.S.A
- 3 MordernParasitology : A Textbook of Parasitology by F.E.G.Cox ., Wiley- Blckwell, U.K.

Course outcome- A study of the immune response to parasite and self-defense mechanisms, immune invasion and biochemical adaptations of parasites and description of parasites of insects and their significance, nematode parasites of plants and host parasite interaction.This course is useful in various competitive exams.

Course Code	Course Title	Credits
B050 904T	Applied Zoology	4

Unit 1: Aquaculture; marine, riverine and lacustrine fishes; Some food fishes of India: *Wallago , Anguilla , Harpodon, Notopterus, Channa , Clarias, Labeo, Catla, Cirrhinus, Barbus*: Fish culture in India: Indian Aquaculture: Culture of Carps, Culture methods, Prawn

culture, exotic fishes ; Importance of pearl culture; methods of pearl culture,; status of pearl industry in India.

Unit 2: Domestic animals- Animal husbandry and Poultry: cattle breeding, artificial insemination, feeding and management of dairy stock , dairy product and chemistry of milk.: Position of goat/ Pig production industry in India, breeds of goat/ pig ; common cattle diseases ; poultry industry in India, important poultry breeds, poultry farming, disease of fowl.

Unit 3: Apiculture : importance of Bee keeping, Apiculture, *Apis* species, bee hive, social life of honey bee, properties of honey: Lac culture, Lac insect and its biology, rearing of Lac insects, collection and processing of Lac: Sericulture : Mulberry and non mulberry Sericulture (tasar , munga and eri sericulture) ; lifecycle of silk moth; physical and chemical properties of silk.

Unit 4: Vermiculture: Introduction, ecology and distribution of earthworms: Vermiculture and vermicomposting methods : chemical composition of waste based vermicompost: Economics of vermiculture and vermicomposting: species of earthworms for vermin composting ; In situ application of vermiculture and crop productivity; use of earthworm in land improvement and reclamation.

Suggested literature:

- 1 Bee keeping in India by A.M. Wadhvani
- 2 Poultry Husbandry by Morley A. Jull.
- 3 Domestic Water Buffalo by M.Fahimuddin
- 4 Life stock and Poultry Production by Harbans Singh and E.N.MOORE
- 5 Textbook of dairy chemistry by M.P. Mathur, D.D Roy, P.Dinaker

Course outcome- To understand concept of fisheries, fishing tools and site selection and introduction to basic concepts of Aqua culture systems, induced breeding techniques, post harvesting techniques. To understand the various concepts in lac Cultivation andalso to know the economical importance of lac cultivation, sericulture and apiculture. To study the methods of Vermiculture and Vermi-composting and economic value of vermiculture and vermi-composting. Uses of earthworm in land improvement and reclamation.

Course Code	Course Title	Credits
B050 905T	Epigenetic & Chromatin Biology Theory	4

Unit 1: Chromatin structure- basic organization of a eukaryotic genome; histone- structure and function; nucleosome as fundamental particle; intra nuclear spatial organization of chromatin: MARs and SARs and their importance.

Unit 2: Epigenetics- from phenomenon to field, a brief history of epigenetics- overview and concepts: chromatin modifications and their mechanism of action, concept of ‘ Histone-code’ hypothesis, position effect variegation heterochromatin formation, and gene silencing in *Drosophila* , role of non coding RNAs;

Unit 3: Chromatin structure and epigenetic marks – transcriptional silencing by polycomb group proteins, histone variants and epigenetics, epigenetic regulation of chromosome inheritance, epigenetic regulation of the X chromosomes.

Unit 4: Epigenetics and genome imprinting – DNA methylation in mammals, genomic imprinting in mammals, germ line stem cells, nuclear transplantation and the reprogramming of the genome, epigenetic and human disease, epigenetic determinants of cancer.

Suggested Literature:

1. Epigenetics by C.David Allis and Thomas Jenuwein, (2007) Cold spring Harbor Laboratory PRESS, New York. USA
2. Molecular biology of gene by Watson et.al(5th.E.d 2004), Pearson Education Delhi India

Course outcome- Detailed understands of chromatin structure and different levels of its organization. Awareness of brief history of epigenetics and key concepts. Detailed knowledge chromatin modifications and their mechanism of action, concept of ‘histone code’ hypothesis in the phenomenon of epigenetics. Developing skill in describing chromatin structure and epigenetics marks, dosage compensation and mechanism of chromatin remodeling. Learning of epigenetics and genome imprinting and the reprogramming of the genome.

Course Code	Course Title	Credits
B050 906T	Structure & Function of Genes	4

Unit 1: Structure of nucleic acid, denaturation, renaturation, super-coiling of DNA, packaging of DNA in the nucleus, structure of chromatin,. Genetic material and its evolution structure and function relationships, evolution of genetic material, genes and genomes.

Unit 2: DNA replication, recombination DNA polymerases proof-reading activity, mechanism of DNA repair; genome instability, transcriptional control of gene expression – positive and negative regulations, RNA polymerase, promoters and regulatory sequences, activators and repressors of transcription, regulation of transcriptionfactor activity, elongation and termination of transcription.

Unit 3: Post-transcriptional gene control and nuclear transport- types of introns and their splicing, catalytic RNA, regulation of Pre-mRNA Processing, micro RNA and other non coding RNAs, degradation of RNA.

Unit 4: Transport across the nuclear envelope and stability of RNA- structure of nuclear membrane and nuclear pore complexes, processes of nuclear import and export and their regulation, degradation of RNA, Translation machinery, tRNAs and their modifications, aminoacyl tRNA synthetases, inhibitors of translation.

Suggested Literature

1. Genes by Lewin,(9th Edition 2008), Jones and Bartlen Publishers, Boston, USA
2. Genetics (Analysis of genes and Genomes) by Denial L.Hartl, Jones and Bartlett publishers.
3. Molecular Biology of The Cell by Bruce Alberts, Garland Science Taylorand Francis Group
4. Molecular Biology of the Gene by Watson et.al. (5th Ed. 2004), Pearson Education, Delhi India
5. The Cell *A Molecular Approach* by Geoffrey M. Cooper, Sinauer Associates, INC.

