# Syllabus of FYUGP-Zoology

**Approved in the BOS held on 28th February 2025**
**DIBRUGARH UNIVERSITY**
**Dibrugarh, Assam 786004**

# FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN ZOOLOGY, DIBRUGARH UNIVERSITY

## 1. The Preamble:

Present-day zoology is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, Zoology has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With the global need for conservation, field biologists have contributed significantly in assessing and exploring newer dimensions for animal diversity. New insights on various dimensions of the zoological world have been gained by utilizing modern tools and techniques for zoological research. Concern for ever-increasing pollution and climate change is at its highest than ever before. Keeping the above-mentioned advancements and rich resources in North East India in view, a revised curriculum is offered by Dibrugarh University at the undergraduate level as per the National Education Policy-2020 so that the undergraduate Zoology students of Dibrugarh University shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of zoology, namely animal diversity, physiology, cell biology, genetics, evolution, biochemistry, molecular biology, developmental biology, reproductive physiology, comparative anatomy, chronobiology, ecology and economic zoology. All these aspects have been given due weightage over the eight semesters. The undergraduate students need to acquaint themselves with various tools and techniques for exploring the world of animals. Keeping view of employment entrepreneurship, skill based courses of sericulture and aquaculture have been introduced. These courses shall provide the students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Zoology with the new curriculum will be able to explore the rich animal diversity of North East India.

## 2. Introduction:

Dibrugarh University UG syllabus of Zoology is designed as per the guidelines of National Education Policy-2020. This Four Year Under Graduate Programme (FYUGP) in Zoology consists of Major (Core) disciplines, Minor disciplines, Multi Disciplinary Generic Elective Courses (GE), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), YOGA, Community Engagement like NCC/NSS, Digital and Technological solutions, Internship, Field Studies, Research Ethics, Research Projects and Discipline Specific electives (DSE) to acquaint the students with balanced knowledge on the animal resources, environment, contemporary issues and entrepreneurship.

# FYUGP-ZOOLOGY

The Bachelor of Science in Zoology of Dibrugarh University under NEP-2020 is a programme with multiple exit options. UG certificate, UG Diploma, UG Degree and UG Degree (Honours with Research) in Zoology will be awarded to students after successful completion of one, two, three and four years, respectively. It is expected that, on successful completion of this four year programme students will be skilled in multidisciplinary aspects for exploration and sustainable utilization of natural resources of NE region of India.

## 3. Aims of Four Year Under-Graduate Programme (FYUGP) in Zoology:

1. To introduce the students with the rich world of animal diversity with a focus on biodiversity of North east India.
2. To enable the students to explore the potential of natural resources for human welfare and their use in a sustainable way.
3. To develop capabilities of students for critical evaluation of contemporary issues related to environment and conservation.
4. To generate skilled human resources for biological entrepreneurship.

## 4. Graduate Attributes of the FYUGP in Zoology:

***Disciplinary Knowledge***

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoretical and applied components of animal science and allied areas of study in a multidisciplinary context.

Students should have the ability to connect relevant disciplines, and recent trends in biological and contemporary issues.

***Communication Skills***

The graduates in Zoology should have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals and nature.

***Moral and Ethical Awareness/Reasoning***

Ability to recognise ethical issues that are pertinent to one's work and pledge not to engage in unethical behaviour such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one’s research with honesty and integrity in all aspects.

***Multicultural Competence***

Ability to correlate and compare recent developments in various branches of animal science worldwide; ability to collaborate research in various fields of biology with other researchers from allied organisations; acquisition of knowledge on traditional practices of different ethnic communities.

***Information/Digital Literacy***

The graduates of Zoology should have the ability to utilize Information and Communications Technology (ICT) tools, biological databases and computer and softwares in solving biological problems. ***Reflective Thinking and Problem Solving:***

After completion of graduation in Zoology the students will be able to understand the value of animal diversity, need for conservation of animals, bio-prospecting and sustainable utilization of natural resources for human welfare.

***Critical Thinking***

The graduates of Zoology should be competent for critical analysis of problems related to animals and nature, sustainable uses of biological resources and their conservation strategies.

**5. Programme Educational Objectives (PEOs)**

1) Formulate strategies to achieve sustainable development in harnessing biological resources.
2) Evaluate environmental problems and design innovative solutions.
3) Demonstrate an attitude to employ multidisciplinary approaches for problem solving.

**6. Programme Outcomes (POs)**

1) Develop ideas to assess and inventorize existing biological resources of this region
2) Formulate innovative strategies for conservation of biogenetic resources for human welfare
3) To explore and validate ethnobiological knowledge of Northeast India
4) To provide solutions for existing societal problems using biological knowledge
5) Develop research skills to solve complex biological issues and achieving SDGs
6) Execute good communication skills for disseminating knowledge of biological sciences
7) To promote the attitude to work as a team appreciating ethical values

**7. Programme Specific Outcomes (PSOs)**

1) Evaluate the diversity and evolution of organisms
2) Analyze the fundamentals of life-sustaining processes
3) Design strategies for issues concerning public health and human welfare
4) Critically analyze the environmental issues and develop strategies to address them
5) Formulate measures to mitigate climate change effects

# FYUGP-ZOOLOGY

COURSE OUTLINE

| Semester | Course Code | Course | Course Name | Credit |
|---|---|---|---|---|
| **I** | ZOO-C-01 | CORE-I | Animal Diversity I | 4 |
| | ZOO-MIN-01 | Minor I | Animal Diversity I- Minor | 4 |
| | ZOO-GEC-01 | GEC – 1 | Natural resource management | 3 |
| | | AEC 1 | Modern Indian Language | 4 |
| | ZOO-VAC-01 | VAC 1 | Understanding India | 2 |
| | ZOO-SEC-01 | SEC I | a) Freshwater Aquaculture/<br>b) Apiculture | 3 |
| | | TOTAL CREDIT | | **20** |
| II | ZOO-C-02 | CORE-II | Animal Diversity II | 4 |
| | ZOO-MIN-02 | Minor II | Animal Diversity II – Minor | 4 |
| | ZOO-GEC-02 | GEC II | Wildlife Conservation and Management | 3 |
| | | AEC II | English Language and Communication Skills | 4 |
| | ZOO-VAC-02 | VAC II | Environmental Science | 2 |
| | ZOO-SEC-02 | SEC II | a) Sericulture/<br>b) Aquarium Fish Keeping | 3 |
| | | TOTAL CREDIT | | **20** |
| **III** | ZOO-C-03 | Core-III | Cell Biology | 4 |
| | ZOO-C-04 | Core-IV | Comparative Anatomy of Vertebrates | 4 |
| | ZOO-MIN-03 | Minor-III | Comparative Anatomy of Vertebrates-Minor | 4 |
| | ZOO-GEC-03 | GEC-III | Insect vectors and Diseases | 3 |
| | ZOO-SEC-03 | SEC-III | a) Vermicomposting/<br>b) Medical Diagnostics | 3 |
| | ZOO-VAC-03 | VAC III | Digital and Technological Solutions / Digital Fluency | 2 |
| | | TOTAL CREDIT | | 20 |
| IV | ZOO-C-05 | CORE-V | Biochemistry | 4 |
| | ZOO-C-06 | CORE-VI | Animal Physiology | 4 |
| | ZOO-C-07 | CORE-VII | Genetics and Evolutionary Biology | 4 |
| | ZOO-C-08 | CORE-VIII | Molecular Biology | 4 |
| | ZOO-MIN-04 | Minor-IV | Animal Physiology-Minor | 4 |
| | | **TOTAL CREDIT** | | **20** |

# FYUGP-ZOOLOGY

| | | | | |
|---|---|---|---|---|
| **V** | ZOO-C-09 | CORE-IX | Developmental Biology | 4 |
| | ZOO-C-10 | CORE-X | Animal Behaviour and Chronobiology | 4 |
| | ZOO-C-11 | CORE-XI | Basic Microbiology and Vector-borne Diseases | 4 |
| | ZOO-MIN-05 | Minor-V | Developmental Biology-Minor | 4 |
| | ZOO-FS/PRJ | | Field Study/ Internship/Community Engagement-NSS/NCC | 4 |
| | | **TOTAL CREDIT** | | **20** |
| **VI** | ZOO-C-12 | CORE-XII | Controlling and Co-ordinating Physiology and Immunology | 4 |
| | ZOO-C-13 | CORE-XIII | Animal Ecology and Wildlife Management | 4 |
| | ZOO-C-14 | CORE-XIV | Bioinformatics, Biostatistics, and Techniques in Biology | 4 |
| | ZOO-C-15 | CORE-XV | Animal Taxonomy and Systematics | 4 |
| | ZOO-MIN-06 | Minor-VI | Controlling and Co-ordinating Physiology and Immunology -Minor | 4 |
| | | **TOTAL CREDIT** | | **20** |
| **VII** | ZOO-C-16 | CORE-XVI | Environmental Biology | **4** |
| | ZOO-C-17 | CORE-XVII | Advanced Molecular Biology | **4** |
| | ZOO-C-18 | CORE-XVIII | Advanced Cell Biology and Genetics | **4** |
| | ZOO-RM | | Research Methodology and Research Ethics | **4** |
| | ZOO-MIN-07 | Minor-VII | Advanced Analytical Techniques | **4** |
| | | **TOTAL CREDIT** | | **20** |
| **VIII** | ZOO-C-19 | CORE-XIX | Intermediary Metabolism | 4 |
| | ZOO-C-20 | CORE-XX | Biodiversity and Bioprospecting | 4 |
| | ZOO-MIN-08 | Minor-VIII | Bioethics, Biosafety and IPR | 4 |
| | Dissertation/ 2DSE | | Dissertation Or<br>DSE 1: Climate Change and Biological Adaptation<br>DSE 2: Computational Biology | 8/4+ 4 |
| | | **TOTAL CREDIT** | | **20** |

# FYUGP-ZOOLOGY

**SEMESTER I**

**Title of the Course : Animal Diversity I**
**Course Code : ZOO-C-01**
**Nature of the Course : CORE I**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1) Describe different phyla in animal kingdom
2) Organize the organisms in different categories based on morphological characteristics
3) Analyze the interrelationship among different species and genera within each group of animals

**Learning Outcomes:**

1) Understand the various phyla in Animal Kingdom
2) Compare various organisms based on morphology
3) Classify different groups of animals

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | CO2, CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**MODES OF IN-SEMESTER ASSESSMENT:**

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

# FYUGP-ZOOLOGY

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

| UNIT | CONTENT | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Protista, Parazoa and Metazoa**<br>General characteristics and Classification up to Classes<br>Structural organization & nutrition of *Amoeba ,Euglena*, and *Paramecium.*<br>Locomotion and Reproduction in protista (Protozoa) | 10 | 2 | - | 12 |
| 2 | **Porifera, Cnidaria& Ctenophora**<br>General characteristics and Classification up to classes with examples<br>Canal system in sponges and Evolutionary significance | 7 | 1 | - | 8 |
| 3 | **Platyhelminthes & Nemathelminthes** General characteristics and Classification up to classes<br>Life cycle of *Taenia solium, Fasciola hepatica* and *Ascaris lumbricoides*<br>Parasitic adaptation in Helminths. | 7 | 1 | - | 8 |
| 4 | **Introduction to Coelomates, Annelida and Arthropods**<br>Evolution of coelom and metamerism<br>General characteristics and Classification up to classes<br>Excretion in Annelida. Respiration in Arthropoda | 8 | 1 | - | 9 |
| 5 | **Onychophora& Mollusca and Echinodermata**<br>General characteristics Classification<br>up to classes<br>Torsion and detorsion in Gastropoda<br>Water-vascular system in Asteroidea | 7 | 1 | - | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course**<br>1) Study of the following specimens: Protista: Amoeba, Euglena, Plasmodium, Paramecium<br>Cindaria: Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora and One specimen/slide of any ctenophore<br>Annelids: Nereis, Aphrodite, Chetopterus, Pheretima, Hirudanaria Arthropods:Limulus,Belastoma, Palamnaeus, Daphnia, Palaemon, Cancer, Brachionus, Bombyx, Periplaneta, Samia ricini. Antherae spp.Termite and honey bee.<br>Helminths: Ascaris, Taenia, Fasciola.<br>Molluscs:Chiton,Dentalium,Pila,Doris,Helix,Unio, Sepia, Octopus and Nautilus.<br>Echinoderms: Pentaceros, Asterias, Ophiura, Echinus, Antedon<br>*2)* Study of *Sycon*(T.S. and L.S.), *Hyalonema, Euplectella,Spongilla*<br>*3)* Study of whole mount of *Euglena*, *Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium.*<br>4) Study of mouth parts of Periplaneta<br>*5)* Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro- photographs)<br>6) Study of adult *Ascaris lumbricoides* and its life stages(Slides/micro-photographs).<br>7) Study of septal nephridia in earthworm, digestive system of Periplaneta (virtual). | - | - | 15 | 15 |
| | | 39 | 6 | 15 | 60 |

**Suggested Readings**


1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Kingsley J. Text Book of Vertebrate Zoology Publisher: Nabu Press ISBN: 9781171586524, 1171586523
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrate

# FYUGP-ZOOLOGY

## SEMESTER I

**Title of the Course** : **Animal Diversity I-Minor**
**Course Code** : **ZOO-MIN-01**
**Nature of the Course** : **Minor-I**
**Total Credits** **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Describe different phyla in animal kingdom
2. Organize the organisms in different categories based on morphological characteristics
3. Analyze the interrelationship among different species and genera within each group of animals

**Learning Outcomes:**

1. Understand the various phyla in Animal Kingdom
2. Compare various organisms based on morphology
3. Classify different groups of animals

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | CO2,CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**MODES OF IN-SEMESTER ASSESSMENT:**

