



# **RANI CHANNAMMA UNIVERSITY**

## **BELAGAVI**

**REVISED CURRICULUM FRAMEWORK FOR  
UNDER GRADUATE COURSE**

**STRUCTURE & SYLLABUS OF BACHELOR OF SCIENCE**

**ZOOLOGY**

**1<sup>ST</sup> TO 2<sup>ND</sup> Semesters**


**w.e.f.**

**Academic Year 2024-25 and Onwards**

Submitted by

Chairman,  
Board of Studies (UG),  
Bachelor of Science,  
Rani Channamma University, Belagavi.

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**RANI CHANNAMMA**  **UNIVERSITY, BELGAVI**  
**VIDYASANAGAMA**  
Accredited with B+ Grade by NAAC

**FACULTY OF SCIENCE: DEPARTMENT OF ZOOLOGY**

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**Board of Studies in ZOOLOGY**

<b>Sl. No.</b>	<b>Name and Address</b>	<b>Designation</b>
01	Prof. Basavaraj Padmashali Department of Chemistry Rani Channamma University Belagavi-591156	Chairman
02	Shri G.M. Karki Maratha mandal College Belagavi	Member
03	Smt. Surekha Deshapande Basaveshwara Science College Bagalkot	Member
04	Dr. Umesh M Shaygoti jSS College Gokak	Co-opt member



## First Semester B.Sc. Zoology Theory

<b>Paper Title: Zoology-1T</b>	<b>Marks: Th-80+IA-20</b>
<b>Paper Code : SEPBSZOOT01</b>	<b>Total hours: 60</b>
<b>Teaching Hours: 4 Hours/Week</b>	<b>Credits : 03</b>

<b>UNIT-I</b>	<b>15 Hours</b>
<p><b>Animal Diversity:</b> Brief History and General Principles of Animal classification. Prokaryotes and Eukaryotes. Phylum Protozoa- General characters and classification up to classes with one example for each class. Locomotion in Protozoa</p> <p><b>Phylum Porifera:</b> General characters and classification up to classes with one example for each class. Canal System in <i>Sycon</i></p> <p><b>Phylum Coelenterata:</b> General characters and classification up to classes with one example for each class. Polymorphism</p> <p><b>Phylum Platyhelminthes:</b> General characters and classification up to classes with one example for each class. Parasitic adaptations</p> <p><b>Phylum Nemathelminthes:</b> General characters and classification up to classes with one example for each class. Life history of <i>Ascaris</i>. Parasitic adaptations in roundworms</p>	
<b>UNIT-II</b>	<b>15 Hours</b>
<p><b>Phylum Annelida:</b> General characters and classification up to classes with one example for each class. Metamerism in Annelida</p> <p><b>Phylum Arthropoda:</b> General characters and classification up to classes with one example for each class. Metamorphosis in Insects. Life history of <i>P. americana</i></p> <p><b>Phylum Mollusca:</b> General characters and classification up to classes with one example for each class.</p> <p><b>Phylum Echinodermata:</b> General characters and classification up to classes with one example for each class. Water-vascular system in Asteroidea</p>	
<b>UNIT-III</b>	<b>15 Hours</b>
<p><b>Phylum Chordata:</b> Characters of chordates. Differences between chordates and non-chordates. General features of Protochordata (Brief note on Hemichordata, Urochordata, Cephalochordata)</p> <p><b>Agnatha and Gnathostomata:</b> General features of Agnatha and Gnathostomata. Classification of cyclostomes up to classes</p> <p><b>Pisces:</b> General features and classification up to living orders. Scales in fishes Migration in Fishes</p> <p><b>Amphibia:</b> General features and classification up to living orders. Parental care in amphibians</p> <p><b>Reptiles:</b> General features and Classification up to living orders. Differences between poisonous and non-poisonous snakes. Snake bite and treatment</p>	
<b>UNIT-IV</b>	<b>15 Hours</b>
<p><b>Aves:</b> General features. Salient features of Passeriformes, Pisciformes, Columbiformes, Mammals: General characters. Salient features of Monotremes, Marsupialia, Insectivora, Rodentia, Perissodactyla, Chirpotera, Edentata, Cetaceae and Primates with one example for each. Ear ossicles in mammals.</p>	

### References

1. Agarwal V. P. and Dalela R. C. (1975): Textbook of Vertebrate Zoology. Jai Prakashnath Co.
2. Barnes, R.D. (1982): Invertebrate Zoology. Fifth edition
3. Barnes, R.D. (1982): Vertebrate Zoology. Fifth edition
4. Barnes, R.S.K., Calow, P., Olive, P.J.W. Golding, D.W. and Spicer, J.I. (2002): The Invertebrates: A
5. New Synthesis, III Edition, Blackwell Science
6. Barrington E. J. W. (1981): Invertebrate structure and Function. ELBS. Dhama P.S. and Dhama J. K.
7. (2000): Chordate Zoology. S. Chand & Co. Dhama P.S. and Dhama J. K. (2000):