Course outcome- An introduction to structure of nucleic acids, folding motifs, conformation flexibilities, denaturation, renaturation, kinetics of hybridization, super-coiling of DNA, packaging of DNA in the nucleus, structure of chromatin, chromatin territories used for the students for further study. regulation of Pre-mRNA Processing, micro RNA and other non-coding RNAs, degradation of RNA. Description of transport across the nuclear envelope and stability of RNA, processes of nuclear import and export and their regulation, degradation of RNA. This courses useful in various competitive exams like CSIR-NET etc.

Course Code	Course Title	Credits
B050 907T	Animal Behaviour	4

UNIT -1 Introduction –definition ,historical out line ,patterns of Behaviour , Objectives of Behaviour , mechanism of Behaviour , Reflexes;reflex action , types of reflexes, reflex arch, characteristics of reflexes and complex Behaviour; orientation; primary and secondary orientation ; kinesis.

UNIT-2 Production of new queen and hive , swarming, honey bee as super organism ; fixed actin pattern mechanism, learning and instincts, conditioning ,sensitization.

UNIT 3 physiological basis of motivation , role of hormone ,motivational control and decision making , displacement activity , models of motivation ,measuring motivation , hormones and pheromones influencing animal Behaviour .

UNIT -4 Pattern of communication (chemical , visual , light , audio , species specificity of songs, evolution of language with respect to primates);. Sexual Behaviour, courtship, sexual selection, mating patterns, parental care, migratory Behaviour of fishes and birds. Territorial Behaviour.

Course outcome-

Exhibit critical and integrative thinking skills. Demonstrate ability to communicate scientific information in both oral and written formats. Demonstrate knowledge of key concepts in animal Behaviour. Exhibit quantitative research skills (or demonstrate ability to perform all parts of the scientific method).Demonstrate ability to think flexibly and apply knowledge to new problems.

Suggested literature:

1. An introduction to Animal Behaviour by A. Manning and M.S. Dawskins Cambridge University Press, UK.
2. Animal Behaviourer an Evolutionary Approach by V.S. Lamourens, Academic Press.
3. Animal Behaviour. Reena Mathur, rastogi publication
4. Principles of Animal Behaviour by J.R. Millenson. The Mac Millan Company
5. Reading in Animal Behaviour by T.F. Mac Gikll
6. Animal behavior by Dr. Devbrat Mishra

Course Code	Course Title	Credits
B050 908T	Molecular Endocrinology	4

Unit 1: Discovery of hormones as chemical signals for control and regulation of physiological processes: Nature of hormonal actions;

Unit 2: Structure of peptide and protein hormones;; Structure-Function relationships in different hormones; Phylogenic analysis of hormonal structure and functions; Biosynthesis of protein hormones; Storage and secretion of hormones;

Unit 3: Nature of hormonal effects and actions; Discovery of receptors in target tissues; Mechanisms of hormone action and signal attenuation; Signal discrimination, Signal transduction and signal amplification in hormone regulated physiological processes; Metabolism of hormones by target and non-target tissues; Hormones behaviour –

Unit 4: Hormones as therapeutic agents; Recombinant protein hormones-production and application in regulation of fertility in farm animals and humans;

Suggested Literature:

1. Molecular Biology of Steriod and Nuclear Hormone Receptorsby L.P. Freedom, Bickhauser, Boston.USA
2. Biochemical actions of Hormones *by ed.* G.Litwack, Academic press, New York, USA
3. Comparative Vertebrate Endocrinology by P.J.Bentlay

Course outcome- Understanding the nature of hormonal action and its experimental methods of evaluation elucidation of biosynthesis of protein hormones and molecular mechanisms of regulation. Knowledge of signal discrimination, signal transduction and signal amplification in hormone regulated physiological processes. To Developing knowhow of pharmacokinetics of hormones and Behaviour.

Course Code	Course Title	Credits
B050 909P/R	Practical	4

Max. Marks: 75

Time: 6 hours

Distribution of marks:

Ecology exercise (2)	10
Statistical Exercise	10
Exercise for parasitism (2)	10
Exercise for applied zoology (2)	10
Exercise for epigenetics and chromatin biology (2)	05

Exercise for structure and function of gene (2)	05
Exercise for animal Behaviour (2)	10
Exercise for Molecular endocrinology (2)	05
Viva voice and seminar	10
Total	75

Course B050 901: Study of different structural adaptation of animals to ecological conditions ; Study of micro and macro fauna of soil by froth floatation method; Comparative estimate of physicochemical eco factor of in different localities; Temperature , pH , Carbonate, sulphate , nitrate, and turbidity , in fresh water sample; moisture contenting soil sample; Study of seasonal variation in plankton population demonstration of parallax vision and height perception ; Analysis of plant community and biodiversity and biomass ; Study of seasonal plankton population both qualitative and quantitative

Course B050 902: Use of excel sheet for data processing. Designing simple experiment for testing mean differences, test of significance (Chi-square test), extra.

Course B050 903: Study prepared slides and museum specimen of selected parasites of representative groups of protozoans, helminthes, and arthropods; demonstration of in vitro and in vivo, infection of *Fasciola* in snails and mammals by histopathology and immune reactions. Culturing insect parasitic nematodes and their life-cycle. Culturing an insect parasitoid and studying their infection on an insect host; survey of vector born diseases in local and adjoining areas.

Course B050 904: Field study at different Government/ Non Government farm houses/ apiaries/ dairies/ poultries/ seri culture in local areas and project has to be submitted.