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

# FYUGP-ZOOLOGY

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

| UNIT | CONTENT | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Protista, Parazoa and Metazoa**<br>General characteristics and Classification up to Classes<br>Structural organization & nutrition of *Amoeba ,Euglena*, and *Paramecium.*<br>Locomotion and Reproduction in protista (Protozoa) | 10 | 2 | - | 12 |
| 2 | **Porifera, Cnidaria& Ctenophora**<br>General characteristics and Classification up to classes with examples<br>Canal system in sponges and Evolutionary significance | 7 | 1 | - | 8 |
| 3 | **Platyhelminthes & Nemathelminthes** General characteristics and Classification up to classes<br>Life cycle of *Taenia solium, Fasciola hepatica* and *Ascaris lumbricoides*<br>Parasitic adaptation in Helminths. | 7 | 1 | - | 8 |
| 4 | **Introduction to Coelomates, Annelida and Arthropods**<br>Evolution of coelom and metamerism<br>General characteristics and Classification up to classes<br>Excretion in Annelida. Respiration in Arthropoda | 8 | 1 | - | 9 |
| 5 | **Onychophora& Mollusca and Echinodermata**<br>General characteristics Classification<br>up to classes<br>Torsion and detorsion in GastropodaWater-vascular system in Asteroidea | 7 | 1 | - | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course**<br>Study of the following specimens: Protista: Amoeba, Euglena, Plasmodium, Paramecium<br>Cindaria: Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora and One specimen/slide of any ctenophore<br>Annelids: Neries, Aphrodite, Chetopterus, Pheretima, Hirudanaria Arthropods:Limulus,Belastoma, Palamnaeus, Daphnia, Palaemon, Cancer, Brachionus, Bombyx, Periplaneta, Samia ricini. Antherae spp.Termite and honey bee.<br>Helminths: Ascaris, Taenia, Fasciola.<br>Molluscs:Chiton,Dentalium,Pila,Doris,Helix,Unio, Sepia, Octopus and Nautilus.<br>Echinoderms: Pentaceros, Asterias, Ophiura, Echinus, Antedon<br>*2)* Study of *Sycon*(T.S. and L.S.), *Hyalonema, Euplectella,Spongilla*<br>*3)* Study of whole mount of *Euglena*, *Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium.*<br>4) Study of mouth parts of Periplaneta<br>*5)* Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro- photographs)<br>6) Study of adult *Ascaris lumbricoides* and its life stages(Slides/micro-photographs).<br>7) Study of septal nephridia in earthworm, digestive system of Periplaneta (virtual). | - | - | 15 | 15 |
| | | 39 | 6 | 15 | 60 |

**Suggested Readings**


- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Kingsley J. Text Book of Vertebrate Zoology Publisher: Nabu Press ISBN: 9781171586524, 1171586523

# FYUGP-ZOOLOGY

## SEMESTER I

**Title of the Course : Natural Resource Management**
**Course Code : ZOO-GEC-01**
**Nature of the Course. : Generic Elective Course-I**
**Total Credits : 03**
**Distribution of Marks : 100 ( 60 End + 40 IA)**

**COs:**

1. Distinguish between renewable and non-renewable resources
2. Analyse threats to natural and biological resources of NE India
3. Examine management strategies for sustainable utilization of resources

**Learning outcomes:**

1. Differentiate natural and biological resources of NE India
2. Identify the threats and issues related to the natural resources
3. Execute conservation and management strategies for natural resources

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2, CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

1. Internal examination
2. Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination

| UNIT | CONTENT | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Natural resources:** Definition and types. Natural resources of NE India. Renewable and non-renewable sources of energy. | 7 | - | - | 7 |
| 2 | **Sustainable utilization of land and water resources**: Soil degradation and management; water resources (Freshwater, marine, estuarine) wetlands; Threats and management strategies and their management. | 15 | - | - | 15 |
| 3 | **Biodiversity:** Definition, types, significance, threats, management strategies, CBD, Bioprospecting | 8 | - | - | 8 |
| 4 | **Contemporary practices in resource management**: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management. National and international efforts in resource management and conservation. | 15 | - | - | 15 |
| | | 45 | - | - | 45 |

**SUGGESTED READINGS:**

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

# FYUGP-ZOOLOGY

## SEMESTER I

**Title of the Course : Freshwater Aquaculture**

**Course Code : ZOO-SEC-01-A**
**Nature of the Course : SEC I a**
**Total Credits : 03**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Analyze concept of freshwater aquaculture.
2. Evaluate the technique of fish rearing, transportation and the technique of induced breeding.
3. Discuss the maintenance of fish health.

**Learning Outcomes:**

- Understand the freshwater aquaculture concept.
- Analyze fishing gears and induced breeding techniques.
- Identify fish diseases.

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO3 | | |
| Procedural | | | | | CO2 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1.8 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.1 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1.8 |
| AVERAGE | 3 | 2 | 2.0 | 1.7 | 1.7 | 1.7 | 1.7 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

1. One theory Internal examination
2. One practical Internal examination
3. Viva-voce/ Home assignments

Of COs strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | Introduction to Aquaculture, Basic concept of extensive, intensive and superintensive aquaculture, monoculture, polyculture and integrated farming. | 5 | 1 | - | 6 |
| 2 | Rearing of Larval and brood fishes, Traditional and Chinese hatcheries, feed preparation for carps and catfishes, Live food culture, Transportation of fish seeds and brooders. | 7 | 1 | - | 8 |
| 3 | Concept of induced breeding, ornamental fish, Captive breeding of carp, catfishes, Diagnostic characters of brood fishes and ornamental fishes, Breeding of carps and catfishes in simulated environments, Standardisation of hormonal doses. | 7 | 1 | - | 8 |
| 4 | Maintenance of fish health and prophylactic measures, Diagnostic of common fungal, bacterial, protozoan and ectoparasites, Control measures for common fish diseases, Role of immunostimulants in aquaculture. | 6 | 2 | - | 8 |
| 5 | **Lab Course:**<br>1. Study of fishing gears<br>2. Basic symptoms of fish diseases<br>3. Demonstration of Induced Breeding | **-** | **-** | **15** | **15** |
| | **TOTAL** | **25** | **5** | **15** | **45** |

***Where,*** ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

**SUGGESTED READINGS**


- D. Kapoor, R. Dayal and A.G. Ponniah: Fish Biodiversity of India, NBFGR Publication, Lucknow.
- R.H. McConnell: Ecological Studies in Tropical Fish Communities, Cambridge University Press.
- Matty: Fish Endocrinology.
- T.K. Govindan: Fish Processing Technology, Oxford & IBH, New Delhi
- Fish and Fisheries - S.S. Khanng
- Fresh Water Aquaculture – Rath
- Hand Book of fish and Fisheries - ICAR

## FYUGP-ZOOLOGY

### SEMESTER I

**Title of the Course : Apiculture`**
**Course Code : ZOO-SEC-01-B**
**Nature of the Course : SEC Ib**
**Total Credits : 03**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Discuss the concept of apiculture
2. Analyze bee rearing process and tools used in bee keeping
3. Analyze the bee diseases

**Learning Outcomes:**

- Understand about apiculture
- Apply the knowledge the bee rearing process for commercial purposes
- Identify the health of bees

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2, CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

- One theory Internal examination
- One practical Internal examination
- Viva-voce/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Biology of Bees**<br>History, Classification and Biology of Honey Bee species, Social Organization of Bee Colony, Bee plants | 5 | - | - | 5 |
| 2 | **Rearing of Bees**<br>Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth, Bee Pasturage, Selection of Bee Species for Apiculture, Bee Keeping Equipment, Methods of Extraction of Honey (Indigenous and Modern) | 5 | - | - | 5 |
| 3 | **Diseases and Enemies**<br>Bee Diseases and Enemies, Control and Preventive Measures | 10 | - | - | 10 |
| 4 | **Bee Economy and Entrepreneurship in Apiculture**<br>Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc<br>Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens | 10 | - | - | 15 |
| 5 | **Lab Course**<br>1) Draw a diagram by observing mouth parts of a worker bee under microscope.<br>2) Check a bee colony and note variations in the size and shape of a worker, drone and queen.Measure the body size (length of body and wing size)<br>3) Note special features of fore leg, middle leg and hind leg of the worker bee and wing coupling apparatus<br>4) Follow a returning forager and observe its activities in side a colony in an observation hive.<br>5) Check a brood frame containing brood and honey and differentiate between: sealed brood and sealed honey; sealed worker and drone brood if present<br>Remove sealed frames of honey, uncap using uncapping knife and extract honey using honey extractor | **-** | **-** | **15** | **15** |
| | **TOTAL** | **30** | **-** | **15** | **45** |

# FYUGP-ZOOLOGY

## SEMESTER II

**Title of the Course : Animal Diversity II**
**Course Code : ZOO-C-02**
**Nature of the Course : CORE II**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. describe different phyla in animal kingdom
2. organize the organisms in different categories based on morphological characteristics
3. analyze the interrelationship among different species and genera within each group of animals

**Learning Outcomes:**

1) understand the various phyla in Animal Kingdom
2) compare various organisms based on morphology
3) classify different groups of animals

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | CO2,CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**MODES OF IN-SEMESTER ASSESSMENT:**

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

## FYUGP-ZOOLOGY

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Introduction to Chordates:** General characteristics and outline classification **Protochordata:** General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata<br>**Origin of Chordata:** Theories of origin of chordates, Advanced features of vertebrates over Protochordata | 10 | 1 | - | 11 |
| 2 | **Agnatha and Pisces:**<br>Agnatha: General characteristics and classification of cyclostomes up to class with example<br>Pisces: General characteristics of Chondrichthyes and Osteichthyes, classification up to order; Osmoregulation | 8 | 1 | - | 9 |
| 3 | **Amphibia & Reptilia**<br>Amphibia: Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order; parental care in Amphibia; Reptilia: General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes | 8 | 1 | - | 9 |
| 4 | **Aves & Mammals**<br>Aves: General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations Mammals: General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages | 8 | 1 | - | 9 |
| 5 | **Zoogeography**<br>Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms | **7** | **-** | **-** | **7** |

| | | | | | |
|---|---|---|---|---|---|
| | TOTAL | **41** | **4** | **15** | **60** |

**Suggested Readings**


- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
- Pough H. *Vertebrate life,* VIII Edition, PearsonInternational.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger PubCo.
- Hall B.K. and Hallgrimsson B. (2008).*Strickberger's*
- *Evolution*. IV Edition. Jones and Bartlett PublishersInc.

# FYUGP-ZOOLOGY

## SEMESTER II

**Title of the Course** : **Animal Diversity II-Minor**
**Course Code** : **ZOO-MIN-02**
**Nature of the Course** : **Minor II**
**Total Credits** : **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1) describe different phyla in animal kingdom
2) organize the organisms in different categories based on morphological characteristics
3) analyze the interrelationship among different species and genera within each group of animals

**Learning Outcomes:**

1. understand the various phyla in Animal Kingdom
2. compare various organisms based on morphology
3. classify different groups of animals

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | CO2,CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**MODES OF IN-SEMESTER ASSESSMENT:**

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

## FYUGP-ZOOLOGY

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Introduction to Chordates:** General characteristics and outline classification **Protochordata:** General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata<br>**Origin of Chordata:** Theories of origin of chordates, Advanced features of vertebrates over Protochordata | 10 | 1 | - | 11 |
| 2 | **Agnatha and Pisces:**<br>Agnatha: General characteristics and classification of cyclostomes up to class with example<br>Pisces: General characteristics of Chondrichthyes and Osteichthyes, classification up to order Osmoregulation | 8 | 1 | - | 9 |
| 3 | **Amphibia & Reptilia**<br>Amphibia: Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order; parental care in Amphibia ; Reptilia: General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes | 8 | 1 | - | 9 |
| 4 | **Aves & Mammals**<br>Aves: General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations Mammals: General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages | 8 | 1 | - | 9 |
| 5 | **Zoogeography**<br>Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms | **7** | **-** | **-** | **7** |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course**<br>1. To study the following specimen: **Protochordata**; Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata. Sections of Balanoglossus through proboscis and branchiogenital regions,<br>**Fishes;** *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas,* Flat fish,*Channa* spp. *Puntius*spp. *Trichogaster, Heteropneusteus* spp., *Clarias* spp., *Mystus* spp. **Amphibia;** *Ichthyophis/ Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandr*<br>**Reptilia;** *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*<br>**Aves**; Study of six common birds from different orders.<br>**Mammalia;** Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous.<br>*2.* Dissection of weberian ossicles of *Mystus,* , pecten from Fowlhead.<br>3. To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes.<br>4. Study of animal organ system: Urinogenital System of fish (locally available fish).<br>5. Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmania spicules, Placoid and Cycloid Scales in Fishes, Types of beaks and claws.<br>6. To submit a Project Report on any related topic to larval forms. | **-** | **-** | **15** | **15** |
| | TOTAL | **41** | **4** | **15** | **60** |

**SUGGESTED READINGS**


- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
- Pough H. *Vertebrate life,* VIII Edition, PearsonInternational.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger PubCo.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett PublishersInc.

# FYUGP-ZOOLOGY

## SEMESTER II

**Title of the Course : Sericulture**
**Course Code : ZOO-SEC-02-A**
**Nature of the Course : SEC II a**
**Total Credits : 03**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Analyze the concept of sericulture.
2. Evaluate the rearing technique and associated tools.
3. Examine the diseases and learn the control measures.

Learning outcomes:

- Understand the concept of sericulture
- Apply the rearing techniques and tools for commercial purposes
- Identify diseases of the silkworm

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO3 | | |
| Procedural | | | | | CO2 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

- One theory Internal examination
- One practical Internal examination
- Viva-voce/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Sericulture:** Definition, history and present status; Silk route Types of silkworms, Distribution and Races Exotic and indigenous races, Hybrids Mulberry and non-mulberry Sericulture Life cycle of Bombyx mori, Antheraea assamensis Structure of silk gland and secretion of silk; Sex linked traits | 5 | - | - | 5 |
| 2 | **Rearing of silkworms:** Mulberry silkworm rearing : Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing. Types of mountages Spinning, harvesting and storage of cocoons Non mulberry silkworm rearing: Host plants of non mulberry silkworm, maintenance of host plants of *Antheraea assamensis*, rearing technology of *Antheraea spp* and *Samia cynthia ricini* | 5 | - | - | 5 |
| 3 | **Pests and diseases:** Pests of silkworm: Uzi fly, Apanteles, dermestid beetles and vertebrates. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial.Control and prevention of pests and diseases | 10 | - | - | 10 |
| 4 | **Entrepreneurship in sericulture:** Prospects of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres. | 10 | - | - | 15 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | **Lab Course:**<br>1. Study of life cycle of different silkworms<br>2. Sex separation in larva, pupa and adult of silkworm<br>3. Anatomy of Silkworm: A)Digestive system b) Silk gland<br>4. Identification of common insects associated with sericulture industry<br>5. Identification of different diseased silkworms based on external symptoms (Grasserie, Flacherie, Muscardine and Pebrine)<br>6. Identification of permanent slide of bacteria, spores of Pebrine, spores of Muscardine<br>7. Identification and study Sericulture products : Silk Yarn different types, Pupae<br>8. Visit to field and farmers rearing house/ silk reeling establishments | **-** | **-** | **15** | **15** |
| | **TOTAL** | **30** | **-** | **15** | **45** |

***Where,*** ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

**SUGGESTED READINGS**


- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press,Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI,Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo,Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore,1986.