- Invertebrate Zoology. S. Chand & Co.
8. Ekambaranatha Iyer M. and Anantakrishnan T. N. (1990): A manual of Zoology. Vol. I. Invertebrata (Part 1 & 2). S. Vishwanathan Pvt. Ltd.
  9. Ekambaranatha Iyer M. and Anantakrishnan T. N. (1990): A manual of Zoology. Vol. II. Chordata S. Vishwanathan Pvt. Ltd.
  10. Jordan E. L. and Verma P.S. (1976): Chordate Zoology. S. Chand & Co. Jordan E. L. and Verma
  11. P.S. (1976): Invertebrate Zoology. S. Chand & Co.
  12. Kotpal R. L. (1993): Protozoa- Echinodermata (all volumes). Rastogi Publ.
  - Pough H (2004): Vertebrate life, VIII Edition, Pearson International.
  13. Ruppert and Barnes, R.D. (2006): Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

## First Semester B.Sc. Zoology Practical-1

<b>Paper Title: Zoology-1P</b>	<b>Marks: Th-40+IA-10</b>
<b>Paper Code : SEPBSZOO01</b>	<b>Total hours: 60</b>
<b>Teaching Hours: 4 Hours/Week</b>	<b>Credits : 02</b>

### ZOOLOGY PRACTICAL-I

#### 1. Study of the following specimens making use of permanent slides / specimens:

Study of unicellular and cellular grade organized animals: *Amoeba*, *Euglena*, *Paramecium* and *Sycon*

Study of tissue grade organized animals: *Obelia*, *Physalia*, *Aurelia*, *Metridium*, Study of flat worms: *Planaria*, *Taenia solium*

Study of round worms: Male and female *Ascaris lumbricoides*

Study of segmented Animals: *Nereis*, *Pheretima*, *Hirudinaria*,

Study of animal forms with jointed appendages: *Palaemon*, *Cancer*, *Limulus*, *Apis*,

Study of soft bodied animals: *Chiton*, *Dentalium*, *Pila*, *Unio*, *Loligo*, *Sepia*,

Study of spiny skinned animals: *Pentaceros*, *Ophiura*, *Echinus*, *Cucumaria* and *Antedon*

Study of Protochordates: *Balanoglossus*, *Herdmania*, *Branchiostoma*

Study of Fishes: *Torpedo*, *Labeo*, *Exocoetus*, *Anguilla*

Study of Amphibians: *Ichthyophis*, *Salamandra*, *Bufo*, *Hyla*

Study of Reptiles: *Chelone*, *Chamaeleon*, *Draco*, *Vipera*, *Naja*

Study of Birds: *Duck*, *Cucchoo*, *Wood pecker*, *Kingfisher*, *Owl*, *Peacock*

Study of Mammals: *Duck billed platypus*, *Manis*, *Bat*, *Loris*

Mounting of setae, blood glands, nephridia in Earthworm

(Collect the dead worms from vermicompost pits of farmers and preserve)

Mounting of mouth parts of honeybee, cockroach, housefly, mosquitoes

Mounting of brain in fowl / rat (collect dead fowl / rat heads and preserve)

Study tour / field visit: Compulsory tour / visit to understand faunal diversity

### References

1. Ruppert and Barnes, R.D. (2006): Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002): *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Young, J. Z. (2004): *The Life of Vertebrates*. III Edition. Oxford university press.
4. Pough H (2006): *Vertebrate life*, VIII Edition, Pearson International.
5. Hall B.K. and Hallgrimsson B. (2008): Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
6. P. S. Dhami and J. K Dhami (2000): Practical Zoology S. Chand and Co, New Delhi

## Second Semester B.Sc. Zoology Theory

<b>Paper Title: Zoology-2T</b>	<b>Marks: Th-80+IA-20</b>
<b>Paper Code : SEPBSZOOLT02</b>	<b>Total hours: 60</b>
<b>Teaching Hours: 4 Hours/Week</b>	<b>Credits : 03</b>

<b>UNIT-I:</b>	<b>15 Hours</b>
<p><b>Integument in different classes of chordates:</b> (fishes, amphibian, reptilian, aves and Mammalia)</p> <p><b>Skeletal System (Girdles):</b> Pectoral girdle and pelvic girdle in Frog, Varanus, Fowl and Rabbit</p> <p><b>Digestive System:</b> Brief account of alimentary canal (digestive tract) of different vertebrates</p>	
<b>UNIT-II:</b>	<b>15 Hours</b>
<p><b>Respiratory System:</b> Brief account of gills, lungs, trachea and air sacs in vertebrates</p> <p><b>Circulatory System:</b> Comparative account of heart in different vertebrates</p> <p><b>Nervous System:</b> Comparative account of brain in different vertebrates</p>	
<b>UNIT-III:</b>	<b>15 Hours</b>
<p><b>Early Embryonic Development:</b> Gametogenesis (Spermatogenesis and oogenesis), Fertilization, Types of Eggs and Patterns of Cleavage, Types of Eggs and Patterns of Cleavage, Placenta types, functions and structure</p>	
<b>UNIT-IV:</b>	<b>15 Hours</b>
<p><b>Early Development:</b> Frog development up to Gastrulation. Organizer phenomenon. Development of chick (Fertilization, structure of egg, cleavage, blastulation) chick embryo. Human Development – up to implantation</p>	