Course B050 905: Isolation of nuclei (as a source for studies on structure of chromatin) from rat/mouse liver by discontinuous sucrose density gradient centrifugation; Isolation of total histones and resolution on SDS-PAGE, Studies on modifications of histones (such as acetylation, methylation etc) by western blotting using modification specific- anti bodies; Expression and purification of recombinant histones ; isolation and characterization of total nuclear proteins. Digestion of nuclei by MNase and calculation of ‘repeat-length’ of nucleosomes. Digestion of nuclei by DNase-I, and studies of DNA super helicity in the nucleosomes; Preparation and characterization of soluble chromatin(10 and 30 nm chromatin fibres); Purification and characterization of mono nucleosomes; reconstitution of nucleosome-core PCR Amplified synthetic DNA ; chromatin immuno precipitation (Chip)

Course B050 906: Familiarization with sterile handling techniques for growth of bacteria, such as sterilization, growth media types of culture etc. Isolation of genomic DNA from bacteria and mouse/rat liver, measurement of absorption spectrum of DNA, RNA and nucleotides ; study of denaturation of DNA and determination of T_m and calculation of G:C content ; Studies on stability of DNA and RNA towards alkali; Study on growth curves of *E.coli* in synthetic medium and calculation of log phase for metabolic experiments ; Studies on induction of *lac* operon : Studies on catabolite repression of *lac* operon and role of cAMP ; Generation and selection of mutants for *lac* operon, calculation of mutation frequency.

Course B050 907: STUDY OF Taxis; Kinesis; Habituation; Trial and error learning; Visual discrimination; Feeding Behaviour, Pheromonal communication with reference to sexual/special Behaviour. To study the responses of woodlice to hygrostimuli. To study the geotaxis Behaviour of earthworm; to study the orientation responses of first instar noctuid larvae to photo stimuli. To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly ; To study the orientation responses of larvae to volatile and visual stimuli.

Course B050 908: Isolation of protein of bio-activity in an in vivo bio-assay (e.g: FSH); and chemical localization of a pituitary hormone using light or electron microscopy (e.g; Prolactin), In vivo bio-assay for estrogen; In vivo Bio-assay for testosterone; vivo bio-assay for luteinizing hormone; In vitro biochemical assay for a hormone (LH or PRL); Effect of hCG on poly A rich RNA content in ovary; Quantification of specific transcript (mRNA) after ovarian stimulation by hCG or FSH.

purification of bovine/bubaline pituitary TSH; Preparation and characterization of hormone-enzyme conjugate, ELISA for any one hormone and estimation of plasma level; Estimation of cAMP in a rat tissue (example adipose) with and without hormone stimulation; Streptozotocin administered rat model for diabetes; Demonstration of phospholipase C action; Molecular cloning of a protein hormone (eg., buffalo prolactin); Expression of recombinant buffalo prolactin in *E.coli*.

Semester :4

ELECTIVE COURSES STREAM 1 : ENTOMOLOGY

Course Code	Course Title	Credits
B050 1001T	Insect Morphology Physiology & Development	4

Unit-I : The integumentary system: histology of the integument, physical property and chemical composition of cuticle, colouration and moulting.

Unit II: Nervous system : the neurons, central visceral and peripheral nervous system. Sensory mechanisms ; mechanoreceptors (tango reception, proprioception, sound perception), chemoreception, thermoreception, hygromoreception and photoreception (compound eyes, image formation , stemmata, ocelli); Bioluminescence and sound production.

Unit III: Alimentary system : nutrition, feeding Behaviour, morphology of the gut and physiology of digestion and absorption, Circulatory system: dorsal vessel, accessory pulsating structures, sinuses and diaphragms mechanism of circulation, composition and function of haemolymph : respiratory system structure of trachea, tracheoles, air sacs , spiracles, physiology of respiration, respiratory adaptation of aquatic and parasitic insects; Excretory system : Malpighian tubules and its arrangements, physiology of excretion (nitrogenous excretion, salt and water balance) **Unit IV:** Reproductive system: male and female: development, post embryonic development ,metamorphosis , types of larvae and pupae. Exocrine glands: structure and function, pheromones, Endocrine glands: structure and function of non neural, neural and peptide hormones, regulation of general body function and metabolic activities, moulting, polymorphism and diapauses.

Suggested Literature:

1. A text Book of Entomology by R. Mathur, Campus books
2. A text book Entomology by Patnaik, D.D (2013), Dominant Pbl.
3. Biochemistry of insects Rockestein , M(1978), Academic Press, New York
4. College Entomology by Essig, E.O.(1942) Macmillan, New York
5. Comprehensive insect Physiology, Biochemistry and Pharmacology by kerkut, GA and B.I Gilbert (1985) volume 1-13, Pergamon press Oxford New York
6. Elements of Entomology by Singh, R(2015) Rastogi Publication.
7. Entomology Ecology and Biodiversity by Tyagi B.K.(2011), Scientific Publishers (India)

8. Fundamentals of Entomology by Elzinga, R.J (2004) 6TH edition. Publication. Prentice Hall
9. Fundamental s of insect physiology by Blum, M.S(1985) , Wile and sons , New York
10. General and applied Entomology by Nayar, K.K.,T.N. Ananthkrishnana B.V. David (1979), Tata McGraw Hill publication Co Ltd., New Delhi
11. General Entomology by Mani, M.S(1982) Oxford and IBH publishing Co. Pvt. LTD. New Delhi
12. General text book of Entomology by Kuzman H., Apple academics
13. Imm's General text book of Entomolgy By Richerds, O.W. and R.G Davis (1977) Vol I (structure, physiology, and development), 10th Edition, Chapman & Hall, London, New York34
14. Insect Biology A text Book of Entomology by Evans. H.E,. (1984) Addison Wisley publishing company, Reading EGKFOKY
15. Insect physiology and Anatomy by Pant, N.C and S.Ghai(1981), ICAR , New Delhi
16. Insect physiology by W. Hening, John Wiley and Sons
17. Insect plant Relationships by Van Emden, Hf (1972) Black Well, London
18. Introduction to comparative Entomology by Fox.R.M. and Fox.J.W. (1964), Van Nostrand Reinhold, New York
19. Pest control by van Emden , H.F.(1992) 2nd Edition Cambridge University Press, New York
20. Principles of insect Morphology by Snod Grass, R.E (1935) , McGraw , Hill, New York
21. Text book on Agricultural Entomology by Pruthi, H.S (1969), ICAR New Delhi
22. The Insects : An Outline of Entomology by P.J. Gullan, Wiley-Blackwell
23. The Insects : An Outline of Entomology by P.J. Gullan and Cranston. P.(2010)4THEd.,Wiley- Blackwell Press.584 pp
24. The Insects Structure and Function by Chapman. R.F.(1998), 4th Edition, Cambridge University Press.
25. The Principles of Insect physiology by Wigglesworth.V.V (1982), Chapman & Hall, London
26. The Science of Entomology by Romoser,. W.S. and J.G. Stoffolano(1994), 3rd Edition, Wm. C.Brown Publisher, USA.