## FYUGP-ZOOLOGY

### SEMESTER II

**Title of the Course** : **Aquarium Fish Keeping**
**Course Code** : **ZOO-SEC-02-B**
**Nature of the Course** : **SEC II b**
**Total Credits** : **03**
**Distribution of Marks** : **100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Analyze the concept of aquarium fish keeping.
2. Discuss ornamental fishes and their importance.
3. Evaluate the technique of fish feed preparation.

Learning Outcomes:

- Explain the concept of fish keeping in aquariums
- Discuss about ornamental fishes
- Formulation of fish feeds

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2, | | |
| Procedural | | | | | CO3 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

- One theory Internal examination
- One practical Internal examination
- Viva-voce/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction:**The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes | 5 | - | - | 5 |
| 2 | **Biology:** Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish, Botia, Gourami, *Channa bleheri, Channa barca* | 5 | - | - | 5 |
| 3 | **Food and feeding :** Use of live fish feed organisms. Preparation and composition of formulated fish feeds Live fish transport - Fish handling, packing and forwarding techniques | 10 | - | - | 10 |
| 4 | **Transportation and maintenance:** General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry, Scope of aquarium fish industry in NE India | 10 | - | - | 15 |
| 5 | **Lab Course:**<br>1) Management of aquarium environment<br>2) Collection of ornamental fishes<br>3) Acclimatization of fish<br>4) Preparation of feed and Feeding of aquarium fish | **-** | **-** | **15** | **15** |
| | TOTAL | **30** | **-** | **15** | **45** |

***Where, L: Lectures T: Tutorials P: Practicals***

**SUGGESTED READINGS**


- G. Helfman, Bruce B. Collette, D.E. Facey, B. W. Bowen: The Diversity of Fishes: Biology, Evolution, and Ecology, John Wiley & Sons
- R. J. Wootton: Fish Ecology, Springer
- W. Vishwanath, W.S. Lakra and U.K. Sarkar: Fishes of North East India, NBFGR Publication, Lucknow
- Handbook of Fisheries and Aquaculture – ICAR
- Ornamental Fish culture and Aquarium Maintenance – AO Dholakia

# FYUGP-ZOOLOGY

## SEMESTER II

**Title of the Course : Wildlife Management and Conservation**
**Course Code : ZOO-GEC-02**
**Nature of the Course. : Generic Elective Course II**
**Total Credits: : 03**
**Distribution of Marks : 100 ( 60 End + 40 IA)**

**COs:**

1. To discuss the concept of wildlife and its management
2. To explain the importance of wildlife and its conservation
3. To apply conservation tools and methods

Learning outcomes:

- To understand the concept of wildlife and its management
- To define the importance of wildlife and its conservation
- To understand conservation tools and methods

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1, CO2 | CO3 | | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

1. Internal examination
2. Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination

| UNIT | CONTENT | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Introduction to WildLife :** Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies. | 5 | 1 | - | 6 |
| 2 | **Evaluation and management of wildlife**: Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS. | 9 | 1 | - | 10 |
| 3 | **Management of habitats:** Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats | 7 | 1 | - | 8 |
| 4 | **Population estimation**: Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method. | 7 | 1 | - | 8 |
| 5 | **Management planning of wild life in protected areas**: Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Ecology of perturbence. Care of injured and diseased animal; Quarantine | 5 | 1 | - | 6 |
| 6 | **Protected areas**: National parks & sanctuaries, Community reserve; Important features of protected areas in India with special reference to NE India. | 7 | 1 | - | 7 |
| | | 40 | 5 | - | 45 |

**SUGGESTED READINGS:**


- Wildlife Ecology, conservation and management by John M. Frysell.
- Wildlife Conservation and Management By Reena Mathur
- Textbook of Wildlife Management by S K Singh

# FYUGP-ZOOLOGY

## SEMESTER III

**Title of the Course** : **Cell Biology**

**Course Code** : **ZOO-CORE-03**
**Code** : **CORE-III**
**Total Credits** : **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1) differentiate the structure and functions of cellular components
2) evaluate the cell division mechanism and cell cycle.
3) analyze cell signalling mechanism.

**Learning Outcomes:**

1) understand the cell structure and functions of cell organelles.
2) analyze cell division and cell cycle mechanisms.
3) interpret the cell signalling mechanisms.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO3 | CO2 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce/Group discussion/Home assignments

Attainment strategy of COs**:**

1. Continuous evaluation through in and end semester theory and practical examinations
2. Laboratory practices on cells, cellular organelles and cellular processes
3. Practical record book/field book

# FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Overview of cell:** Prokaryotic and Eukaryotic cells, Plasma Membrane and Cytoskeleton: Various models of plasma membrane structure, Transport across membranes: Active and Passive transport, Cell junctions: Tight junctions, Desmosomes, Gap junctions, Structure and Functions: Microtubules, Microfilaments and Intermediate filaments | 8 | 2 | - | 10 |
| 2 | **Endomembrane System: Structure and Functions:** Endoplasmic Reticulum, Golgi Apparatus, Lysosomes | 8 | - | - | 8 |
| 3 | **Mitochondria and Peroxisomes:** Mitochondria: Structure,Semi- autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis,Peroxisomes | 8 | 1 | - | 9 |
| 4 | **Nucleus:** Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome). | 8 | 1 | - | 9 |
| 5 | **Cell Division and Cell Signalling**<br>Mitosis, Meiosis, Cell cycle and its regulation, GPCR and Role of second messenger (cAMP). | 8 | 1 | - | 9 |
| 6 | **Lab courses:**<br>1. Preparation of temporary squash of any suitable material to study various stages of mitosis.<br>2. Study of various stages of meiosis.<br>3. Preparation of permanent slide to demonstrate: Mucopolysaccharides by PAS reaction, Proteins by Mercurobromophenol blue/FastGreen, DNA by Feulgen reaction, DNA and RNA by MGP.<br>4. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells. | - | - | 15 | 15 |
| | | 40 | 5 | 15 | 60 |

**Suggested Readings**


- Karp G., Cell and Molecular Biology: Concepts and Experiments, 7th Edition (John Wiley & Sons, Inc., 2013).
- Scott, M. P. et al, Molecular Cell Biology, 6th Edition (W. H. Freeman, 2007).
- Alberts, B. et al., Molecular Biology of the Cell, 5th Edition (Garland Publishing, 2008).
- Becker, W. M. et al., The World of Cell, 8th Edition (Benjamin Cummings, 2011).
- Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D.Stansfield, J. S.C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.
- Cooper, G. M. and Hausman, R. E., The Cell: A Molecular Approach, 5th Edition (ASM Press and Sinauer Associates, Inc., 2009).

## FYUGP-ZOOLOGY

### SEMESTER III

**Title of the Course : Comparative Anatomy of Vertebrates**
**Course Code : ZOO-C-04**
**Nature of the Course : Core IV**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**Course Outcomes:**

1. Discuss the anatomy of different systems in Vertebrates
2. Analyze the structural modifications in anatomy of different groups

Learning Outcomes:

- Describe the anatomy of different systems in Vertebrates
- Compare the structural modifications in anatomy of different groups

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of assessment**

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce/Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

## FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Integumentary System:** Structure, functions and derivatives of integument | 8 | 1 | - | 9 |
| 2 | **Skeletal System:**<br>Overview of axial and appendicular skeleton, Visceral arches | 8 | 1 | - | 9 |
| 3 | **Digestive System and Urinogenital System**<br>Alimentary canal and associated glands, dentition Succession of kidney, Types of mammalian urinogenital system | 8 | 1 | - | 9 |
| 4 | **Respiratory System:**<br>Skin, gills, lungs and air sacs; Accessory respiratory organs<br>General plan of circulation, evolution of heart | 8 | 1 | - | 9 |
| 5 | **Nervous System and Sense Organ**<br>Comparative account of brain<br>Autonomic nervous system,<br>Brief account of visual and auditory receptors in man | **8** | **1** | **-** | **9** |
| 6 | **Lab Course:**<br>1. Dissection of fish (carp) to study efferent and afferent branchial system(subject to permission)<br>2. Study of placoid, cycloid and ctenoid scales through permanent slides / photographs.<br>3. Study of Disarticulated skeleton of Frog, *Varanus,*Fowl,Rabbit.<br>4. Study of Mammalian skulls: One herbivorous and one carnivorous animal<br>5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted) | **-** | **-** | **15** | **15** |
| | **TOTAL** | **40** | **5** | **15** | **60** |

***Where,*** ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

**SUGGESTED READINGS:**


- Comparative Anatomy of Vertebrates by RK Saxena
- Anatomy of the Vertebrates by George C Kent
- Modern Textbook of Zoology by RL Kotpal

# FYUGP-ZOOLOGY

## SEMESTER III

**Title of the Course : Comparative Anatomy of Vertebrates-Minor Course**
**Code : ZOO-MIN-03**
**Nature of the Course : MINOR-III**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Discuss the anatomy of different systems in Vertebrates
2. Analyze the structural modifications in anatomy of different groups

Learning Outcomes:

- Describe the anatomy of different systems in Vertebrates
- Compare the structural modifications in anatomy of different groups

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | | |
| Procedural | | | CO2 | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

- One internal examination (theory)
- One internal examination (Lab)
- Viva-voce/Group discussion /Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | TOTAL |
|---|---|---|---|---|---|
| 1 | **Integumentary System:** Structure, functions and derivatives of integument | 8 | 1 | - | 9 |
| 2 | **Skeletal System:**<br>Overview of axial and appendicular skeleton, Visceral arches | 8 | 1 | - | 9 |
| 3 | **Digestive System and Urinogenital System**<br>Alimentary canal and associated glands, dentition Succession of kidney, Types of mammalian urinogenital system | 8 | 1 | - | 9 |
| 4 | **Respiratory System:**<br>Skin, gills, lungs and air sacs; Accessory respiratory organs<br>General plan of circulation, evolution of heart | 8 | 1 | - | 9 |
| 5 | **Nervous System and Sense Organ**<br>Comparative account of brain<br>Autonomic nervous system,<br>Brief account of visual and auditory receptors in man | **8** | **1** | **-** | **9** |
| 6 | **Lab Course:**<br>1. Dissection of fish (carp) to study efferent and afferent branchial system(subject to permission)<br>2. Study of placoid, cycloid and ctenoid scales through permanent slides /photographs<br>*3.* Study of Disarticulated skeleton of Frog, *Varanus, Fowl,Rabbit*<br>4. Study of Mammalian skulls: One herbivorous and one carnivorous animal<br>5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted) | **-** | **-** | **15** | **15** |
| | **TOTAL** | **40** | **5** | **15** | **60** |

***Where,*** ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

**SUGGESTED READINGS:**


- Comparative Anatomy of Vertebrates by RK Saxena
- Anatomy of the Vertebrates by George C Kent
- Modern Textbook of Zoology by RL Kotpal

# FYUGP-ZOOLOGY

## SEMESTER III

**Title of the Course : Insect Vectors and Diseases**
**Course Code : ZOO-GEC-03**
**Nature of the Course : GEC III**
**Total Credits : 03**
**Distribution of Marks : 100 ( 60 End + 40 IA)**

**Course Outcomes:**

1. Analyze the concept of insects as vectors of diseases
2. Evaluate the general features of insects
3. Examine the role of different insects in transmission of diseases

Learning Outcomes:

- Explain the concept of insects as vectors of diseases
- Analyze insect features and their role in disease transmission

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO3 | CO2 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce
- Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examination
- Viva-voce examination
- Submission of Assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction to insects:** General features of insects; Morphological features- Head, Eyes, Antenna, Mouthparts | 6 | 1 | - | 7 |
| 2 | **Concept of Vectors:** Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity | 5 | 1 | - | 6 |
| 3 | **Insect as vectors:** Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera | 7 | 1 | - | 8 |
| 4 | **Dipterans as important insect vectors** – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Control of house fly | 8 | 1 | - | 9 |
| 5 | **Siphonaptera and Siphunculata as disease vectors**: Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas. Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever. | **8** | **1** | **-** | **9** |
| 6 | **Hemiptera as Disease vectors:** Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention Measures | **5** | **1** | **-** | **6** |
| | **TOTAL** | **39** | **6** | **-** | **45** |

***Where, L: Lectures T: Tutorials P: Practicals***

**SUGGESTED READINGS:**


- Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge,University Press, UK
- Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication.
- Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

## FYUGP-ZOOLOGY

### SEMESTER III

**Title of the Course : Vermicomposting**

**Course Code : ZOO-SEC-03-A**
**Nature of the Course : SEC III a**
**Total Credits : 03**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1) describe the biology of some important species of earth worms used in vermiculture
2) demonstrate skills on production of vermicompost.
3) analyze benefits and problems with vermiculture and vermicompost

**Learning Outcome:**

1) identify the earthworm species used in vermiculture
2) understand the benefit of vermiculture
3) display the skill of vermicompost production
4) interpret the problems associated with the vermicomposting technique

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | | | |
| Procedural | | | CO2 | CO3 | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

1. One internal examination (Theory)
2. Practical exam and Viva-voce
3. Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNIT | CONTENTS | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Introduction to vermiculture**<br>Vermiculture - definition, meaning, history, economic importance, value in maintenance of soil structure, role as four r's of recycling (reduce, reuse, recycle and restore), Role in bio transformation of the residues generated by human activity and production of organic fertilizers, Useful species of earthworms, local and exotic species of earthworms | 7 | - | - | 7 |
| 2 | **Biology of certain important earthworm native to NE India**<br>Taxonomy Anatomy, physiology and reproduction of Lumbricidae. Vital cycle: alimentation,fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors). | 8 | - | - | 8 |
| 3 | **Process of Vermicomposting**<br>Small scale earthworm farming for home gardens - earthworm compost for home gardens<br>Conventional commercial composting - earthworm composting larger scale (pit, brickand, heap systems) Earthworm farming, extraction (harvest), vermicomposting harvest and processing. Vermiwash collection, composition and use.<br>Enemies of earthworms, sickness and worm's enemies; frequent problems – prevention and fixation. | 7 | 1 | - | 8 |
| 4 | **Applications of vermiculture**<br>Benefits of vermicompost, Use of vermicompost in agriculture,Basic characteristics of earthworm suitable for vermicomposting,Problems in vermicomposting, vermicomposting of dairy waste. | 6 | 1 | - | 7 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | **Lab Course:**<br><br>1. Key to identify different types of earthworms.<br>2. Study of Life stages & development o f earthworms.<br>3. Study of Vermiculture, Vermiwash& Vermicompost equipments, devices.<br>4. Preparation vermibeds, maintenance o f vermicompost & climatic conditions.<br>5. Study of verms diseases & enemies<br>6. Field trip- collection of native earthworms & their identification | **-** | **-** | **15** | **15** |
| | TOTAL | **28** | **2** | **15** | **45** |