### References

1. Comparative anatomy of vertebrates By R. K. Saxena
2. Comparative Anatomy by Aurora M. Sebastiani and Dale W. Fishbeck
3. Developmental biology By Rastogi & Jayraj. Kedarnath Ramnath publishers, Meerut.
4. Introduction to Embryology B I Ballinsky Publisher: Thomson
5. Learning Patten's foundation of Embryology Bruce M Carlson Publisher: McGraw Hill Education Principles of Embryology Waddington C H Publisher: Macmillan, New York.
6. Developmental Biology Scott F Gilbert. Publisher: Sinauer Associates Inc., U.S
7. Developmental Biology –a modern Synthesis By K Vasudev Rao. Published by The Associated Pub, Ambala Cantt.
8. Embryology By Mohan Arora. Himalaya Publishing House Pvt. Ltd, New Delhi.
9. Embryology – Constructing the Organism Scott F Gilbert. Publisher: Sinauer Associates Inc., U.S.
10. Elements of Developmental Biology Dr P.C. Jain Vishal Publishing Co. New Delhi  
Vertebrate Embryology N N Majumdar Publisher: McGraw-Hill Education

## Second Semester B.Sc. Zoology Practicals

<b>Paper Title: Zoology-2P</b>	<b>Marks: Th-40+IA-10</b>
<b>Paper Code : SEPBSZOLP-02</b>	<b>Total hours: 60</b>
<b>Teaching Hours: 4 Hours/Week</b>	<b>Credits : 02</b>

1. Osteology: Disarticulated skeleton of frog and rabbit
2. Comparative study of girdles: Pectoral girdle and pelvic girdle in Frog, Varanus, Fowland Rabbit (Three practical)
3. Comparative account of heart in different vertebrates
4. Comparative account of brain in different vertebrates
5. Embryology: Study of developmental stages – Whole mounts and sections through permanent slides, specimens: cleavage stages, blastula, gastrula
6. Chick embryo mounting -24 hour.
7. Chick embryo mounting -36 hour.
8. Chick embryo mounting - 48hour
9. Revision
10. Test

### References

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
5. Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
6. Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
7. Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc.

## Third Semester B.Sc. Zoology (Theory)

### Paper Title: Animal Physiology, Biochemistry and Histology

Teaching Hours: 4 H / Week

Total hours: 60

Marks: Th-80+IA-20

Credits :3

#### UNIT - 1

15 Hours

**Digestion:** Physiology of digestion. Absorption of carbohydrates, proteins and lipids  
Concept of balanced diet.

**Respiration:** Pulmonary ventilation, Transport of Oxygen and carbon dioxide in blood. Chloride shift, Respiratory pigments.

**Excretion:** Structure of Nephron, Mechanism of Urine formation, Ornithine cycle, countercurrent Mechanism.

#### UNIT - 2

15 Hours

**Circulation:** Composition of blood, Homeostasis, Structure of Heart.

Types of Hearts -Neurogenic and Myogenic heart., Origin and conduction of the cardiac impulse. Cardiac cycle. Blood pressure.

Carbohydrate Metabolism: Glycolysis, Krebs cycle, Gluconeogenesis, Glycogen metabolism, Electron transport chain.

#### UNIT - 3

15 Hours

**Protein metabolism:** Transamination and Deamination.

**Enzymes:** Introduction, Mechanism of action, Enzyme inhibitors, specificity of Enzymes, reversibility of enzymes action and Enzyme inhibitors. Brief account of coenzymes and cofactors. Clinical importance of enzymes.

#### UNIT - 4

15 Hours

**Nerve and muscle:** Structure of a neuron, resting membrane potential, Origin of Action potential and its propagation in myelinated fibre, Ultra-structure of skeletal muscle, Sliding filament theory of muscle contraction, neuromuscular junction, neurotransmitters.

**Histology:** Histological details of the organs - Salivary gland, Pancreas, Liver, Kidney, Adrenal, Testis and Ovary.

#### SUGGESTED READINGS:

1. Essentials of Animal Physiology by Rastogi, S. C. New Age International Publishers, New Delhi.
2. Animal Physiology by Nigam, H. C. Vishal Publishing Co., New Delhi.
3. Animal Physiology by Verma, P. S., Agarwal, V. K., and Tyagi, B. S. S. Chand & Company Ltd., New Delhi.