Course outcome- To the value of wildlife, field observations sign and foot prints, locomotory pattern in tetrapods. Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and

restoration. Sociobiology of wild animals, migratory and breeding Behaviour and their sociobiological importance. Description of reason for wild life depletion and wild life ecotourism management measures for wild life conservation.

Course Code	Course Title	Credits
B0501002T	Ecology, Evolution & Taxonomy	4

UNIT 1

Abiotic environment: effect of temperature, moisture and light on insect population; insect plant interaction; plant and insect herbivore relationship; primary and secondary metabolic plant products. Host selection by insects; chemical defence in plants; allocation of protective chemicals, primary role of toxic chemicals; response of insects to chemical defence; temporal avoidance of chemical semiochemicals.

UNIT2

Insect origin and evolution: Ancestry of insect origin and evolution of insects, relationship between entognathous and ectognathous, outline classification of insects: classification, characters, economic importance and examples of following: Entognatha (proturan, collembola, dipluran); Thysanura (Lepismatidae); Palaeoptera(Ephemeroptera, odonata) Orthoptera

UNIT 3

Classification, characters, economic importance, and examples of following : Hemiptera (Fulgoridae, Lophopidae, Cicadidae, Membracidae, Cicadellidae, Psyllidae, Aleyrodidae, Aphididae, Margarodidae, Kerridae, Pseudococcidae, Coccidae, Diaspididae,

UNIT 4

Siphonophera:(Pulicidae,Ceratophyllidae);Diptera(pschodidae,Culicidae,Simulidae,Chironomidae,Bibionidae,Myctophilidae,Cecidomyidae,Tabanidae,Asilidae,Bombyliidae,Syrphidae,Agromyzidae,Drosophilidae,Gasterophilidae,Muscidae,Calliphoridae,Hippoboscidae);Lepidoptera

Suggested literature:

1. Elements of Entomology by Singh.R, (2015), Rastogi Publ, Meerut.
2. Dynamics of Insect-Plant Interaction by Ananthkrishnana, T N & A Raman(1988). Oxford & IBH Publishing Co Pvt. Ltd., New Dehli.36

3. Navel aspects of insect plant interaction by Barbosa. P.& D.K. Letoumeau (1988). John Wiley & Sons New York.
4. Arthropoda Phylogeny by Boudreaux, B.H (1997), with special reference to insects, Wiley and Sons , New York, pp. 320.
5. Evolution of the insects by Grimaldi . D &Engel .M.(2005), Cambridge University Press, New York and Cambridge, pp. 755.
6. Arthropoda Phylogeny by Gupta , A.P. (1979), Van Nostrand reinhold, New York.
7. insectEcology by Price, P.W 1984, 2nd edition, John Wiley & Sons, New York.

Course outcome-By biological evolution we could understand that many of the organisms that inhabit the Earth today are different from those that inhabited it in the past Explained adaptation, providing examples from several different fields of biology explained how the molecular record provides evidence for evolution Understood the Human origin and evolution.

Course Code	Course Title	Credits
B050 1003T	Economic Entomology	4

UNIT 1

Beneficial insects: biology of beneficial insects (Apis, Bombyx , Kerria), Insect products, use of insects in medicines, insects in biological Research, Pollination by insects, insects as consumers, Scavengers and as food, forensic entomology. Harmful insect: life history, damage caused and control measures of following insects pests: household insects: insect injurious to man (aedes, Anopheles, Culex. Cimex, Xenopsylla, Pediculus)

UNIT 2

Life history, damage caused and control measures of following insect pests, pest of cereal crops (Leptocorsiaacma, Scirpophagaincertulus, ChlioSuppressalis, Hieroglyphus banian, Dicladispaarmigera, Nephotettix spp, Sesamiainferens); pest of pulses (Hehcoverpaarmigera), pests of vegetables (Aulacophoraindica, Leucinodesorbanalis, Bactroceracucurbitae, Henosepilachna spp., Phthorimaeaoperculella, Pieris brassicae);

UNIT 3

Methods of pest management: physical control measures (temperature, electromagnetic fields and ionizing radiations,); mechanical control measures(handpicking of infested plants and their destruction, netting, bagging and dislodging insect pests, trenching, insect barriers, insect traps, destruction of crops residues, weeds and trash); cultural control measures

UNIT 4

Chemical control measures: insecticides: classification, properties, synergistic, repellants, attractions: feeding deterrents: feeding deterrents; formulations, biopesticides; benefits and risks of chemical control; application; modes of action of insecticides, developments of insect resistance against insecticides; biocontrol measures (organisms used in biocontrol, inoculation, augmentation and conservation of natural enemies – pathogens, predators and parasitoids; selected criteria of a promising natural enemy).

Suggested literature:

1. Integrated pest management by Abroi, D.P. (2014). Academic press, USA.
2. A text book of Agricultural entomology by Alford, D.V. (1990), Wiley – Blackwell.
3. Agriculture pests of South Asia and their Management by Atwal, A.S. & Dhalwal, G.S (1997), Kalyani Publishers, New Delhi.
4. Agricultural pests and their control by Awasthi, V.B (2001), Scientific Publishers, New Delhi
5. Elements of economic entomology by David, B.V (2000), Popular Book Depot, Chennai

Course outcome - To study the methods of pest management physical control measures mechanical control measure selected of quality seeds, clean cultivation, destruction of alternative/trap plants, crop rotations, tillage operations, timing of planting/harvesting, nutrient/water management.