**SUGGESTED READINGS**


- Vermitechnology by A. Mary Violet Christy
- A textbook of Vermicompost by Keshav Singh
- The worm farmer's handbook by Rhonda Sherman
- Vermicomposting Principles, practice and benefits by Maximallian Schiller
- Vermiculture and Organic farming by TV Sathe
- Vermicompost production by Dr. S Rehan Ahmad
- Commercial vermiculture by Peter Bogdanov

## FYUGP-ZOOLOGY

### SEMESTER III

**Title of the Course : Medical Diagnostics**
**Course Code : ZOO-SEC-03-B**
**Nature of the Course : SEC III b**
**Total Credits : 03**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Analyze the concept of medical diagnostics
2. Compare the basic diagnostic tools and techniques.
3. Examine biological samples

Learning Outcomes:

- Understand the concept of medical diagnostics
- Distinguish between various diagnostic methods

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | | |
| Procedural | | | | CO2 | CO3 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment:**

1. One internal examination –Theory and Practical
2. Viva-voce
3. Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total |
|---|---|---|---|---|---|
| 1 | **Introduction to Medical Diagnostics:** Importance of medical diagnostics.Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.). | 5 | 1 | - | 6 |
| 2 | **Urine Analysis:** Physical characteristics; Abnormal constituents Tumours: Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, MRI and CT Scan (using photographs). | 10 | 2 | - | 12 |
| 3 | **Non-infectious diseases:** Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit<br>Infectious diseases: Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis | 10 | 2 | - | 12 |
| 4 | **Lab Course:**<br>1. Introduction to various tools involved in medical diagnosis<br>2. Determination of sugar in urine and blood<br>3. Determination of erythrocyte sedimentation rate<br>4. Study of ECG (PQRS)<br>5. Study of heart functioning<br>6. Whole blood count.<br>7. Urea estimation in urine. | - | - | 15 | 15 |
| | TOTAL: | 25 | 5 | 15 | 45 |

**SUGGESTED READINGS**


- Park, K. (2007), *Preventive and Social Medicine*, B.B.Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani PublishingHouse
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for TrainingCourses*
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*,Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition,Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co.Ltd.

# FYUGP-ZOOLOGY

## SEMESTER IV

**Title of the Course : Biochemistry**

**Course Code : ZOO-C-05**
**Nature of the Course : CORE V**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. differentiate the biomolecules of living organisms, their interactions for perpetuation of life
2. analyze structure-function relationships of nucleic acids and protein
3. distinguish between replication, transcription and translation in prokaryotes and eukaryotes and interpret the gene expression mechanisms
4. Evaluation of biochemical constituents

Learner Outcome:

1) identify the various biomolecules and understand their function
2) differentiate the cellular processes such as replication, transcription and translation
3) understand gene expression mechanism

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2, CO3 | | |
| Procedural | | | | | CO4 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| CO4 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.5 | 1.5 | 1.5 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

1. Internal examination
2. Viva-voce/Group discussion/Home assignments

Attainment strategy of COs**:**

1. Continuous evaluation through in and end semester examinations
2. Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction to Biochemistry:** Chemical basis of life, functional groups, types of chemical bonds and biomolecules in biological systems; pH, buffer solution; Laws of thermodynamics, concept of free energy, energy coupling reactions, ATP as energy currency molecule, redox reactions, and concept of Electron Transport Chain. | 7 | 1 | - | 8 |
| 2 | **Proteins:** Classification and functions of proteins. structural organisation of protein and protein stabilising bonds. Protein denaturation and renaturation. Amino acids, properties, and functions. Peptide bonds and peptide groups<br>Catabolic reactions of amino acids (Transamination, oxidative deamination and decarboxylation, Urea cycle). | 10 | 2 | - | 12 |
| 3 | **Carbohydrates:** Structure, classification, and biological functions. Catabolic pathways of carbohydrate (Glycolysis, Krebs cycle, Pentose phosphate pathway, gluconeogenesis, glycogen metabolism)<br>**Lipids:** Structure, classification, and biological functions; storage and membrane lipids, lipoprotein. Fatty acids: classification; saturated, unsaturated; essential and non-essential fatty acids. beta-oxidation of fatty acids. | 11 | 2 | - | 13 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | **Enzymes:**<br>Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis-Menten equation, enzyme inhibition and factors affecting enzyme activity. | 10 | 2 | - | 12 |
| 5 | **Lab Course:**<br>1. Preparation of different biochemical solutions, dilutions, preparation of buffer solution.<br>2. Qualitative tests of functional groups in carbohydrates, proteins and lipids.<br>3. Paper chromatography of amino acids.<br>4. Action of salivary amylase under optimum conditions.<br>5. Effect of pH, temperature and inhibitors on the action of salivary amylase.<br>6. Demonstration of proteins separation by SDS-PAGE (theoretically). | - | - | 15 | 15 |
| | | 38 | 7 | 15 | 60 |

**SUGGESTED READING**


- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition,
- W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson

# FYUGP-ZOOLOGY

## SEMESTER IV

**Title of the Course : Animal Physiology**

**Course Code : ZOO-C-06**
**Nature of the Course : CORE VI**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Describe the different systems of vertebrates
2. Distinguish between the mechanisms of various physiological systems
3. Examine the body parameters based on the knowledge

**Learning outcomes:**

- Compare the various physiological systems
- Analyze the mechanisms involved in the systems
- Apply the knowledge to correlate various parameters of the body

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2 | | |
| Procedural | | | | | CO3 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/ Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

## FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Digestive System, Urinogenital System and Excretory System**<br>Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of enzyme secretion in Gastrointestinal tract.<br>Structure of kidney and its functional unit; Mechanism of urine formation | 12 | 2 | - | 14 |
| 2 | **Respiratory System**<br>Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves ($O_2$ and $CO_2$) and the factors influencing it. | 8 | 1 | - | 9 |
| 3 | **Blood and Cardiovascular System**<br>Components of blood and their functions; Structure and functions of haemoglobin Haemostasis, Blood clotting system, Haemopoiesis, Blood groups: Rh factor, ABO and MN system of blood grouping.<br>Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses, Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram. | 12 | 1 | - | 13 |
| 4 | **Reproductive system**<br>Histology of testis and ovary; comparative structure of male and female reproductive system, physiology of reproduction in human, puberty, menstrual cycle. Methods of contraception in male and female, pregnancy and lactation | **8** | **1** | **-** | **9** |
| 5 | **Lab course:**<br>1. Determination of Blood groups<br>2. RBC Count and WBC count<br>3. Study permanent slides of Ovary and Testes.<br>4. Preparation of haemin and hemochromogen crystal from fish/mammals | **-** | **-** | **15** | **15** |
| | | **40** | **5** | **15** | **60** |

**Suggested Readings**


- Hall and Hall, 2020, Guyton and Hall Textbook of Medical Physiology, 14th Edition, ISBN:13:978-0323597128
- Barett et al., 2019, Ganong's Review of Medical Physiology, 26th Edition, ISBN:13:978-1260122404
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- Kenneth, S. Saladin, 2017, Anatomy and Physiology: The Unity of Form and Function, 8th Edition, ISBN:13:978-1259277726

## FYUGP-ZOOLOGY

### SEMESTER IV

**Title of the Course : Genetics and Evolutionary Biology**
**Course Code : ZOO-C-07**
**Nature of the Course : CORE VII**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1) Interpret the basic patterns of inheritance
2) Evaluate genetic disorders and mutations
3) Relate evolutionary forces leading to the variations and diversification of species
4) Examine evidences ranging from fossil records to molecular data and to establish phylogenetic relationships of species.

**Learning Outcome:**

1) Understand the concept of inheritance
2) Analyze mutations and genetic disorders
3) Examine forces of evolution
4) Interpret evidences of evolution

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | | |
| Procedural | | | | CO3, CO4 | CO2 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| CO4 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.5 | 1.5 | 1.5 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Mendelian Genetics and its Extensions**<br>Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, penetrance and expressivity, Epistasis, Phenocopy, Pleiotropy, Polygenic Inheritance, Sex-linked, Sex- influenced, and Sex-limited characters inheritance and sex determination. | 9 | 1 | - | 10 |
| 2 | **Linkage, Crossing Over and ChromosomeMapping and sex determination**<br>Linkage and crossing over, Cytological basis of crossing over, Recombination frequency as a measure of linkage intensity, two-factor and three-factor crosses, Linkage map, Coefficient of Coincidence and Interference, Gene mapping<br>Basis of sex determination: Genetic and environmental; Sex determination human; Mechanism of dosage compensation. Comparison of nuclear and extranuclear inheritance, maternal effects with examples. | 9 | 1 | - | 10 |
| 3 | **Chromosomal and gene mutation and Extra-chromosomal Inheritance**<br>Types of gene mutations, Mutagens: Physical and chemical, molecular basis of spontaneous and induced mutations, Chromosomal aberrations: Structural Variations in chromosomes, Aneuploidy & Polyploidy. Transposons and its significance | 9 | 1 | - | 10 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | **Evolutionary Concepts and Beginning of Life and Evidences of Evolution:** Lamarckism, Darwinism, Neo-Darwinism, Chemogeny, RNA world, biogeny, endo-symbiotic theory, geological time scale; phylogeny of horse; Molecular Evolution<br>**Process and Product of Evolution:** Variations: Heritable variations and their role in evolution; Natural selection, types of natural selection, adaptive resemblances, sexual selection, frequency dependent selection; Hardy-Weinberg law , genetic drift(founder's effect, bottleneck phenomenon), migration and mutation (genetic load); Speciation: micro- evolutionary changes, species concept, isolating mechanisms; Mass extinctions (events, causes and effects). | 13 | 2 | - | 15 |
| 5 | **Lab course:**<br>1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.<br>2. Study of Human Karyotypes (normal and abnormal) by pictorial demonstration.<br>3. Pedigree analysis of some human inherited traits<br>4. Preparation of Polytene chromosomes from Chironomous / Drosophila larvae<br>5. Study of fossils (types, forms and dating) from models/pictures<br>6. Study of homology, analogy and homoplasy from suitable specimens | - | - | 15 | 15 |
| | | 40 | 5 | 15 | 60 |

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**Suggestive readings**


- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming
- Pierce, B. A. (2012). Genetics-A Conceptual Approach. IV Edition. W. H. Freeman and Company
- Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, Sean B. Carroll (2007). Introduction to Genetic Analysis. 9th Edition. W H Freeman.
- Roberts, A. (2018) Evolution: the human story, Dorling, Kindersley Ltd.
- Hall, B.K. and Hallgrimson, B. (2013). Evolution. V Edition, Jones and Barlett Publishers.
- Barton N.H., Briggs D.E.G., Eisen J.A., Goldstein D.B. and Patel N.H., (2007) 1st Ed. Evolution, Cold Spring Harbor Laboratory Press.

# FYUGP-ZOOLOGY

**SEMESTER IV**

**Title of the Course : Molecular Biology**
**Course Code : ZOO-C-08**
**Nature of the Course : CORE VIII**
**Total Credits : 4**
**Distribution of Marks : 100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)]**

**COs:**

1. Analyze biochemical solutions
2. Estimation of DNA
3. Examine the principles of gene interactions
4. Differentiate between various fossils, homologous and analogous organs
5. Distinguish between blood groups and analyze blood parameters

**Learning Outcome:**

- Compare biochemical solutions
- Analyze DNA
- Discuss the principles of gene interactions
- Compare between various fossils, homologous and analogous organs
- Understand the blood groups and test blood parameters

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO3, CO4 | | |
| Procedural | | | | | CO2, CO5 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| CO4 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO5 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.4 | 1.6 | 6 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

## FYUGP-ZOOLOGY

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments
- Submission of practical record book

| UNIT | CONTENT | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Nucleic acids:**<br>Types and functions of DNA, RNA; constituent monomers (nucleotides and nucleoside), DNA as genetic material, Structure of DNA and tRNA | 7 | 1 | - | 8 |
| 2 | **DNA replication:**<br>Chemistry of replication, DNA polymerases, synthesis of leading and lagging strands | 8 | 2 | - | 10 |
| 3 | **Transcription and Operon Concept:**<br>Introduction to Prokaryotic and eukaryotic transcription.<br>Types of RNA polymerases, structure of transcription unit, initiation, elongation, and termination.<br>Operon Concept: *lac* and *trp* operons in bacteria | 10 | 2 | - | 12 |
| 4 | **Translation:** Concept of Genetic code, Translation in prokaryotes and eukaryotes: Ribosome, tRNA, amino-acyl t R N A synthetases, translation-initiation, elongation, termination, and ribosome recycling.<br>**rDNA technology:** Concept of Recombinant DNA technology and gene cloning | 13 | 2 | - | 15 |
| 5 | **Lab Course:**<br>1. Estimation of DNA by Diphenylamine method<br>2. Quantitative estimation of RNA by Orcinol method<br>3. Study of DNA replication mechanisms through photographs (rolling circle, theta replication, and semi-discontinuous replication)<br>4. Study of steps of genetic engineering for production of Bt-cotton, golden rice, Flavr Savr tomato through photographs | - | - | 15 | 15 |
| | | 38 | 7 | 15 | 60 |

**Suggested Readings:**


- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

# FYUGP-ZOOLOGY

## SEMESTER IV

**Title of the Course** : **Animal Physiology -Minor**
**Course Code** : **ZOO-MIN-04**
**Nature of the Course** : **Minor -IV**
**Total Credits** : **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Lab: 15) + 40 IA (30 + 10 Lab)**

**COs:**

1. Describe the different systems of vertebrates
2. Distinguish between the mechanisms of various physiological systems
3. Examine the body parameters based on the knowledge

**Learning outcomes:**

- Compare the various physiological systems
- Analyze the mechanisms involved in the systems
- Apply the knowledge to correlate various parameters of the body