4. Lehninger Principles of Biochemistry by Nelson, D. L. Publisher: W. H. Freeman & Co.  
Biochemistry by Mathews, Van Holde. Publisher: Ahren Pearson Education.
5. Animal Physiology by Schmidt-Nielsen. Cambridge University Press.  
Introduction to Histology by Gauba, R. K. Tata McGraw-Hill, New Delhi.
6. Cells and Tissues: Introduction to Histology by N. D. Cells and Rogers, A. W. Academic Press.
7. Basic Medical Histology: Biology of Cells, Tissues and Organs by Kessel, Richard G. Oxford University Press.
8. Textbook of Histology by Bloom and Fawcett. Saunders Publishers, Philadelphia.
9. Bailey's Textbook of Histology by Copenhaver, W. M., Bunge, R. P., and Bunge, Mary B. Williams and Wilkins Company, Baltimore.

## **Third Semester B.Sc. Zoology (Practical)**

### **Paper Title: Animal Physiology, Biochemistry and Histology**

**Teaching Hours: 4 H / Week**

**Total hours: 48**

**Marks: 40+IA-10**

**Credits: 02**

1. Preparation of haemin crystals.
2. Study of permanent histological sections of mammalian Salivary gland, pancreas, liver, kidney, adrenal gland, testis and ovary.
3. Qualitative tests for carbohydrates in given solutions (Glucose, Sucrose and Starch).
4. Qualitative tests for proteins and lipids in given solutions.
5. Study of activity of salivary amylase under optimum conditions.
6. Enumeration of Red Blood Cells using haemocytometer (Neubauer chamber).
7. Enumeration of White Blood Cells using haemocytometer.
8. Estimation of haemoglobin by Sahli's Method.

#### **SUGGESTED READINGS**

1. Tortora, G. J., and Derrickson, B. H. (2009). Principles of Anatomy and Physiology, XII Edition. John Wiley & Sons, Inc.
2. Widmaier, f E. P., Raff, H., and Strang, K. T. (2008). Vander's Human Physiology, XI Edition. McGraw-Hill.
3. Guyton, A. C., and Hall, J. E. (2011). Textbook of Medical Physiology, XII Edition. Harcourt Asia Pvt. Ltd. / W. B. Saunders Company.
4. Berg, J. M., Tymoczko, J. L., and Stryer, L. (2006). Biochemistry, VI Edition. W. H. Freeman and Co.
5. Nelson, D. L., Cox, M. M., and Lehninger, A. L. (2009). Principles of Biochemistry, IV Edition. W. H. Freeman and Co.
6. Murray, R. K., Granner, D. K., Mayes, P. A., and Rodwell, V. W. (2009). Harper's Illustrated Biochemistry, XXVIII Edition. Lange Medical Books / McGraw-Hill.

## **Third Semester B.Sc. Zoology**

### **ELECTIVE-I**

#### **Paper Title: Medical Diagnostics**

**Teaching Hours: 3 H / Week**

**Total hours: 30**

**Marks: Th-40+IA-10**

**Credits: 2**

#### **UNIT – 1**

Introduction to Medical Diagnostics and its Importance Diagnostic methods used for analysis of blood: 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)

Diagnostic Methods Used for Urine Analysis: Urine Analysis: Physical characteristics; Normal and abnormal constituents

#### **UNIT – 2**

**Non-infectious Diseases:** Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary),

**Infectious Diseases:** Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis.

**Tumours:** Types (Benign/Malignant), Detection and metastasis; Syndrome: AIDS – causes, symptoms, prevention .

#### **SUGGESTED READINGS**

1. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
2. Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House
3. Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
4. Guyton A.C. and Hall J.E. Text book of Medical Physiology, Saunders
5. Robbins and Cortan, Pathologic Basis of Disease, VIII Edition, Saunders
6. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

## Fourth Semester B.Sc. Zoology

### Paper Title: Genetics and Evolutionary Biology

Teaching Hours: 4H / Week  
Total Hours: 60

Marks: Th-80+IA-20  
Credits: 3

#### UNIT - 1 15 Hours

**Introduction to Genetics:** Mendel and his contribution. Monohybrid, Dihybrid cross (Laws). Definition of genetics terminologies. Genetic Variation, Molecular basis of Genetic Information.

**Mendelian Genetics:** Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, sex linked inheritance

**Chromosomes:** Normal and giant chromosomes (salivary gland & lamp brush)  
**Linkage, Crossing Over and Chromosomal Mapping:** Linkage and crossing over, Recombination frequency as a measure of linkage intensity.

#### UNIT - 2 15 Hours

**Mutations:** Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, back versus Suppressor mutations.

**Sex Determination:** Chromosomal mechanisms. Dosage compensation.

#### UNIT - 3 15 Hours

**Origin of Life:** origin of life and its theories

**Introduction to Evolutionary Theories:** Lamarckism, Darwinism, Neo-Darwinism.

**Evidence in favour of organic evolution:** Fossilization, Types of fossils. Dating of fossils. Geological Time Scale, Morphological and paleontological evidence in favour of evolution Processes.

**Evolutionary Change:** Organic variations, Isolating Mechanisms; Natural selection (Example: Industrial melanism). Artificial selection.