Course Code	Course Title	Credits
B050 1004T	Dissertation	4

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

Course Code	Course Title	Credits
B050 1005 P/R	Practical	4

PRACTICAL COURSE OF THEORY COURSES ZOO 523- ZOO 525

Max Marks: 75 Time: 6 hours

Distribution of marks:

Major Dissection	10
Minor Dissection	05
Taxonomy (identification of two insects)	15
Physiology Exercise	15
Spotting (10 spots)	20
Viva-voice and seminar	10
Total	75

1. Detailed study of the external features of grasshopper
2. Dissection of different systems of Gryllotalpa, Dysdercus, Housefly/Calliphora, Moth/butterfly/Catterpillars/Wasp, honey bee, Dung beetle, Water beetle.
3. Permanent preparation of testis of Coxkroach, salivary gland of dysdercus , ovary, spermatheca and accessory gland of house fly.
4. Sting apparatus of wasp/ honey bee.
5. Spiracles of the caterpillar and wing scales of a lepidopteran insect.
6. Legs of terrestrial and aquatic insects showing simple adaptation concerning locomotion.
7. Study of prepared slides of : T.S / L.S. of integument and the various region of gut, ovary, testis and brain.
8. Whole mounts of thoracic/ abdominal spiracles, different types of antennae, legs, moth parts, wings and sting apparatus of honey bee/ wasp.
9. Determination of pH of insects guts and haemolymph .
10. Qualitative assay of free amino acids and haemolymph and fat body.
11. Quantitative estimation of glycogen, protein and lipid.
12. Qualitative determination of uric acid from fat body/ Malpighian tubules.
13. Determination of the rate of passage of food through gut.
14. Collection of different kinds of larvae and pupae of insects.
15. Collection, preservation and identification of locally available insects.
16. Permanent preparation of mouth parts, antennae, wings, legs, Spiracles and external genitalia of insects from different groups.
17. Identification of various insects pests, their life -history and materials damaged by them.
18. Study of various groups of insecticides and equipment's used for insecticide application.
19. To study histology and to demonstrate the presence of lipid and glycogen in microtomy sections of suitable material.
20. Study of life -history of beneficial insects and their products.

**ELECTIVE COURSES
STREAM 2: FISH BIOLOGY**

Course Code	Course Title	Credits
B050 1101T	Morphology, Physiology & Development of Fishes	4

UNIT 1

Structure and function of internal ear-air bladder; connection with Weberian apparatus; different types of caudal fins; specialized organs in fishes(electric organ, sound producing organs, light producing organs, poison glands); sense organs and nervous system in fishes.

UNIT2

Different types of feeding habits in fishes and their adaptation. osmoregulation (freshwater and marine fishes); structure of kidney of freshwater and marine fishes and physiology of excretion.

UNIT 3

Structure of reproductive organs and physiology of reproduction; embryogenesis; process of gastrulation, neurulation, organ formation, larval development and metamorphosis in freshwater fish.

UNIT 4

Structure of pituitary gland, thyroid, adrenal glands, corpuscles of stannius and urophysis in fishes: hormones, secreted by these glands and their physiological significance.

Suggested literature:

1. Behaviour of teleost fishes by Tony J. Pitcher, Chapman and hall.
2. Ecology of freshwater by Bria mass , Willey Blackwell
3. Fish and fisheries by S.S Khanna.
4. Fish by C.B. L. Srivastava
5. Fish life Environment and diversity by N.B. Marshal, agrobios(india)
6. Fish physiology edited by W.S Hoar & D J Randall Vol I and II academic press INC.

Course outcomes-Study of the physiology of fish structure and function of ear-air bladder; connection with Weberian apparatus; different types of caudal fins; specialized organs in fishes(electric organ, sound producing organs, light producing organs, poison glands); sense organs and nervous system in fishes. Understand the basic of this course and think & develop new ideas in this course.

Course Code	Course Title	Credits
B050 1102T	Taxonomy & Ecology of Pisces Theory	4

UNIT 1

Characteristics of fishes: classification by L.S berg, modern classification of fishes: detail taxonomic studies of following orders of fishes of U.P. and Bihar upto families: clupeiformes, cypriniformes, beloniformes, cyprinodontiformes, mugiliformes, ophiocephaliformes, symbranchiformes, perciformes, mastacembaliformes and tetradontiformes.

UNIT 2

Adaption to different modes of life with special reference in hill stream and deep sea fishes: relation between fishes and their abiotic and biotic environment; influence of following abiotic factors on life of fishes, e.g. density and pressure, temperature, salt content in water, light, sound, electric current, bottom deposits and particle suspended in water.

UNIT 3

Influence of biotic factors on life of fishes; interspecific and intraspecific interrelationship among fishes with different other organisms- parasitisms, commensalisms, mutualisms, predatorisms and cannibalisms

UNIT 4

Plankton in relation to fish production: sewage fed fisheries and its importance; pollution affecting fishery water with special reference to oil spills, domestic pollution, industrial water pollution, radioactive waste;

Suggested Literature:

1. Behaviour of teleost fishes by Tony J. Picher, Champman and Hall.
2. Comparative Vertebrate Endocrinology by P.J. Bentley
3. Ecology of fishes by G.V. Nikolsky, Academy press, London.
4. Ecology of fresh waters by Bria Mass, Willey Blackwell
5. Fish and fisheries by S.S Khanna
6. Fish by C.B.L Srivastava.

Course outcomes-Students to know the study of the influence of biotic factors on life of fishes; interspecific and intraspecific interrelationship among fishes with different other organisms- parasitism, commensalisms, mutualisms, predations and cannibalisms for help to prepare competitive examinations.

Course Code	Course Title	Credits
B050 1103T	Applied Ichthyology	04

UNIT 1

Marine, freshwater, eusturine, reservoir and cold water fisheries of India: fish culture-nutritional requirements of carp, siluroids and murrels , carp cultivation in India; spawning, collection, hatcheries, rearing, stocking, transport and mortality of fish fry.

UNIT 2

Fertilization and management of fishery pond. Composite fish culture, cage culture and culture of exotic fishes; induced breeding: methods of fishing in India with particular reference to U.P. preservation, processing, transport and Marketing of fish. Food value and flavours of different fishes.