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2 | | |
| Procedural | | | | CO3 | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

## FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Digestive System, Urinogenital System and Excretory System**<br>Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of enzyme secretion in Gastrointestinal tract.<br>Structure of kidney and its functional unit; Mechanism of urine formation | 12 | 2 | - | 14 |
| 2 | **Respiratory System**<br>Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves ($O_2$ and $CO_2$) and the factors influencing it. | 8 | 1 | - | 9 |
| 3 | **Blood and Cardiovascular System**<br>Components of blood and their functions; Structure and functions of haemoglobin Haemostasis, Blood clotting system, Haemopoiesis, Blood groups: Rh factor, ABO and MN system of blood grouping.<br>Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses, Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram. | 12 | 1 | - | 13 |
| 4 | **Reproductive system**<br>Histology of testis and ovary; comparative structure of male and female reproductive system, physiology of reproduction in human, puberty, menstrual cycle. Methods of contraception in male and female, pregnancy and lactation | **8** | **1** | **-** | **9** |
| 5 | **Lab course:**<br>1. Determination of Blood groups<br>2. RBC Count and WBC count<br>3. Study permanent slides of Ovary and Testes.<br>4. Preparation of haemin and hemochromogen crystal from fish/mammals | **-** | **-** | **15** | **15** |
| | | **40** | **5** | **15** | **60** |

**Suggested Readings**


- Hall and Hall, 2020, Guyton and Hall Textbook of Medical Physiology, 14th Edition, ISBN:13:978-0323597128
- Barett et al., 2019, Ganong's Review of Medical Physiology, 26th Edition, ISBN:13:978-1260122404
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- Kenneth, S. Saladin, 2017, Anatomy and Physiology: The Unity of Form and Function, 8th Edition, ISBN:13:978-1259277726

# FYUGP-ZOOLOGY

## SEMESTER V

**Title of the Course** : **Developmental Biology**
**Course Code** : **ZOO-C-09**
**Nature of the Course** : **CORE IX**
**Total Credits** : **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Practical: 15) + 40IA(30+10Lab)]**

**COs**:

1. Understand and analyse the basic principles and concepts in the developmental processes from a single cell system to a multi-cellular system
2. Distinguish the embryonic and post embryonic developmental processes
3. Analyze the developmental process of a single fertilized egg into a fully developed complex organism

Learning Outcome:

- Describe developmental processes of animal system
- Compare various embryonic developmental processes

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1,CO2 | | |
| Procedural | | | CO3 | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.1 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.1 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2.0 |
| AVERAGE | 3.0 | 2.2 | 2.2 | 1.7 | 1.7 | 1.7 | 1.7 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- One Theory Internal examination
- One Practical Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction**<br>Historical perspectives and basic concepts: Phases of development, Pattern formation, Differentiation and growth, Cytoplasmic determinants and asymmetric cell division | 10 | 1 | - | 11 |
| 2 | **Early Embryonic Development**<br>Gametogenesis: oogenesis, spermatogenesis; Types of eggs, Egg membranes;<br>Fertilization (External and Internal), Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps; Gastrulation in frog and chick, Embryonic induction and organizers. | 10 | 1 | - | 11 |
| 3 | **Late Embryonic Development**<br>Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, structure, types, and functions of placenta. | 10 | 1 | - | 11 |
| 4 | **Post Embryonic Development**<br>Metamorphosis and its hormonal regulation in amphibians and insects; Regeneration: brief concept of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: concepts and theories. Teratogenesis: Teratogenic agents and their effects on embryonic development. | 10 | 2 | - | 12 |
| 5 | **Lab Course**<br>1. Study of whole mounts and sections of developmental stages of Amphibia through permanent slides: Cleavage stages, blastula, gastrula, neurula.<br>2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours, Stage 7- 24 hours, Stage 8-28 hours, Stage10-33 hours, Stage 11-40 hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation.<br>3. Model/chart preparation on embryonic development in insect/fish/amphibia/chick. | **-** | **-** | **15** | **15** |
| | | **40** | **5** | **15** | **60** |

**Suggested readings**


- Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley- Blackwell.
- Gilbert, S. F. (2010) Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA
- Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.
- Balinsky B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.

# FYUGP-ZOOLOGY

## SEMESTER V

**Name of course.** : **Animal Behaviour and Chronobiology**
**Nature of the Course** : **CORE X**
**Course Code** : **ZOO-C-10**
**Total Credits** : **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10Lab)]**
**Course outcomes:**

1. Analyze behaviour patterns in the brain, genes, and hormones, as well as the surrounding ecological and social environments
2. Interpret the concept of chronobiology.
3. Evaluate the phenomena of seasonal migration and hibernation

Learning Outcomes:

- Distinguish various behaviour patterns of animals
- Understand chronobiology concept
- Analyze different behaviours such as migration and hibernation

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1, CO2 | | |
| Procedural | | | CO3 | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination (Theory and practical)
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction to Animal Behaviour**<br>Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour | 10 | 1 | - | 11 |
| 2 | **Patterns of Behaviour and Communication**<br>Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, Habituation, Imprinting. Importance of communication; Role of Chemical, Tactile, Auditory, Visual stimuli in communication. | 10 | 1 | - | 11 |
| 3 | **Social and Sexual Behaviour**<br>Concept of Society, Social insect, bee communication and the senses; Altruism, Hamilton Rule, Sexual Behaviour: Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care. Aggressive behaviour. | 10 | 1 | - | 11 |
| 4 | **Introduction to Chronobiology**<br>Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Photoperiod and insects.Relevance of biological clocks; Chronomedicine, Chronotherapy. | 10 | 2 | - | 12 |
| 5 | **Lab Course**<br>**1.** To study nests and nesting behaviour of the birds and social insects.<br>**2.** To study the taxis behaviour in insect larvae.<br>**3.** To study colouration pattern in fishes.<br>**4.** To study habituation in mosquito larvae<br>**5.** Observation of animal architects: Termites, wasp, Harvester ant and any bird. | **-** | **-** | **15** | **15** |
| | | **40** | **5** | **15** | **60** |

**Suggestive Readings:**


- Alcock, J. (2013) Animal Behaviour, Xth Edition, Sinauer Associates Inc., USA.
- Manning, A. and Dawkins, M. S, (2012) An Introduction to Animal Behaviour, VIth Edition, Cambridge University Press, UK
- McFarland, D. (1985) Animal Behaviour, Pitman Publishing Limited, London, UK
- Binkley, S. (2020). Biological clocks: Your owner's manual. CRC Press.
- Vinod Kumar (2017): Biological Timekeeping: Clocks, Rhythms and Behaviour.

# FYUGP-ZOOLOGY

## SEMESTER V

**Title of the Course : Basic Microbiology and Vector Borne Diseases**
**Course Code : ZOO-C-11**
**Nature of the Course : CORE XI**
**Total Credits :04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10 Lab)]**

**COs:**

1. Describe the principle and practices in microbiology .
2. Explain the basic concept of vector-borne diseases
3. Describe different measures for the prevention and control of vector-borne diseases

Learning Outcomes:

- Discuss the basic concept of microbiology
- Discuss and analyse the different aspects of vector-borne diseases along with its preventive and control measures.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO2 | | |
| Procedural | | | CO1, CO3 | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Basics in Microbiology**<br>Introduction to study of Microbiology, role of microorganisms in disease, Development of Koch's postulate, Classification and characterisation of microbes, culture media, microbial growth curve, uncultured microbes; Structure and classification of viruses | 11 | 1 | | 12 |
| 2 | **Introduction to Insects**<br>General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits | 5 | 1 | - | 6 |
| 3 | **Concept of Vectors**<br>Brief introduction of Carrier and Vectors, Reservoirs, Host-vector relationship. Principles of vector control. | 6 | 1 | - | 7 |
| 4 | **Insects as vectors**<br>Classification of insects up to Orders, Detailed features of Orders of insect vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera<br>Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, encephalitis, symptoms and transmission.<br>Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; symptoms and transmission.<br>Study of house fly and bed bugs as vector,<br>Study of Flea-borne diseases –Plague, Typhus fever; Symptoms, transmission.<br>Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Symptoms, transmission. | 11 | 2 | - | 13 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | **Lab Course**<br>1. Gram staining of Bacteria<br>2. Preparation of liquid culture medium (LB) and inoculation<br>3. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking<br>4. Study of different kinds of mouth parts of insects<br>5. Study of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica*, through permanent slides/ photographs. | - | - | 15 | 15 |
| | | 40 | 5 | **15** | **60** |

**Suggested Readings**

1. Willey, J., Sherwood, L. and WoolvertonC., Microbiology, 10th edition (McGraw-Hill Science, 2017).
2. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R., Microbiology, Publisher McGraw Hill Education (India) Private Limited, ISBN-10 0074623206, 5th Edition, 2001.
3. Tortora, G.J., Fernke, B.R. and Case, C.L., Microbiology – An Introduction, 9th Edition
4. Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
5. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
6. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication
7. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

## FYUGP-ZOOLOGY

### SEMESTER V

**Title of the Course : Developmental Biology-Minor**
**Course Code : ZOO-MIN-05**
**Nature of the Course : MINOR**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40IA (30+10Lab)]**

**COs**:

1. Understand and analyse the basic principles and concepts in the developmental processes from a single cell system to a multi-cellular system
2. Distinguish the embryonic and post embryonic developmental processes
3. Analyze the developmental process of a single fertilized egg into a fully developed complex organism

Learning Outcome:

- Describe the developmental processes of animal system
- Compare various embryonic developmental processes

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | CO2,CO3 | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.1 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.1 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2.0 |
| AVERAGE | 3.0 | 2.2 | 2.2 | 1.7 | 1.7 | 1.7 | 1.7 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- One Theory Internal examination
- One Practical Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments
- Submission of practical record book

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction**<br>Historical perspectives and basic concepts: Phases of development, Pattern formation, Differentiation and growth, Cytoplasmic determinants and asymmetric cell division | 10 | 1 | - | 11 |
| 2 | **Early Embryonic Development**<br>Gametogenesis: oogenesis, spermatogenesis; Types of eggs, Egg membranes;<br>Fertilization (External and Internal), Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps; Gastrulation in frog and chick, Embryonic induction and organizers. | 10 | 1 | - | 11 |
| 3 | **Late Embryonic Development**<br>Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, structure, types, and functions of placenta. | 10 | 1 | - | 11 |
| 4 | **Post Embryonic Development**<br>Metamorphosis and its hormonal regulation in amphibians and insects; Regeneration: brief concept of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: concepts and theories. Teratogenesis: Teratogenic agents and their effects on embryonic development. | 10 | 2 | - | 12 |
| 5 | **Lab Course**<br>1. Study of whole mounts and sections of developmental stages of Amphibia through permanent slides: Cleavage stages, blastula, gastrula, neurula<br>2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours, Stage 7- 24 hours, Stage 8-28 hours, Stage10-33 hours, Stage 11-40 hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation<br>3. Model/chart preparation on embryonic development in insect/fish/amphibia/chick. | **-** | **-** | **15** | **15** |

| | | | | | |
|---|---|---|---|---|---|
| | | **40** | **5** | **15** | **60** |

**Suggested readings**


- Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley- Blackwell.
- Gilbert, S. F. (2010) Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA
- Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.
- Balinsky B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.

# FYUGP-ZOOLOGY

## SEMESTER VI

**Title of the Course : Controlling and Co-ordinating Physiology and Immunology**
**Course Code : ZOO-C-12**
**Nature of the Course : CORE XII**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10 Lab)]**

**COs:**

1. Examine the internal working of organs and organ systems.
2. Evaluate the functioning of various organ systems such as muscular, nervous, blood and endocrine systems in vertebrates.
3. To explain the basic principle of immunology

Learning Outcomes:

- Discuss the working of organ and organ systems
- Analyze the functioning of the various systems
- Describe the role of endocrine system
- Analyse the basic principle of Immunology

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Tissues, Bone and Cartilage**<br>Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue, Structure and types of bones and cartilages | 5 | 1 | - | 6 |
| 2 | **Muscle and Nervous system**<br>Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus<br>Types of nerves and nervous system, Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc | 10 | 1 | - | 11 |
| 3 | **Endocrine System**<br>Endocrine glands in vertebrates-pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their functions; Classification of hormones, mode of hormone action, Neuro-endocrine system and feedback mechanism. | **10** | 1 | - | **11** |
| 4 | **Overview of Immune System**<br>Cells and organs of the Immune system. Innate immunity, Adaptive immunity (Cell mediated and humoral), Passive and active Immunity. | 5 | 1 | - | 5 |
| 5 | **Antigen and Antibody**<br>**A**ntigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-cell epitopes, Stucture and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA) | 10 | 1 | - | 11 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course**<br>1. Recording of muscle twitch with electrical stimulation (or virtual)<br>2. Demonstration of the unconditioned reflex action (Deep tendon Reflex such as knee jerk relex)<br>3. Examine sections of mammalian nerves, different types of muscles, and study of permanent slides of bone, cartilage, tissues, neurons, pituitary, pancreas, adrenal, thyroid, hypothalamus and parathyroid.<br>4. Demonstration of lymphoid organs (by video)<br>5. Histological study of spleen, thymus and lymph nodes through slides/ photographs<br>6. Demonstration of ELISA | | | - | 15 |
| | | **40** | **5** | **15** | **60** |

**SUGGESTED READINGS**


- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
- Tortora, G.J. - and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander 's Human Physiology, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition,Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

# FYUGP-ZOOLOGY

## SEMESTER VI

**Title of the Course** : **Animal Ecology and Wildlife Management**
**Course Code** : **ZOO-C-13**
**Nature of the Course** : **CORE XIII**
**Total Credits** : **04**
**Distribution of Marks** : **100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10 Lab)**

**COs:**

1. Describe the ecological principles and processes.
2. To explain concepts, evaluate environmental parameters and skills related to wildlife conservation and management.