#### UNIT - 4 15 Hours

**Species Concept:** Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric and Sympatric)

**Macro-evolution:** Macro-evolutionary Principles (example: Darwin's Finches)

**Direct Evidence of Evolution:** Evolution of man, Phylogeny of horse.

#### SUGGESTED READINGS:

1. **Principles of Genetics** by Gardner Eldon John, Michael J. Simmons, and Peter Snustad. John Wiley & Sons, Inc., New York.
2. **Genetics** by Kavita B. Ahluwalia, Wiley Eastern Ltd., New Age International Ltd., New Delhi.

3. **A Textbook of Genetics** by H. S. Bhamrah and C. M. Chaturvedi, Anmol Publications Pvt. Ltd., New Delhi.
4. **Cell Biology, Genetics, Molecular Biology, Evolution and Ecology** by Dr. P. S. Verma and Dr. V. K. Agarwal. S. Chand & Company Pvt. Ltd., New Delhi.
5. **Genetics: A Survey of the Principles of Heredity** by A. M. Winchester. Oxford and IBH.
6. **Principles of Molecular Genetics** by S. Sundara Rajan. Anmol Publications Pvt. Ltd.
7. **Genetics** by P. S. Verma and V. K. Agarwal. S. Chand & Company Pvt. Ltd., New Delhi.
8. **Principles of Genetics** by Edmund W. Sinnott, L. C. Dunn, and T. Dobzhansky. Tata McGraw Hill Publishing Company, New Delhi.
9. **Genetics** by Monroe W. Strickberger. Prentice Hall of India Pvt. Ltd., New Delhi.

## Fourth Semester B.Sc. Zoology (Practical)

### Paper Title: Genetics and Evolutionary Biology

Teaching Hours: 4 H / Week  
Total hours: 48

Marks: 40+IA-10  
Credits: 2

1. Study of Mendel an Inheritance and gene interactions (Non-Mendelian Inheritance) using suitable examples.
2. Study of Linkage, recombination.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil (Use models and pictures).
5. Study of homology and analogy from suitable specimens / pictures.
6. Evolution of horse and Darwin's Finches (with diagrams / pictures).
7. Evolution of man with diagrams.
8. Preparation of salivary gland chromosomes.
9. Compulsory visit and submission of report.

#### SUGGESTED READINGS:

1. **Snustad, D. P., & Simmons, M. J.** (2009), *Principles of Genetics* (5th ed.), John Wiley and Sons.
2. **Klug, W. S., Cummings, M. R., & Spencer, C. A.** (2012). *Concepts of Genetics* (10th ed.). Benjamin Cummings.
3. **Russell, P. J.** (2009). *Genetics: A Molecular Approach* (3rd ed.), Benjamin Cummings.
4. **Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C., & Carroll, S. B.** *Introduction to Genetic Analysis* (9th ed.), W. H. Freeman and Co.
5. **Ridley, M.** (2004), *Evolution* (3rd ed.), Blackwell Publishing.
6. **Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B., & Patel, N. H.** (2007), *Evolution*. Cold Spring Harbor Laboratory Press.
7. **Hall, B. K., & Hallgrímsson, B.** *Evolution* (4th ed.). Jones and Bartlett Publishers.
8. **Futuyma, D. J.** (1997) *Evolutionary Biology*, Sinauer Associates.

## **B. Sc –IV Semester Zoology Skill Major-1**

### **Paper Title: Vermi Technology**

#### **No Theory Only Practical**

**Teaching Hours: 4H / Week**

**Total Hours : 48**

**Marks: Th-40+IA-10**

**Credits: 2**

- Practical 1** : Biology of Earthworm-Morphological And Anatomical Study.
- Practical 2** : Study of Endogeeic And Epigeic Earthworms Species.
- Practical 3** : Collection of Earthworm and soil samples of Surroundings(habitat).
- Practical 4** : Establishment of Warmicamposting/Warmiculturing Structures.
- Practical 5** : Solid waste Collection and Segregation, Detailed Study on Decaying And Non Decaying Solid waste.
- Practical 6** : Raring of Eudrilus Eugenia and Eisaniae Foetida.
- Practical 7** : Preparation of WarmiCulture / Warmicamposting beds.
- Practical 8** : Warmicampost Harvesting and storing Methods.
- Practical 9** : Detailed Account - Equipment's and devices required for Warmicamposting.
- Practical 10** : Visit to warmiculture/ Warmicamposting Units - Around Karnataka.

#### **SUGGESTED READINGS:**

1. Radha D. Kale (1998), *Earthworms: Cinderella of Organic Farming*. Prism Books Pvt. Ltd. ISBN: 81-7286-100-1
2. Edwards, C.A., and J.R. Lofty (1977), *Biology of Earthworms*. Chapman and Hall Ltd., London.
3. Lee, K.E. (1985). *Earthworms: Their Ecology and Relationship with Soils and Land Use*. Academic Press, Sydney.
4. Dash, M.C., B.K. Senapati, and P.C. Mishra (1980), *Verms and Vermicomposting*. Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting, Dec. 5–8, 1984 (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa.
5. Kevin, A., and K.E. Lee (1989), *Earthworms for Gardeners and Fishermen*. CSIRO, Australia, Division of Soils.
6. Satchell, J.E. (1983), *Earthworm Ecology*. Chapman and Hall, London.
7. Wallwork, J.A. (1983), *Earthworm Biology*. Edward Arnold (Publishers) Ltd., London.