UNIT 3

Larvivorus fishes and public health, common enemies and symptoms, fish culture in paddy fields and reservoir ; integrated fish farming with prawn, pig, duck and poultry.

UNIT 4

Development of fisheries in india: fish- based industry and their by products: culture of asexual or sterile fish; homosex culture; hybridization, gynogenesis and androgenesis; transgenic fish; fish conservation of threatened fresh water fishes (in situ, ex situ), techniques of Cryopresevation.

Suggested Literature:

1. Aquaculture and fisheries biotechnology Genetic Approaches, Dunha, R.A, CABI publishing USA.
2. Handbook of fishery technology by V.M. Novikov, A.M Erindublishng company.
3. Fish and fisheries of India by V.G. Jhingran Hindustan publication corporation.
4. Fisheries Science by Rounsefell and Evarhart, international books and periodical supply service.
5. Aquaculture principles nad practices, Pillay T.V.R.. Blackwell publicising , USA

Course outcomes-Learnt the general classification of fishes, economically important marine and freshwater fishes, migrations and fishery products. Described recent concepts in fisheries management, endangered species management and Came to know the various aquaculture systems. Understood the type of hatchery, brood stock, larval production, feed management water quality and disease management in cultivable species, live feed production.

Course Code	Course Title	Credits
B050 1104T	Dissertation	4

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

Course Code	Course Title	Credits
B050 1105 P/R	Practical	4

PRACTICAL COURSE OF THEORY COURSES B050 1101T- B050 1004T

Max Marks: 75

Time: 6 hours

Distribution of marks:

Major Dissection of edible/culturable fish	15
Taxonomy (identification of two fishes)	15
Physiology Exercise	10
Ecology exercise	05
Spotting (10 spots)	20
Viva-voice and seminar	10
Total:	75

1. Study of organ system of *Scoliodon*, *labeo* and *wallago*; study of accessory respiratory organs and their blood supply in *heteropneustes*. *Clarias*, *Channa* and Amphipnous: Study of air bladder and ear connection in Notopterus and Gudusia or Hilsa; Morphology of olfactory organs and their innervations on teleosts: preparation of a skeleton and an alizarine mount of fish, Study of prepared microslides: Osteology of *Wallago*.
2. Quantitative estimation of liver glycogen and blood sugar; demonstration of color change.
3. Systematics of marine and freshwater fishes with special reference to identification of local forms; structural adaptations in fishes.
4. Qualitative and quantitative study of freshwater plankton; estimation of Dissolved oxygen, free carbondioxide, alkalinity in a local fish pond; oxygen consumption in local fish sin different habitats.
5. Study of food and structural modifications due to feeding habits, gills and gill-rackers, mouth eye alimentary canal, olfactory organs etc: Study of age and growth in fishes;

Study of amphibians, exotic poisonous, venomous larvivorous and sound producing fishes.

6. Study of common aquatic vegetation and aquatic insects: study of fishing gears, with particular reference to UttarPradesh: soil factors; estimation of hydrobiological parameters temperature, pH, conductivity, salinity, dissolved oxygen, primary productivity, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, chemical oxygen demand, of nursery rearing, stocking and breeding ponds.

7. Estimation of ovarian egg counts: culture of live food organisms and assay of nutritional quality of live food; estimation of popular density of live food organisms; decapsulation and hatching of *Artemia* cysts for use in hatcheries; Demonstration of breeding pools and hatcheries. Induced breeding of Indian major carps and catfishes. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of india.

8. Collection and identification of aquatic weeds and aquatic insects: Study of feeding habits of fishes by gut content analysis, isolation and estimation of fish immunoglobulins; Molecular techniques in fish health management: Aquarium design and maintenance formulation and preparation of artificial fish food for Indian major carps and Prawns; Analysis of proximate composition of fish and processed products.

9. Visit to freshwater marine fish farm.

ELECTIVE COURSES

STREAM 3: CELL BIOLOGY

Course Code	Course Title	Credits
B050 1201T	Cytological Techniques	4

UNIT 1

Microscopy : basic principles of light microscopy, magnification, numerical aperture, resolution, stereo microscopy, principles and instrumentation of phase contrast, interference , polarization, Fluorescence microscopy; principles and instrumentation of electron microscopy(transmission electron microscope (TEM), Scanning electron microscopy(SEM)); different fixation and staining techniques for electron microscope.

UNIT 2

Basic principles of freeze drying technique (Lyophilization) and their uses; X-ray diffraction; basic principle of X-ray diffraction methods and instrumentation uses of X-ray diffraction study in cell biology;

UNIT 3

Chemical basis of fixation of ethanol, methanol, acetone, acetic acid, trichloroacetic acid, picric acid, mercuric chloride, formaldehyde, chemistry of cytochemical localization of glycogen by periodic acid-Schiff method; protein by coupled tetrazonium reaction method; lipid by Sudan Black B method; nucleic acid by Feulgen and methyl green- pyronin; acid and alkaline phosphatase by method Gomori's lead phosphate and Azo-dye coupling method; oxidases by diphenyl amine and nathoquinone.

UNIT 4

Purification and fractionation of nucleic acid, nucleic acid hybridisation, enzymatic replication of DNA by PCR- optimize reaction component, cycling parameters. GISH and FISH.

Suggested Literature:

1. Cell and molecular biology, D. Roberties
2. Cell biology, Saunders
3. Molecular cell biology, Albert Brucee et al
4. The cell nad molecular approach, G.M Cooper
5. Cell biology, Gerald Karp.

Course outcomes-After the course the students will be able to Purification and fractionation of nucleic acid, nucleic acid hybridisation, enzymatic replication of DNA by PCR- optimize reaction component, cycling parameters. Course is useful in various competitive examinations.

Course Code	Course Title	Credits
B050 1202T	Cellular Organization & Fundamental Processes: Cell Structure	4

UNIT 1

The nucleus (the nuclear envelop and traffic between the nucleus and cytoplasm), internal organization of the nucleus, the nucleolus; plasma membrane structure and chemical composition; movements of substances across the membrane.