Learning Outcomes:

- Discuss ecological principles and processes.
- Examine the essential elements, concepts and skills related to wildlife conservation and management.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | | |
| Procedural | | | CO2 | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

## FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction to ecology**<br>Definitions; ecology, habitat, ecozone, biosphere, ecosystems resistance and resilience, autecology, synecology, biome Liebig's law of minimum, Shelford's law of tolerance, ecotype ecological niche. | 8 | 1 | - | 9 |
| 2 | **Ecology of populations and community**<br>Concept of population, metapopulation; characteristics population; density, dispersion, natality, mortality, life ta survivorship curve, age structure, population growth, limits population growth, population interactions; parasitism, mutual commensalism, symbiosis, Community characteristics: spe richness, dominance, diversity, abundance | 8 | 1 | - | 9 |
| 3 | **Ecosystem ecology**<br>Concept of ecosystem; structure and function of ecosyst producer, consumers, decomposers, energy flow, food chain, f web and ecological pyramids. | 8 | 1 | - | 9 |
| 4 | **Introduction to wildlife and its management**<br>Values of wildlife; threats, conservation ethics, importance conservation, world conservation strategies<br>Habitat analysis; physical parameters; topology, geology, soil water; biological parameters; food, cover, forage, browse and c estimation, basics of remote sensing and GIS, HIS, CDI, SDI. | 8 | 1 | - | 9 |
| 5 | **Protected sites and management**<br>Important features of protected areas in India, National parks an sanctuaries, community reserves and Tiger Reserve.Setting back succession, grazing, logging; mechanical treatment; advancing t successional process. Preservation of general; genetic diversity; ecological restoration. | 8 | 1 | - | 9 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course**<br>1. Demonstration of basic equipment needed in wild life stuc by pictures.<br>2. Study of an aquatic ecosystem: Phytoplanktonandzooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's metho<br>3. Study on Symbiosis in (Termite andTrychonympha,hermitc and sea anemone)-virtual.<br>4. Study of Camouflage on leaf insect, chameleon.<br>5. Observationofanimalarchitects: Termites, wasp, Harvester and any bird.<br>6. Breeding and parental care in Amphibia/Fish, Rehabilitat of injured animals | | | 15 | 15 |
| | | **40** | **5** | **15** | **60** |

**Suggested Readings:**


- Ecology and Environment: P.D. Sharma, Rastogi Publications.
- Ecology (Amerind). By Odum • Fundamentals of ecology (W. B. Saunders). by Odum
- Ecology (W. H. Freeman & Co., NewYork).by R. E. Ricklefs & G. Miller.
- Environmental Science (W. B. Saunders) by Turk & Turk
- Ecology, individuals, populations and communities (Blackwell Science Oxford). By M. Begon, J. L. Harper & C. R. Townsend.
- The book of Indian animals (Oxford Univ. Press). By S. H. Prater
- Essentials of Biogeography, by H.S.Mathur, Pointer Publ. Jaipur.
- Fundamental of Ecology; SK Agarwal. Ashis Publication House, New Delhi.
- Biodiversity (Academic Press). By E. O. Wilson.

# FYUGP-ZOOLOGY

## SEMESTER VI

**Title of the Course : Bioinformatics, Biostatistics and Techniques in Biology**
**Course Code : ZOO-C-14**
**Nature of the Course : CORE XIV**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10 Lab)**

**COs:**

1. Understanding the basic concepts of bioinformatics and biostatistics
2. Use of biological databases for data retrieval
3. Examine the fundamental concepts of biostatistics and **e**valuate the significance of biological experiments
4. Investigate biological and chemical samples through the application of different tools and techniques

**Learning Outcomes:**

1. Compare computational tools and databases that facilitate investigation of molecular biology and evolution-related concepts
2. Analyze computational approach for critical analysis and interpret the results of their study.
3. Understand the fundamental concepts of biostatistics.
4. Apply the various statistical methods and software tools for understanding data analysis in biological sciences.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | CO4 | CO1,CO3 | CO2 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction to Bioinformatics** Introduction, Biological Databases, Classification of Biological Databases, Biological Database Retrieval System. National Centre for Biotechnology Information (NCBI), Protein Database, Gene Expression Database, EMBL Nucleotide Sequence Database (EMBL-Bank). DNA Data Bank of Japan (DDBJ), Data Submission at DDBJ, Protein Information Resource (PIR), Swiss-Prot. | 8 | 1 | - | 9 |
| 2 | **Sequence alignment and molecular phylogeny** Sequence analysis tools. BLAST, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino AcidSubstitution Matrix (BLOSUM).Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction. | 8 | 1 | - | 9 |
| 3 | **Introduction to Biostatistics and Statistical Data** Concept of statistics and its Applications in biological sciences, Sampling methods; Primary and secondary data; Qualitative and quantitative data; Discrete and continuous data | 8 | 1 | - | 9 |
| 4 | **Descriptive Statistics, Probability and statistical tests** Measures of Central tendency and Dispersion - Mean, Median and Mode, Variance, Standard Deviation and Standard Error; Coefficient of Variance. Normal, Binomial Skewness and Kurtosis. Null and Alternative hypotheses, t Tests, Correlation Coefficient, Confidence Intervals and Confidence levels | 8 | 1 | - | 9 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | **Techniques in Biology**<br>Microscopy and chromatographic techniques<br>Working Principle and uses of Optical Microscopy (Resolving Power, brightfield, darkfield), electron microscopy (SEM, TEM). Phase contrast microscopy. Chromatographic techniques: Paper chromatography, Thin Layer Chromatography, Column chromatography.<br>Centrifugation: Principle and types, Colorimeter, UV-Vis.Spectrophotometry,(Components, Principle and applications, Precautions ). Gel electrophoresis, Blotting techniques. DNA sequencing techniques (Sanger's sequencing). | 8 | 1 | - | 9 |
| 6 | **Lab Course**<br>1. To compute Coefficient of Variance from data collected and measure variability.<br>2. To collect data on different parameters (e.g. height/ weight) of animal/plant samples and test for significance, difference between mean, mode and median.<br>3. Retrieval of DNA, RNA, protein sequences and structures from the biological databases and to create various datasets.<br>4. Perform pairwise and multiple sequence alignments from the generated datasets in Experiment 1, using online/offline tool.<br>5. Demonstration of microscope, colorimeter, spectrophotometer, pH-meter, and autoclave.<br>6. Visualization of DNA by agarose gel electrophoresis.<br>7. Fractionation of cellular components using centrifugation.<br>8. Separation of amino acids by paper chromatography | - | - | 15 | 15 |
| | | **40** | **5** | **15** | **60** |

**Suggested Readings**


- Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.
- Date C.J, "An Introduction to Database", Addison-Wesley Pub Co, 7th Edition, 2001
- Elmashri& Navathe, "Fundamentals of Database System", Addison-Wesley Publishing, 3rd Edition, 2000
- Jhonson RA et al. (2015) Miller &Freund's probability and statistics for engineers.
- Ross S (2018) Introduction to probability and statistics for engineers and scientists.
- Fundamentals of Biostatistics by Bernard Rosner Publisher: Cengage Learning; 7 edition
- Biophysical Chemistry: Principles and Techniques. Upadhyay, Upadhyay and Nath. Himalaya Publishing House. ISBN: 978-93-5142-227-3
- Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular Biology. Andreas Hofmann (Editor), Samuel Clokie (Editor). ISBN: 978-1316614761
- Biological Instrumentation & Methodology. Bajpai P.K. ISBN: 978-8121926331

# FYUGP-ZOOLOGY

## SEMESTER VI

**Title of the Course** : **Animal Taxonomy and Systematics**
**Course Code** : **ZOO-C-15**
**Nature of the Course** : **CORE-XV**
**Total Credits** : **04**
**Distribution ofMarks** : **100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10 Lab)**

**COs:**

1. Discuss the concept of taxonomy, identification keys and characters
2. Demonstrate taxonomic relations
3. Analyze molecular taxonomy and phylogeny
4. Evaluate taxonomic keys for identification and classification

**Learning Outcome:**

- Understand taxonomic keys and characters for identification of species
- Apply molecular taxonomy and classical tools for classification of organisms

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO1 | | | | |
| Procedural | | | CO2 | CO3 | CO4 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.0 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.0 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2.0 |
| AVERAGE | 2 | 2 | 2 | 2 | 2 | 2 | 2 | |

3 for the highest correlation,2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments
- Submission of practical record book

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Introduction**<br>Animal Taxonomy and systematics: Taxon and Phenon, Chemotaxonomy, cytotaxonomy and molecular taxonomy. Taxonomic categories. Taxonomic keys. Taxonomic characters- morphological, behavioural, ecological and geographical. | 10 | 2 | - | 12 |
| 2 | **Species Concept**<br>Species concept- Typological, nominalistic, biological and evolutionary. Mechanism of speciation. | 9 | 1 | - | 10 |
| 3 | **Zoological Nomenclature**<br>International Code of Zoological Nomenclature (ICZN), Principles, functions and importance of Code of nomenclature, principle of priority, homonymy and synonmymy, principle of typification and use of types for specimens. | 10 | 1 | - | 11 |
| 4 | **Phylogeny**<br>Characters (ancestral vs derived), homology and analogy, parallelism and convergence, monophyly, polyphyly, paraphyly; representing phylogenies- Rooted and unrooted phylogenetic trees; clades, cladograms and Phenograms. | 11 | 1 | - | 12 |
| 6 | **Lab Course**<br>1. To identify and distinguish species of insects/ fishes/amphibians/reptiles/birds using appropriate taxonomic keys.<br>2. Morphometry and meristic study of fish.<br>3. Preparation and study of skeleton of fish.<br>4. Preparation, Mounting and stuffing of Indian Major Carps.<br>5. To identify cryptic, sympatric, allopstric species.<br>6. To study/demonstrate molecular taxonomic variation using RFLP/ RAPD.<br>7. To perform/demonstrate DNA barcoding of insect/fish species. | - | - | 15 | 15 |
| | | **40** | **5** | **15** | **60** |

**Suggested Readings:**


- Kapoor VC (2019). Theory and practice of animal taxonomy, 8th Edition, Oxford and IBH Publishing

- Simpson GG (2012). Principles of Animal taxonomy, Scientific Publishers.
- Mayr E (2022). Principles of Systematic Zoology, United Book prints

# FYUGP-ZOOLOGY

## SEMESTER VI

**Title of the Course : Controlling and Co-ordinating Physiology and Immunology-Minor**
**Course Code : ZOO-MIN-06**
**Nature of the Course : MINOR-VI**
**Total Credits : 04**
**Distribution of Marks :100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10 Lab)**

**COs:**

1. Examine the internal working of organs, organ systems and immune system.
2. Evaluate the functioning of various organ systems such as muscular, nervous, blood, and endocrine system in vertebrates.
3. Explain the importannce of antigens and immunoglubulins .

Learning Outcomes:

- Discuss the working of organ, organ systems and immune system
- Analyze the functioning of the various systems
- Describe the role of antigens and immunoglobulins

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

## FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Tissues, Bone and Cartilage**<br>Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue, Structure and types of bones and cartilages | 5 | 1 | - | 10 |
| 2 | **Muscle and Nervous system**<br>Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus<br>Types of nerves and nervous system, Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc | 10 | 1 | - | 15 |
| 3 | **Endocrine System**<br>Endocrine glands in vertebrates-pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their functions; Classification of hormones, mode of hormone action, Neuro-endocrine system and feedback mechanism. | 10 | 1 | - | 14 |
| 4 | **Overview of Immune System**<br>Cells and organs of the Immune system. Innate immunity, Adaptive immunity (Cell mediated and humoral), Passive and active Immunity. | 5 | 1 | - | 5 |
| 5 | **Antigens and Immunoglobulins**<br>Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA). | 10 | 1 | - | 12 |
| 6 | **Lab Course**<br>1. Recording of muscle twitch with electrical stimulation (or virtual)<br>2. Demonstration of the unconditioned reflex action (Deep tendon Reflex such as knee jerk relex)<br>3. Examine sections of mammalian nerves, different types of muscles, and study of permanent slides of bone, cartilage, tissues, neurons, pituitary, pancreas, adrenal, thyroid, hypothalamus and parathyroid.<br>4. Demonstration of lymphoid organs (by video)<br>5. Histological study of spleen, thymus and lymph nodes through slides/ photographs<br>6. Demonstration of ELISA | - | - | 15 | 15 |

| | | | | | |
|---|---|---|---|---|---|
| | | **40** | **5** | **15** | **60** |

**SUGGESTED READINGS**


- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
- Tortora, G.J. - and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander 's Human Physiology, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition,Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

## FYUGP-ZOOLOGY

**Semester VII**

**Title of the Course : Environmental Biology**
**Course Code : ZOO-C-16**
**Nature of the Course: CORE XVI**
**Total Credits : 04**
**Distribution of Marks: 100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10Lab)**

**COs:**

1. Analyze ecological concepts and population dynamics
2. Evaluate environmental issues
3. Evaluate legislative measures and strategies for achieving SDGs.

Learning Outcomes:

- Apply concepts of ecology to understand issues
- Analyze problems and legislative measures
- Apply strategies for SDG

**Mapping of CO with Bloom Taxonomy**

| Knowlege Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2,CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination,
- Viva-voce/Home assignments,

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations,
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total **Hours** |
|---|---|---|---|---|---|
| 1 | **Scope of ecology;** concepts of ecological factors; Ecosystem dynamics and management: structure and function, energy flow concept, the productivity concept and methods of measurement of productivity; diversity, stability and complexity of ecosystem; nutrient cycling with special reference to carbon, nitrogen & phosphorus cycles | 8 | 1 | - | 9 |
| 2 | **Population dynamics:** population attributes, biotic potential and environmental resistance, population growth forms, age structure, survivorship curves, population fluctuations, interactions and regulation of population; concept of ecological niche, fundamental and realized niche; niche width and overlap; concept of meta population, demes and dispersal. | 10 | 1 | - | 11 |
| 3 | **Environmental degradation and management:** Global environmental issues (deforestation, greenhouse effect, depletion of ozone layer); Concept of EIA; Use of GPS, GIS and remote sensing in environmental management. | 7 | 1 | - | 8 |
| 4 | **Sustainable Development Goals:** India's National Action Plan on Climate Change; concept of ecotoxicology; International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols. | 8 | 1 | - | 9 |
| 5 | **Environment legislation in India:** Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Biological Diversity Act, 2002; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 | 7 | 1 | - | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course:**<br>1. To record the atmospheric temperature, relative humidity (RH), light intensity.<br>2. To study the physical and chemical characteristics of soil (C, N, content, base deficiency and pH of soil by rapid soil test method.<br>3. To determine the minimum size and number of the quadrat necessary for sampling the flora and fauna by "species - area – curve" method.<br>4. To determine the frequency, density and abundance of the primary producers of a grassland community by quadrat method.<br>5. To determine the abundance and density of soil fauna.<br>6. To determine the standing crop biomass of a grassland ecosystem by harvest method.<br>7. Basic exercise to Calculate and Assess carbon footprint/ Solid waste generation/ water consumption for a specific duration at individual/ family/ University/ locality level.<br>8. Estimation of TS, TSS and TDS of water samples.<br>9. Estimation of Turbidity, acididy, alkalinity of water samples | - | - | 15 | 15 |
| | | **40** | **5** | **15** | **60** |

**Suggested readings:**

1. Concepts of Ecology-by E.J. Karmondy
2. Ecology -by C. Krebs
3. Ecology Work Book - by R. Misra.
4. Environmental Chemistry-by A.K.Dey
5. Fundamentas of Ecology - by E.P. Odum.
6. General Animal Ecology by Ananthakrishnan, T.K.and T.R.Viswanathan (1978).
7. Climate and Plant Distribution – Woodword
8. Soil Conservation in India – Gupta & Whytri
9. Tropical Ecosystems: Ecology & Management – Shing & Singh
10. Field Biology and Ecology- Benthon & Weaver
11. Environmental Pollution – S.M. Shafi.
12. Remote Sensing – Sahu & Solanki
13. Handbook of Agricullture – ICAR
14. Modern Concept of Ecology-by H.D. Kumar
15. Plant Ecology and Soil sciences-by Sukla and Sandal
16. Population Ecology-by M. Begon & M. Mortimer.
17. Practical methods in Plant Ecology and Environmetal Sciences- by R.K. Trivedy.