## Fourth Semester B.Sc. Zoology

### ELECTIVE-II

Paper Title: **Aquarium Fish Keeping**

Teaching Hour: 3H / Week  
Total Hours : 30

Marks: Th-40+IA-10  
Credits: 3

#### Unit-1 15 Hours

<b>Introduction to Aquarium Fish Keeping:</b> The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	15
<b>Biology of Aquarium Fishes:</b> Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Goldfish, Angel fish, blue morph, Anemone fish and Butterfly fish	
<b>Food and feeding of Aquarium fishes:</b> Use of live fish feed organisms. Preparation and composition of formulated fish feeds	

#### Unit-2 15 Hours

<b>Fish Transportation:</b> Live fish transport - Fish handling, packing and forwarding techniques.	15
<b>Maintenance of Aquarium:</b> General Aquarium maintenance – budget for setting up an Aquarium Fish Farm. <b>as a, Cottage Industry</b>	
<b>Aquarium design, Construction and preparation:</b> size, shape, substrate, ornamental aquatic plants. Construction and functions of Bio-filters; aerators – accessories for fish tanks and maintenance of water quality: controlling ammonia build up, pH	

#### SUGGESTED READINGS:

1. Baradach, J. E., J. H. Ryther, and W. O. McLarney (1972). *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms*. Wiley Interscience, New York.
2. Jameson, J. D., and R. Santhanam (1996). *Manual of Ornamental Fisheries and Farming Technology*, Fisheries College and Research Institute, Thoothukudi.
3. Mitchell Beazley (1998). *The Complete Guide to Tropical Aquarium Fish Care*. Read and Consumes Book Ltd., London.
4. Jameson, J. D. *Alangara Meen Valarpu* (in Tamil), National Book House, New Delhi.
5. Mill, Dick (1993), *Aquarium Fish*. DK Publ. Co., Inc., New York, USA.



## V SEMESTER B.Sc (ZOOLOGY)

### PAPER I – CYTOLOGY AND MOLECULAR BIOLOGY

Paper Code: ZOODSCT 5.1

Type of Course	Theory / Practical	Credits	Teaching Hours per week	Total no. of teaching hours / semester	Duration of exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 5.1	Theory	03	04	60	03 Hrs	20	80	100

**Course outcomes (COs):** After completion of the course students should be able to:

- Familiarize students with the structural and functional aspects of cell, and its different organelles.
- Understand the cyclic events and types of cell division, processes of cell death and cellular ageing.
- Comprehend the knowledge on cancer cell and causes of cancer.
- Explain the structure and function of DNA, RNA, and proteins, including molecular organization in prokaryotic and eukaryotic systems.
- Describe transcription, RNA processing, translation, and regulation of gene expression in prokaryotes and eukaryotes.
- Illustrate the mechanisms of DNA replication, DNA repair pathways, and genetic recombination processes in cells.

#### UNIT – I : CELL BIOLOGY

**15 HOURS.**

- a) **Ultra structure of animal cell:** Introduction of cell: Definition, Shape, size and types.  
Ultra-Structure & function of cell organelles: Plasma membrane: Chemical composition, Fluid Mosaic model, role of lipids in maintaining fluidity of cell membrane. **05 Hrs.**
- b) **Functions of plasma membrane:** Passive transport (Simple and Faciliated diffusion, Osmosis). Active transport ( $\text{Na}^+$ ,  $\text{H}^+$  and  $\text{Ca}^{2+}$  pumps. Exocytosis, Endocytosis – Phagocytosis and Pinocytosis. **07 Hrs.**
- c) **Cell to cell interactions (Cell Junctions):** Definition, types (Tight junctions, Desmosomes and Gap junctions) and their significance. **03 Hrs.**

#### UNIT – II : CELL BIOLOGY

**15 HOURS.**

- a) **Cytoplasm:** Properties.  
**Ultrastructure and functions of Cell organelles:** Endoplasmic Reticulum, Golgi-complex, Mitochondria, Ribosomes, Centrosome. **05 Hrs.**
- b) **Ultrastructure and functions of Cell organelles:** Lysosomes, Peroxisomes and Glyoxisomes.  
**Cytoskeleton:** Microfilaments, Intermediate filaments and Microtubules. Ultrastructure of cilia and flagella. **05 Hrs.**
- c) **Nucleus:** Introduction, Nuclear envelope, Nucleoplasm, Chromatin network – heterochromatin and euchromatin. Functions of nucleus.  
**Ultrastructure of Chromosome:** Nucleosome model. **05 Hrs.**

#### UNIT – III : CELL BIOLOGY

**15 HOURS.**

- a) **Cell Cycle and Cell division:** Various stages and significance of Mitosis and Meiosis in animal cell. Cell cycle (Phases -  $G_1$ , S,  $G_2$ , M, Checkpoints, Cyclins and CDKs) and its regulation. **05 Hrs.**

b) **Parthenogenesis:** Definition, types – Natural (Arrhenotoky and Thelytoky) and Artificial parthenogenesis. Significance.