UNIT 2

Protein shortening and transport endoplasmic reticulum (the endoplasmic reticulum and protein sectreation, the smooth ER and lipid synthesis, export of protein and lipids from the ER), The Golgi apparatus (organization of the Golgi, protein glycosylation within the Golgi Lipid and polysaccharide metabolism to the Golgi, protein sortening and export from the Golgi apparatus).

UNIT 3

Lysosomes. Types, ultrasound and functions, lysosomal enzymes, endocytosis and lysosome formation, phagocytosis and autophagy; lysosomal storage disorders.

UNIT 4

Bioenergetics and metabolism (mitochondria-organizaton and function, mechanisms of oxidative phosphorylation, peroxisomes- functions of peroxisomes); types of ribosomes, its ultrastructure; functions and biogenesis in eukaryotes and prokaryotes.

Suggested Literature:

1. Biochemistry of lipids and membranes by D.E Vance; J E Vance, the Benjamin/Cumminge Co.
2. Cell & Molecular biology, D Roberties.
3. Molecular cell biology, Albert Brucee et al
4. The cell and molecular approach, G.M Cooper
5. Cell biology, Gerald Karp.
6. Cell biology by Thomas D. Pollard, Saunders.
7. Cell biology and Genetics, Dr. Dev Brat Mishra

Course outcomes-Understood about the transmission, distribution, arrangement, and alteration of genetic information and how it functions and is maintained in populations. Bioenergetics and metabolism. Course is useful to further study of the students.

Course Code	Course Title	Credits
B050 1203T	Cell Regulation-Cell Communication & Differentiation	4

UNIT 1

Cell signalling: general principles of cell signalling, forms of signalling, classes of cell surface receptors protein, signalling of steroid and thyroid hormones through intercellular receptors, signalling via – Gprotein linked cell surface receptors; interferon; the cell division cycle;

UNIT 2

Circular mechanism of development: mechanisms of cell diversification in the early animal embryo, cell memory, cell determination and the concept of positional values; differentiated cells and their maintenance: maintenance of the differentiated state , tissues with permanent cells,

UNIT 3

The immune system: the cellular basis of immunity, antigen & antibody interactions. The functional properties of antibodies. The fine structure of antibodies, production & Synthesis of Polyclonal and monoclonal antibodies. T-cell receptors and subclasses, AIDS, MHC(major histocompatibility cells), molecular and antigen presentation onto T cells, Cytotoxic T cells, Helper T Cells and T cells and T cell activation, Selection of the T cells repertoire.

UNIT 4

Cancer : cancer as a micro-evolutionary process, causes and types of cancer, properties, properties of cancer cells, Molecular diagnosis, prevention and treatment, Molecular genetics of cancer; controlling gene expression : An overview of gene control, promoter and operator genes. Hormone regulation or gene control,

Suggested Literature:

1. Cell & Molecular Biology, D. Roberties.
2. Cell Biology, Saunders
3. Molecular cell biology, Albert Brucee et al
4. The cell and molecular approach, G.M Cooper
5. Cell biology, Gerald Karp

Course outcomes-Outline the key components of the innate and adaptive immune responses. To describe about cell types and organs which are involved in an immune response, described the Infectious diseases, hypersensitivity, autoimmune disorders, immunodeficiency diseases and Understood the microbial diversity, ultra structure, culture techniques of microbes.

Course Code	Course Title	Credits
B050 1204 P/R	Dissertation	4

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

Course Code	Course Title	Credits
B050 1205 P/R	Practical	4

PRACTICAL COURSE OF THEORY COURSES B0501201-B0501203

Max Marks: 75

Time: 6 hours

Distribution of marks:

Cytochemical localization	15
Vital staining	10

Microtomy	10
Isolation of nucleic acid	10
Spotting (10 spots)	20
Viva-voice and seminar	10
Total	75

1. Handling and use of phase contrast microscope.
 2. Quantitative estimation of DNA, RNA, alkaline phosphate.
 3. Cytochemical localization of phosphatases, RNA, DNA, proteins, lipids and glycogen.
 4. Study of chromosomal Behaviour during cell division, using squash preparations of animal (testes of rat and grasshopper; bone marrow of rat) tissues and plants (onion root tip) tissues.
 5. Prepared slides of chromosomes Behaviour during cell division.
 6. Study of salivary gland chromosomes of drosophila and/or Chironomus larvae.
 7. Identification and study of mutant forms of drosophila.
 8. Druyoplina culture technique.
 9. Cytochemical localization of golgi complex, mitochondria, acids and alkaline phosphatases and glycogen.
 10. Supravital staining of Nissl bodies, mitochondria and Cytoplasmic organells and inclusion.
 11. Study of prepared slides of various cytoplasmic organells and inclusion.
 12. Study of prepared slides of various stages during mitotic, and meiotic cell divisions.
- Bacterial culture techniques. Isolation of nucleic acids.

ELECTIVE COURSES

STREAM 4 : ENVIRONMENTAL BIOLOGY TOXICOLOGY

Course Code	Course Title	Credits
B050 1301T	Wild Life Biology	4

UNIT I

Value of Wildlife, field observation, study of sign and symptoms, footprints; locomotory patterns in tetrapod; types of movement; tiger pug marks, footprints of other animals, feeding sign, animal dropping, wildlife photography.

UNIT 2

Wildlife Census Method (water hole survey point count and line transect methods, pug mark count methods, kings census method); major wildlife habitat biomes, tropical and temperate habitat;

UNIT 3

Socio biology of wild animals, terrestrial behaviour, migratory behaviour, breeding behaviour, visual, acoustic and olfactory communication and their socio biological importance; India wildlife (introduction, distribution of wildlife in ecological sub division of India); IUCN categories, cinctures, biosphere, reserves, national parks, sanctuaries and zoos in India; gene -pool,

UNIT 4

Reasons for wildlife depletion (habitat, distribution, commercial wildlife exploitation, overgrazing etc); wildlife ecotourism management, measures for wildlife conservation (policies and programme); special projects for endangered species (project Tiger, Gir Lion Sanctuary, project, crocodile breeding project, project Hangul)

Suggested literature

1. Wildlife ecology, A.N. Moen.
2. Wildlife ecology and management, E.G. Balen
3. Indian wildlife, Ramesh Bedi
4. Wildlife management, Rajesh Gopal.
5. Fundamentals of parasitology wild life and economic zoology. Dr.S.K.Singh Vats

Course Outcomes-Distribution of wildlife in ecological sub division of India); IUCN categories, cinctures, biosphere, reserves, national parks, sanctuaries and zoos in India; gene - pool, habit, habitat and breeding biology of a representative wildlife and weaverbird. This course is useful in various competitive exams like CSIR-NET, IAS PCS.