**Semester VII**

**Title of the Course : Advanced Molecular Biology**
**Course Code : ZOO-C-17**
**Nature of the Course: CORE XVII**
**Total Credits : 04**
**Distribution of Marks: 100 [60 End (Theory: 45, Practical: 15) + 40 IA(30+10Lab)]**

**COs:**

1. Understand the organization of genome in prokaryotes and eukaryotes
2. A detailed conceptual understanding of molecular processes
3. Understand how the expression of genes is regulated, the role of DNA repair and recombination

**Learning Outcomes:**

•Discuss the structural and functional organization of genomes, mechanisms of DNA replication, transcription, translation, and gene regulation in both prokaryotic and eukaryotic systems.

•Analyze the molecular mechanisms of DNA repair, recombination, and post-transcriptional/post-translational modifications, along with their significance in genome stability and cellular function.

•Describe key molecular biology techniques such as DNA/RNA isolation, PCR, electrophoresis, cloning, and gene expression analysis, and apply them in research and biotechnological applications.

**Mapping of CO with Bloom Taxonomy**

| Knowlege Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2,CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and1 for lowest correlation

**Modes of internal assessment**

- Internal examination,
- Viva-voce/Home assignments,

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations,
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Genome organisation and DNA replication**<br>Genome organisation in prokaryotes and eukaryotes, Genome complexity: C-value paradox, Structural and regulatory genes; Enzymology of DNA replication, fidelity in replication, replication of single-stranded circular DNA, end replication problem, DNA synthesis by reverse transcriptase. | 8 | 1 | - | 9 |
| 2 | **Transcription and regulation of gene expression**<br>DNA-dependent synthesis of RNA, Regulatory elements, promoter, operators; Transcription and regulation of *lac*, *trp*, and *ara* operons. Eukaryotic promoters and enhancers, Transcription factors, Activators and repressors.<br>RNA processing and splicing, Transcriptional and post-transcriptional gene silencing, ribozyme, RNA editing. Genetic imprinting, Regulatory RNAs: Ribo-switches, RNA interference, miRNA, siRNA | 10 | 1 | - | 11 |
| 3 | **Protein synthesis and degradation**<br>Genetic code and its features, the translation machinery, the structure and functions of tRNA and ribosomes. Mechanism of protein biosynthesis and its regulation, direction of chain growth. Co- and Post-translational modifications, co-translational transport and degradation of proteins. | 8 | 1 | - | 9 |
| 4 | **DNA Repair and Recombination**<br>Alteration in DNA molecule, repair of incorrect bases, DNA repair enzymes, repair of thymine dimers, recombination repair, SOS repair.<br>Recombination: homologous and non- homologous recombination, site specific recombination, Holliday structure. | 8 | 1 | - | 9 |
| 5 | **Basic methodologies of DNA and gene manipulation**<br>Cutting, separating and visualising DNA, Southern blotting, foot printing, RFLP, DNA sequencing, polymerase chain reaction. | 6 | 1 | - | 7 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | **Lab Course:**<br>**1.** Estimation of RNA in biological samples by orcinol method<br>2. Estimation of DNA in biological samples by diphenylamine method<br>3. Isolation of DNA from biological samples.<br>4. To perform Agarose gel electrophoresis for the detection of DNA<br>5. Calculate molecular mass of unknown DNA and protein fragments from gel pictures<br>6. Restriction digestion analysis of DNA (virtual/ video learning) | - | - | 15 | 15 |
| | | 40 | **5** | **15** | **60** |

**Suggested Readings**


- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G.M. and Robert E. Hausman R.E. *The Cell:A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons.Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennanA., BatesA., Turner,P. and White M. (2015).*Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

# FYUGP-ZOOLOGY

## SEMESTER VII

**Title of the Course : Advanced Cell Biology and Genetics**
**Course Code. : ZOO-C-18**
**Nature of the Course : CORE XVIII**
**Total Credits : 04**
**Distribution of Marks. : 100 [60 End (Theory: 45, Practical: 15) +40IA(30+10Lab)]**

**COs:**

1. Examine the internal structure and working of various cellular organelles.
2. Evaluate the concept of cell communication and cell signaling.
3. Explain Classical genetics and Population Genetics.

**Learning Outcomes:**

- Discuss the working of cell organelles
- Analyze the functioning cell communication and cell signaling
- Describe the concept of classical genetics and population genetics.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs

- Continuous evaluation through in and end semester examinations
- Submission of assignments

## FYUGP-ZOOLOGY

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Membrane & Cytoskeleton:**<br>Membrane structure and function: Molecular organization of plasma membrane; Membrane lipids & Membrane fluidity; Cytoskeletons elements (structure & function), dynamics of microfilaments, Role of actin & microtubule cytoskeleton in cell shape, intracellular motility, motor proteins, mitosis & locomotion, Functions of intermediate filaments. | 6 | 1 | - | 7 |
| 2 | **Cell communication, Cell cycle and Integration of cellular macromolecules**<br>General principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins; Carriers & Channel Proteins; ATP driven pumps, Aquaporins, Ion channels and electrical properties of plasma membrane;<br>neurotransmission and its regulation. Regulation of hematopoiesis<br>Phases of cell cycle, checkpoints and regulators of cell cycle progression in eukaryotes, programmed cell death, autophagy, cellular senescence, fate of cells with regard to morphogen gradients, mechanisms of cell cycle regulation; Protein sorting and transport to the endoplasmic reticulum, Golgi body and lysosomes; protein glycosylation within Golgi body and protein secretion. | 10 | 1 | - | 11 |
| 3 | **Cell signaling & Cancer biology:**<br>Key concepts on cellular signaling mechanism; Receptors, G-proteins and GTPase cycle and its regulation, G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways; bacterial and plant two component systems, light signaling in plants, Role of Calcium and NO in signal transduction.<br>Cancer: Genetic rearrangement in progenitor cells, oncogenes, tumor suppressor genes (pRB, p53, pAPC), cancer and the cell cycle, Oncogenesis; initiation, promotion, progression, cell behavior in oncogenesis, virus induced cancer, carcinogens, metastasis, interaction of cancer cell with normal cells, apoptosis, therapeutic intervention of uncontrolled cell growth. | 8 | 1 | - | 9 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | **Mendelism, Crossing Over, Mutations:** Deviations of Mendelism, Sex Determination, Sex related characters, Extranuclear inheritance, Significance of Crossing over. Mutation at molecular level, Spontaneous and Induced mutation, Mutagens & their action, DNA damage & repair. | 8 | 1 | - | 9 |
| 5 | **Population Genetics:** Importance of hardy Weinberg Equilibrium, Human genetics: Genetic disorders & Syndromes, Genetic counselling, Eugenics, euthenics, euphenics, HGP, Genomic library & Gene targeting. | 8 | 1 | - | 9 |
| 6 | **Lab Course:**<br>1. Localization of neutral mucopolysaccharides in cell by periodic acid Schiff reaction.<br>2. Localization of general lipid by Sudan Black B method.<br>3. Study of cancer cells through permanent slides.<br>4. Localization of metachromatic substances in cells by Toluidine blue/Congo red technique.<br>5. Microtubules in vesicle transport in fish chromatophore.<br>6. Assignment on cell communication and signaling.<br>7. Analysis of deviations of Mendel's laws.<br>8. Analysis of population genetics | - | - | 15 | 15 |
| | | **40** | **5** | **15** | **60** |

**SUGGESTED READINGS**


- Molecular Biology of the Cell – Alberts B., Johnson A., Lewis J., Raff M., Roberts K., and Walter P. (Garland Science, 6th Edition, 2014)
- Cell Biology – Pollard T.D., Earnshaw W.C., Lippincott-Schwartz J., and Johnson G.T. (Elsevier, 3rd Edition, 2016)
- The Cell: A Molecular Approach – Cooper G.M. and Hausman R.E. (Sinauer Associates, 7th Edition, 2018)
- Lodish Molecular Cell Biology – Lodish H., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A., and Martin K.C. (W.H. Freeman, 9th Edition, 2021)
- Karp's Cell Biology – Iwasa J., Marshall W., and Karp G. (Wiley, 9th Edition, 2023)
- Principles of Genetics – Snustad D.P. and Simmons M.J. (Wiley, 7th Edition, 2015)
- Genetics: Analysis and Principles – Brooker R.J. (McGraw Hill, 7th Edition, 2023)
- Concepts of Genetics – Klug W.S., Cummings M.R., Spencer C.A., and Palladino M.A. (Pearson, 12th Edition, 2018)
- Principles of Population Genetics – Hartl D.L. and Clark A.G. (Sinauer Associates, 4th Edition, 2007)
- Population Genetics – Hamilton M.B. (Wiley-Blackwell, 1st Edition, 2009)

## FYUGP-ZOOLOGY

## SEMESTER VII

**Title of the Course : Research Methodology and Research Ethics**
**Course Code : ZOO-RM**
**Nature of the Course : Compulsory**
**Total Credits : 04**
**Distribution of Marks : 40 (IA) + 60 (END) = 100**

**COs:**

1) Apply research concepts for survey and data collection
2) Evaluate collected data through statistical tools
3) Discuss ethics of research and publication

**Learning Outcomes:**

1) Discuss research concepts for data collection
2) Analyze data through statistical tools
3) Understand research ethics and publication guidelines

**Mapping of CO with Bloom's taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | CO3 | CO1 | | CO2 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| AVERAGE | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**MODES OF IN-SEMESTER ASSESSMENT:**

- One Theory exam
- Group Discussion/Seminar/Viva/Assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Fundamentals of Research Methodology:** Introduction to Research in Life Sciences, Types of Research: Basic and Applied, Formulating Research Questions and Hypotheses, Literature Review and Meta-Analysis | 13 | 2 | - | 15 |
| 2 | **Experimental Design, Data Collection and Analysis**: Principles of Experimental Design, Sampling Techniques and Sample Size Determination, Data Collection Methods: Surveys, Observations, and Experiments, Use of Statistical Tools and Software. Data Analysis and Interpretation | 12 | 3 | - | 15 |
| 3 | **Research Ethics:** Ethical Principles in Life Sciences Research, Responsible Conduct of Research (RCR), Avoiding Plagiarism and Misconduct, Guidelines for Animal and Human Research. | 12 | 3 | - | 15 |
| 4 | **Publication Ethics and Communication:** Writing Research Papers and Reports, Peer Review Process and Responding to Reviewers. Open Access Publishing and Predatory Journals. Presenting Research: Posters, Oral Presentations, and Conferences | 12 | 3 | - | 15 |
| | | **49** | **11** | **-** | **60** |

**Suggested Readings:**


- CSIR Guidelines for Ethics in Research and in Governance - CSIR (2019)
- Ethics in Science Education, Research and Governance- Kambadur Muralidhar, Amit Ghosh, Ashok Kumar Singhvi - INSA (2019)
- Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W Creswell and J. David Creswell
- Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar
- Research Methology : methods and techniques by CR Kothari & Gaurav Garg
- Introducing Research Methodology: A Beginner′s Guide to Doing a Research Project by Uwe Flick

## FYUGP-ZOOLOGY

### SEMESTER VII

**Title of the Course : Advanced Analytical Techniques- Minor**
**Course Code : ZOO-MIN-07**
**Nature of the Course : MINOR-VII**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40IA(30+10Lab)]**

**COs:**

1. Analyze and compare different nucleic acid extraction and sequencing techniques
2. Investigate biological samples through the application of different bioimaging and biophysical tools and techniques
3. Examine genomic DNA and products of ts amplification

**Learning Outcomes:**

- Demonstrate various analytical techniques used in biological sciences
- Evaluate biological samples with the use of various analytical tools and techniques
- Describe DNA structure and amplification

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2 | |
| Procedural | | | | | CO3 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- Submission of assignment on relevant topic

- Submission of practical record book
- Hands on activities in operating equipment
- Viva-voce examination

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Nucleic acid extraction and visualization,** Agarose Gel Electrophoresis. Polymerase Chain Reaction (PCR)- principle and types, Plasmid isolation and purification. | 10 | 1 | - | 11 |
| 2 | **Bioimaging techniques-** electron microscopy principle, uses and sample preparation, fluorescent microscopy principle and uses, Flow cytometry – principle and application, Fluorescence in-situ hybridization, Genomic in-situ hybridization and Fluorescence-Activated Cell Sorting (FACS) | 11 | 1 | - | 12 |
| 3 | **Biophysical Methods:** High Performance Liquid Chromatography (HPLC), Fourier Transform Infrared Spectroscopy (FTIR), Nuclear Magnetic Resonance Spectroscopy (NMR), X-ray diffraction (XRD), Gas chromatography (GC), Mass Spectroscopy (MS) | 12 | 1 | - | 13 |
| 4 | **DNA sequencing techniques-** Pyrosequencing, Nextgen sequencing, Genome editing – CRISPR | 8 | 1 | - | 9 |
| 5 | **Lab Course:**<br>1. Nucleic acid extraction from biological samples<br>2. Visualization of DNA by Agarose gel electrophoresis<br>3. Nucleic acid amplification by PCR<br>4. Demonstration of HPLC, FTIR, NMR, XRD, etc. | - | - | 15 | 15 |
| | | **41** | **4** | **15** | **60** |

**Suggested Readings:**


- Principles of Biochemistry and Molecular Biology by K. Wilson and J. Walker, Cambridge University Press.
- Principles of Instrumental analysis by D. A. Skoog and J. J. Leary, Saunders College Publishing, Philadelphia.
- Textbook of Structural biology by Anders Lilgas, Lars Lilgas, JuiPiskur et al, World Scientific Publisher

## FYUGP-ZOOLOGY

### SEMESTER VIII

**Title of the Course : Intermediary Metabolism**
**Course Code : ZOO-C-19**
**Nature of the Course : CORE-XIX**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40IA(30+10Lab)]**

**COs:**

1. Analyse the concept of bioenergetics and energy metabolism.
2. Evaluate the role of co-ordinated regulation of metabolism.
3. Explain the importance of metabolic pathways and regulation in the biological system.