**Cell ageing and Cell death:** Cell Senescence: Definition and examples. Apoptosis: Definition and significance. **5 Hrs.**

c) **Cancer Biology:** Introduction, types, general properties of cancer cells. Carcinogens (Physical, Chemical and Biological carcinogens), Prevention and treatment (Chemotherapy, Radiotherapy and Gene therapy). **05 Hrs.**

#### **UNIT – IV : MOLECULAR BIOLOGY**

**15 HOURS.**

a) **Definition and introduction.**

**Nucleic acids:** Identification of DNA as genetic material (Griffith's experiment), structure of DNA – Watson and Crick double helix model. Types of DNA. Replication of DNA: Conservative and semi-conservative methods. **05 Hrs.**

b) **RNA:** Molecular structure, types of RNA (mRNA, rRNA and tRNA) and functions. Genetic code and protein synthesis. Differences between DNA and RNA. **05 Hrs.**

c) **Concept of gene: Fine structure of Gene:** Cistron, Recon and Muton. Regulation of gene expression in Prokaryotes (**Operon concept**): Lac operon (Inducible) and trp operon (repressible) in E. coli. **05 hrs.**

#### **References:**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VII Edition, Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M and Hausman, R. E (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D. C; Sinauer Associates, MA.
4. 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 Fransico.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the cell, V Edition, Garland publishing Inc. New York and London.
6. Powar C. B; Cell Biology, Himalaya Publication, Meerut.
7. P. S. Verma and V.K Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Multicolour Edition, S. Chand and Company Ltd, New Delhi.

## V SEMESTER B.Sc (ZOOLOGY)

### PAPER II – ECONOMIC ZOOLOGY AND ETHOLOGY (THEORY)

Paper Code: ZOODSCT 5.2

Type of Course	Theory / Practical	Credits	Teaching Hours per week	Total no.of teaching hours / semester	Duration of exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 5.2	Theory	03	04	60	03 Hrs	20	80	100

**Course outcomes:** At the end of the course the student will be able to:

- Gain knowledge about silkworms rearing and their products.
- Gain knowledge in Bee keeping equipment and apiary management.
- Acquaint knowledge on dairy animal management, the breeds and diseases of cattle and learn the testing of egg and milk quality.
- Acquaint knowledge about the culture techniques of fish and poultry.
- Acquaint the knowledge about basic procedure and methodology of Vermiculture.
- Learn various concepts of lac cultivation.
- Students can start their own business i.e. Self-employments.
- Get employment in different applied sectors.

#### UNIT – I : ECONOMIC ZOOLOGY

15 HOURS.

- a) **Prawn fisheries:** Species of prawns, culture of freshwater and marine prawns, processing and preservation of prawns. **04 Hrs.**
- b) **Sericulture:** Definition, Species of silk worm, Life cycle of silk moth (*Bombyx mori*), rearing and management practices, pests and diseases of silkworm, by-products of sericulture. **04 Hrs.**
- c) **Lac culture:** Classification and life history of Lac insect (*Tachardia lacca*). Cultivation, composition, properties of Lac and economic importance. **03 Hrs.**
- d) **Economic importance of Insects:** Beneficial insects and harmful insects. Chemical, Mechanical and Biological control of insect pests. Vectors: prevention and control of termite, mites and ticks. **04 Hrs.**

#### UNIT –II : ECONOMIC ZOOLOGY

15 HOURS.

- a) **Pearl culture:** Pearl producing molluscans, pearl formation (Natural and Artificial insertion of nucleus), pearl producing sites in India. Quality and composition of pearl industry. **03 Hrs.**
- b) **Pisciculture:** Definition, Brief technique of fish culture, Composite fish culture, Processing and Preservation of fishes and their by-products. **03 Hrs.**
- c) **Poultry:** Breeds of fowls - Indigenous and Exotic breeds (American class, Asiatic class, English class and Mediterranean class breeds), maintenance of poultry farm, Backyard and Cage system of rearing, diseases of poultry, Composition of egg and nutritive value of egg. **04 Hrs.**
- d) **Dairy technology:** Cattle (indigenous and exotic) and Buffalo breeds, Artificial insemination and MOET, Diseases of cattle and buffaloes (foot and mouth, mastitis, brucellosis and anthrax). Products and byproducts. Composition and nutritive value of milk. **05 Hrs.**

#### UNIT – III : ECONOMIC ZOOLOGY

15 HOURS.

- a) **Introduction to Host-parasite Relationship:** Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism. **03 Hrs.**