Course Code	Course Title	Credits
B050 1302T	Environmental Chemistry	4

UNIT I

Fundamentals of environmental chemistry: stereochemistry, Gibbs energy, chemical potential, chemical equilibrium, acid base reaction, solubility product, solubility of gases in water,

UNIT 2

Chemical components of air: classification of elements, chemical speciation particles ions and radicals in the atmosphere, chemical processes for information of inorganic and organic particulate matter, thermo chemical and photo chemical reaction in the atmosphere, oxygen and ozone chemistry of air pollutants, photochemical smog.

UNIT 3

Water chemistry: chemistry of water concepts of D.O. BOD, COD.

UNIT 4

Toxic chemicals in the environment: pesticides in air, water and soil: biochemical aspects of Lead, Mercury, Cadmium, Arsenic, carbon monoxide, O₃ and PAN: carcinogens

Suggested literature

1. Environmental chemistry, Ian Williams
2. Environmental chemistry, Colin Baird. M.Cann
3. Environmental chemistry, F. Helmet
4. An introduction to environmental chemistry, J.E. Andrews
5. An introduction to environmental chemistry, Andrews et al.
6. Chemistry of the environment, T.G. Spiro, W.M. Stigliani

Course Outcomes- Fundamentals of environmental chemistry: stereochemistry, Gibbs energy, chemical potential, chemical equilibrium, acid base reaction, solubility product, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbon, radio-nuclides Toxic chemicals in the environment. Get benefit of this course in various competitive examinations.

Course Code	Course Title	Credits
B050 1303T	Environmental Monitoring & Toxicology	4

UNIT I

Air pollution monitoring: air quality standards, sampling methods, instruments, duration of sampling period. Location of sampling sites, Air sampler operation, stacksampling techniques, control of gases contaminants combustion. Ganga action plan.

UNIT 2

Physiochemical and bacteriological sampling and analysis of water quality. Waste treatment, primary, secondary, and tertiary treatment, criteria for the application of aerobic and

anaerobic biological treatment. Types of biological treatment, treatment for various industrial effluents with reference to distillery,

UNIT 3

Pollution control in petroleum refineries and petro-chemical unit. Odours and their control. Threshold concentration oxidation, water supply management: introduction, demand of water, need of water supply. Treatment of ground water, pollution, control in petroleum refineries and petrochemical unit, oil spills. Sources and generation of solid-waste and its control. Sewage treatment, physico-chemical and bacteriological samplings as analysis of soil quality, control of soil pollutants, remedial measures of soil pollutants, protection and control from radiation,

UNIT 4

Toxicology: introduction, basic concept o toxicology, toxicants of health hazards (Lead, Mercury, Cadmium, Arsenic, Vanadium, Cyanide, Cobalt, Iron), Xenobiotics, (absorption, transport and execution of chemicals).

Suggested literature

1. Toxicology, Earnest Hodgson.
2. Environmental pollution and management, G.R. Pathade, P.K. Goel.
3. Pollution, A.D. Stern
4. Pollutants and their determination, Gryson
5. Assessment and Management of Carbon, Nitrogen and Sulphur, P.A. Debarry.
6. Toxicology and risk assessment principles. Methods and application by Anna M Fan, Louis W Chang, Marcel Dekker, inc, New York.

Course Outcomes- Study is useful to physiochemical and bacteriological sampling and analysis of water quality. Types of biological treatment, treatment for various industrial effluents with reference to distillery, paper and pulp, textile and dyeing wastes, industrial pollution abatement for useful to the student applied work.

Course Code	Course Title	Credits
B050 1304 P/R	Dissertation	4

Subject of the Dissertation will be assigned to each student at the end of Semester II and goes until Semester IV. It would be theoretical and not involve any laboratory components.

PRACTICAL COURSE OF THEORY COURSES B0501301- B0501303

Course Code	Course Title	Credits
B050 1305 P/R	Practical	4

Max Marks: 75

Time: 6 hours

Distribution of marks:

Exercise For wildlife biology (2) 25

Exercise(2) For environmental monitoring 25

Exercise Environmental toxicology 15

Viva-voice and seminar 10

Total 75

1. Study of wildlife of local and suburban areas and submission of the report.
2. Study on wild life in adjoining area with biodiversity of wild flora & fauna.
3. Study on wild animals and their behaviour
4. Comparison of dissolve oxygen (D.O) in water samples from different sources.
5. Determination of the chloride demand and chloride residue.
6. Estimation of chemical oxygen demand.
7. Estimation of biological oxygen demand.
8. Estimation of free carbon dioxide demand.
9. Estimation of chloride concentration.
10. Determination of turbidity.
11. Estimation of pH
12. Effect of UV radiation on animals
13. Demonstrations of vectors of different diseases
14. Determination of temperature, colour, odour.
15. Determination of conductivity.
16. Determination of total solids in water samples.
17. Determination of alkalinity
18. Determination of total kjedol nitrogen and sulphate.
19. Determination of gas pollution in different localities of the city.
20. Measurement of humidity by hair hygrometer.
21. Measurement of temperature by Max. Min thermometer
22. Study on environmental awareness in different group of society

23. Estimation of LC50, LC10, LC90, measurement of selected toxicant for selected organisms. Determination of upper and lower confidence limits, slope with value of each study
24. Study of selected biological effect of selected pollutants, especially on the behaviour on animals
25. Effect of toxicant on enzyme acetyl cholinesterase (AChE) and alkaline phosphatase (ALP) in the nervous tissues of aquatic animals of different groups.

Convener

Member (PG)

External Expert