**Learning Outcomes:**

- Discuss the mechanisms involved in energy metabolism
- Analyze lipid, nitrogen and nucleotide metabolism
- Describe the integration and regulatory strategies of metabolic pathways in the biological system.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| | | | | | |
|---|---|---|---|---|---|
| 1 | **Bioenergetics and energy metabolism:** Biological oxidation-reduction reactions, reduction potential and free energy, Electron transport chain, Structure of ATP and its phosphoryl transfer potential, ATP Synthesis and Chemiosmosis; Phosphorylation: substrate level and oxidative phosphorylation and its regulation. Photophosphorylation and carbon fixation reactions in chloroplast; photorespiration. | 10 | 1 | - | 11 |
| 2 | **Lipid metabolism:** Fatty acid transport, β-oxidation in mitochondria and peroxisomes, and its energetics, oxidation of saturated and unsaturated fatty acids (odd and even number carbon atoms), Omega oxidation. Biosynthesis of fatty acid (Palmitate), chain elongation and desaturation, biosynthesis of eicosanoids, ketone bodies, and cholesterol, and their physiological significance. | 9 | 1 | - | 10 |
| 3 | **Overview of nitrogen fixation in biological system:** biosynthesis of amino acids (phenylalanine, arginine, histidine, tryptophan), Cofactors of amino acid metabolism. Metabolism of purine and pyrimidine (de novo and salvage pathway) and degradation of nucleotides, regulation of nucleotide biosynthesis, inborn errors of metabolism. | 11 | 1 | - | 12 |
| 4 | **Integration and regulatory strategies of metabolic pathways:** Citric acid cycle as metabolic hub, amphibolic and anaplerotic reactions. Co-ordinated regulation-glycolysis and gluconeogenesis, glycogen synthesis and breakdown; Co-ordinated regulation of fatty acid oxidation and biosynthesis; hormonal regulation of fatty acid and carbohydrate metabolism; allosteric and covalent modifications. | 11 | 1 | - | 12 |
| 5 | **Lab Course:**<br>1. Fractionation of tissue by differential centrifugation.<br>2. Estimation of protein, carbohydrate, free phosphate in biological samples.<br>3. Estimation of ascorbic acid (Colourimetric).<br>4. Estimation of cholesterol.<br>5. Estimation of urea in biological samples.<br>6. Separation of protein and determination of molecular mass by SDS-PAGE. | - | - | 15 | 15 |
| | | **41** | **4** | **15** | **60** |

**Suggested Readings:**


- Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
- Principles of Biochemistry (2013) 4th ed., Voet, Donald,Voet, Judith &Pratt, charlotte. Wiley & Sons, Inc. (New Jersey), ISBN:978-1-11809244-6.
- Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
- Berg, J.M., Tymoczko, J.L. and Stryer L., (2012) W.H. Biochemistry (7th ed.), Freeman and Company (New York), ISBN:10: 1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

## FYUGP-ZOOLOGY

### SEMESTER VIII

**Title of the Course : Biodiversity and Bioprospecting**
**Course Code : ZOO-C-20**
**Nature of the Course : CORE-XX**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40IA(30+10Lab)]**

**COs:**

- Analyze the concept of bioprospecting
- Evaluate microbial and entomological prospecting
- Evaluate the potential of medicinal plant resources

Learning Outcomes:

- Apply the knowledge of bioprospecting
- Analyse biodiversity for bioprospecting

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Bioprospecting:** Definition, Introduction, Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act: Introduction, Phases of Bioprospecting, Exemption to Act. Fields of Bioprospecting. | 10 | 1 | - | 11 |
| 2 | **Renowned medicinal plants of India,** Medicinal Plants Bioprospecting/ Pharmaceutical Bioprospecting: for new drugs, assays in Bioprospecting. Antioxidant assay – NO free radical scavenging assay, Antigenotoxicity assay – MTT assay, Antiviral activities of plants – SRB assay. | 10 | 1 | - | 11 |
| 3 | **Entomological bioprospecting:** concept and practices of entomophagy and entomotherapy. Insect peptides, Insect as fish feed, fish in mosquito control | 10 | 1 | - | 11 |
| 4 | **Microbial Bioprospecting:** Isolation of Microbial metabolites and their bio-activity against multidrug resistant bacteria, Endophytic microbial products as Antibiotics, mushroom as a source of food and medicine, Lichen as a source of medicine | 11 | 1 | - | 12 |
| 5 | **Lab Course:**<br>1. Antioxidant assay – by DPPH method.<br>2. Antibiotic bioassay<br>3. Chromatographic separation of plant extracts to determine active principles (Paper, TLC & Column)<br>4. Determination of phytochemicals in plant extracts<br>5. Determination of nutritive value in edible insects<br>6. Submission of herbarium of common medicinal plants<br>7. Submission of insects with therapeutic/food value<br>8. Field survey of medicinal plants/insects/mushrooms | - | - | 15 | 15 |
| | | **41** | **4** | **15** | **60** |

**Suggested readings**

1. Arora, R.K. and Nayar, E.R. (1984), Wild relatives of crop plants in India, NBPGR Science MonographNo.7.

2. Baker, H.G. (1978), Plants and civilization. Ill Ed. (A. Wadsworth, Belmount).

3. Bole, P.V. and Vaghani, Y. (T986). Field guide to common Indian trees, Oxford University Press, Mumbai.

4. Thakur, R.S., Puri, H.S. and Husain, A. (1969). Major medicinal plants of India, Central Institute of medicinal and aromatic plants, Lucknow.

5. Swaminathan, M.S. and Kocchar, S.L. (Es.) (1989). Plants and Society, MacMillan Publication

Ltd.,

6. Sharma, O.P. (1996). Hills Economic Botany, Tata McGraw Hill co., Ltd., New Delhi,

7. Kocchar, S.L. (1998). Economic Botany of the tropics, II Edn. MacMillan India Ltd.,

8. CSIR (1986), The useful plants of India Publication and Information directorate, CSIR^ New Delhi. 9. CSIR (1948 - 1976) The wealth of India, 53

## FYUGP-ZOOLOGY

### SEMESTER VIII

**Title of the Course : Bioethics, Biosafety, and IPR-Minor**
**Course Code : ZOO-MIN-08**
**Nature of the Course : MINOR-VIII**
**Total Credits : 04**
**Distribution of Marks : 100 ( 60 End + 40 IA)**

**COs:**

1. Analyze biosafety and ethical perspectives in research.
2. Evaluate various types of IPRs.
3. Discuss the various agreement and treaties.
4. Apply the knowledge to apply for a patent.

Learning Outcomes:

- Describe the concept of biosafety and bioethics.
- Analyze the IPR types.
- Understand the agreement and treaties.
- Discuss the patent filling process.

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | Biosafety and Bioethics: Biosafety in Laboratories. Historical perspective of Bioethics, Conflicting issue (GMO, GMP, Cloning, environmental hazards), Principles and guidelines for research in human and animals. Indigenous knowledge system and biopiracy | 12 | 3 | - | 15 |
| 2 | Concept of Intellectual Property Rights (IPR) and its significance. Types of IPR- Patents, copyright, trademarks, industrial design, trade secrets and geographical indication | 15 | 5 | - | 20 |
| 3 | Agreement and treaties: GATT & TRIPs Agreement, Madrid Agreement, Hague Agreement , WIPO Treaties. | 10 | 5 | - | 15 |
| 4 | Indian Patent Act 1970 and recent amendments patent cooperation treaty, Patent filling and granting procedure. | 6 | 4 | - | 10 |
| | | **42** | **17** | **-** | **60** |

**Suggested Readings:**


- M K Sateesh .Bioethics and Biosafety. Kindle Edition
- Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013
- Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan K. Sell Cambridge University Press, 2000
- Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition)
- Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006

## FYUGP-ZOOLOGY

### SEMESTER VIII

**Title of the Course : Climate Change and Biological Adaptation**
**Course Code : DSE-1**
**Nature of the Course : DSE-I**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40IA(30+10Lab)]**

**COs:**

1. Analyze Climate change and biological responses to it.
2. Evaluate biodiversity and impact of human interference
3. Evaluate conservation strategies, GIS and remote sensing tools

Learning Outcomes:

- Discuss biological changes in response to climate change
- Apply the GIS and remote sensing tools for evaluation of biodiversity
- Analyze conservation measures

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | CO1 | CO2, CO3 | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2.0 |
| AVERAGE | 3 | 2 | 2.3 | 1.7 | 1.7 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Fundamentals of Climate Change**<br>Introduction to climate systems and climate change, Greenhouse gases and Global warming, Climate change indicators and feedback loops, Historical climate patterns and predictions | 10 | 1 | - | 11 |
| 2 | **Biological Responses to Climate Change**<br>Physiological adaptations in plants and animals, Behavioral changes in species, Evolutionary adaptations and natural selection, Phenological shifts (e.g., migration, flowering times) | 10 | 1 | - | 11 |
| 3 | **Ecosystem level impacts**<br>Changes in biodiversity and species distribution, Ecosystem resilience and vulnerability, Impact on aquatic and terrestrial ecosystems, Role of keystone species | 10 | 1 | - | 11 |
| 4 | **Human Influence and Conservation, GIS & remote sensing**<br>Anthropogenic drivers of climate change, Conservation strategies for threatened species, Restoration ecology and habitat management, Policy and international agreements (e.g., Paris Agreement)<br>Introduction to Remote Sensing and GIS techniques: Satellites, Sensors, Platforms and Resolutions, Infrared and Microwave Remote Sensing: Principles and Applications, Interpreting Optical Remote Sensing Images, Projection of climate change scenarios and Tools for mapping and monitoring<br>GIS applications based on model outputs and GIS databases, Remote sensing technologies to monitor climate change processes (vegetation biomass, monitoring flooding, soil moisture and depth, surface micro topography etc.) | 11 | 1 | - | 12 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | **Lab Course:**<br>1. Effect of temperature in plant growth and germination<br>2. Effect of pH on aquatic ecosystem (plankton diversity and DO)<br>3. Study of butterfly diversity in different habitats<br>4. Study of the process of remote sensing & GIS (demonstration)<br>5. Study of plant adaptations in xeric and aquatic environment<br>6. Study of ant behavior in different temperature gradients<br>7. Study of life cycle of any insect under different temperature conditions | **-** | **-** | **15** | **15** |
| | | **41** | **4** | **15** | **60** |

**Suggested Reading:**

1. "Climate Change Biology" by Lee Hannah

2. "The Sixth Extinction: An Unnatural History" by Elizabeth Kolbert

3. Research papers on climate change and adaptation from journals like Nature and Science.

## FYUGP-ZOOLOGY

### SEMESTER VIII

**Title of the Course : Computational Biology**
**Course Code : DSE-2**
**Nature of the Course : DSE-II**
**Total Credits : 04**
**Distribution of Marks : 100 [60 End (Theory: 45, Practical: 15) + 40IA(30+10Lab)]**

**COs:**

1. Analyse biological databases and interpret data.
2. Evaluate protein structure and conformations
3. Analyse ligand properties
4. Evaluate protein ligand interactions

Learning Outcomes:

- Apply the concepts of computational biology to interpret data
- Analyze protein structure, predict structure and conformational changes
- Describe pharmacokinetic properties of ligands
- Analyze protein ligand interactions through docking and simulation

**Mapping of CO with Bloom Taxonomy**

| Knowledge Dimension | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | | | |
| Procedural | | | | CO1, CO3 | CO2, CO4 | |
| Metacognitive | | | | | | |

**Mapping of Course outcomes to Programme outcomes**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | AVERAGE |
|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2.14 |
| CO3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2.0 |
| CO4 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2.8 |
| AVERAGE | 3 | 2 | 2.5 | 2 | 2 | 2 | 2 | |

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Home assignments

Attainment strategy of COs

- Continuous evaluation through in and end semester examinations
- Submission of assignments

| UNITS | CONTENTS | L | T | P | Total Hours |
|---|---|---|---|---|---|
| 1 | **Scope of Computational Biology and Bioinformatics.** Major biological databases and information retrieval. Conversion of file types. BLAST analysis and Primer designing. Computational Phylogenetic analysis. | 8 | 2 | - | 10 |
| 2 | **Protein structure, protein folding and Ramachandran plot analysis.** Protein structure prediction tools, homology modeling and structure validation. Molecule visualization tools. | 8 | 2 | - | 10 |
| 3 | **Computer Aided Drug Designing-** Pharmacokinetics and Pharmacodynamics, ADMET properties, Lipinski rule of 5, Molecular Docking analysis and OSAR. | 12 | 3 | - | 15 |
| 4 | **Concept of Molecular dynamics simulation –** protein preparation, ligand preparation, forcefields, energy minimization. Steps of MD simulation. RMSD, RMSF. | 7 | 3 | - | 10 |
| 5 | **Lab Course:**<br>1. Retrieval of sequences of nucleotides and amino acids, structure of proteins from databases<br>2. BLAST analysis<br>3. Phylogenetic tree construction<br>4. Primer designing<br>5. Protein structure prediction and validation<br>6. ADMET screening and Lipinski analysis<br>7. Active site dectection<br>8. Protein ligand docking analysis | - | - | 15 | 15 |
| | | **35** | **10** | **15** | **60** |

**Suggested Reading:**


- Bioinformatics: Principles and Applications by Z. Ghosh and B. Mallick, Oxford University Press.
- Bioinformatics: Sequence and Genome Analysis by D.W. Mount, Cold Spring Harbor Laboratory
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F.F. Ouellette, Wiley-interscience.
- Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum, Garland Science.