- b) **Parasites:** Study of morphology, life cycle, pathogenicity and control measures of parasitic protozoans: *Entamoeba histolytica*, *Plasmodium vivax*, *Trypanosoma gambiense* and *Giardia intestinalis*. **04 Hrs.**
- c) **Study of morphology, life cycle, pathogenicity and control measures of parasitic worms:** *Taenia solium*, *Fasciola hepatica*, *Ancylostoma duodenale*, *Wuchereria bancrofti*. **04 Hrs.**
- d) **Epidemiology of Diseases:** Transmission, Prevention and control of diseases: Tuberculosis, Typhoid, Cholera. **04 Hrs.**

**UNIT – IV : ETHOLOGY (ANIMAL BEHAVIOUR)**

**15 HOURS.**

- a) Introduction to animal behaviour, historical perception, aims and objectives. Contributions of Lorenz, Tinbergen and Karl Von Frisch. **02 Hrs.**
- b) **Types of animal behaviour:** **06 Hrs.**
1. Innate (Stereotyped) Behaviour: Taxes, Reflexes, Instincts and Motivation with suitable examples.
  2. Learned (Acquired) Behaviour: Habituation, Imprinting, Conditioned, Reflexes and Insight learning with suitable examples.
  3. Social behaviour: Types of animal society and colony in Honey Bees and Monkeys troops.
  4. Territoriality & Courtship Behaviour in Scorpion Stickle Back Fish and Peacock.
- c) **Pheromones (Chemical communication):** Definition and types. Pheromones in insects and vertebrates. **02 Hrs.**
- Biological rhythms:** Definition, Circadian rhythm and Biological clock. **01 Hr.**
- Communication in Animals:** Dances of Honey bees, Echolocation system in Bat, Alarm calls, Aggression and Bioluminescence. **03 Hrs.**
- d) **Parental care:** Concepts, Parental care in Fishes and Birds (two examples in each). **01 Hr.**

**REFERENCES:**

1. Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers
2. Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors
3. Kumar and Corton. Pathological Basis of Diseases
4. Atwal, A.S. (1986). Agricultural Pests of India and South East Asia, Kalyani Publishers
5. Dennis, H. (2009). Agricultural Entomology. Timber Press
6. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher
7. Dunham R.A. (2004). Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K
8. Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall
9. Economic Zoology by Shukla and Upadhyay (2016)
10. Economic Zoology by Reena and Mathur (2006)
11. Animal behavior by Alock (2013)
12. Animal behavior by Robert A (1966)
13. Learning and Instinct in animals by Thorpe (1956)
14. Ethology by Reena Mathur (1998)
15. Introduction to Animal behavior by Manning A and M. S. Dawkins (1012)
16. E. L. Jordan and P. S. Verma (2002) Invertebrate Zoology, S. Chand and Company.
17. P. S. Dhami and J. K Dhami (1994), Invertebrate Zoology, R. Chand and Company Ltd.
18. Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

19. Ganga, G. (2003). Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
20. Mahadevappa, D., Halliyal, V.G., Shankar, D.G. and Bhandiwad, R., (2000). Mulberry Silk.

## V SEMESTER B.Sc (ZOOLOGY) - PRACTICAL

### CYTOLOGY, MOLECULAR BIOLOGY, ECONOMIC ZOOLOGY AND ETHOLOGY

#### Paper Code: ZOODSCP 5

Type of Course	Theory / Practical	Credits	Teaching Hours per week	Total no.of teaching hours / semester	Duration of exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 5	Practical	02	04	48	04 Hrs	10	40	50

1. Squash preparation of onion root tips to study various stages of Mitosis.
2. Mounting: Preparation of a whole mount of fish scale / Appendages of prawn.
3. Study of permanent slides of Mitosis and Meiosis
4. Study of types of silkworm species and life cycle of *Bombyx mori*
5. Social behaviour in termites – study of different castes.
6. Preparation of buccal smear for sex chromatin.
7. Mounting of mitochondria by using Janus green stain.
8. Study of fresh water and marine fishes –Oil sardine, Indian mackerel, Seer fish, Indian salmon, Pomfret, Rohu, Catla, Mrigala, Tilapia, Wallago attu.
9. Study of poultry breeds (Indigenous and Exotic breeds) and diseases.
10. Study of Cattle and buffalo breeds.
11. Study of Mimicry / Camouflage by using charts/models of Viceroy butterfly, Spider tailed horned viper, Scarlet king snake, Stick insect/Leaf insect, Chameleon, Octopus.
12. Visit to poultry farm or animal breeding center/Molecular cell Biology Center / Lab. and Submission of report

**SCHEME OF PRACTICAL EXAMINATION.**

**V SEMESTER B.Sc ZOOLOGY**

**CYTOLOGY, MOLECULAR BIOLOGY, ECONOMIC ZOOLOGY AND ETHOLOGY**

**Paper Code: ZOODSCP 5**

**Duration: 4 hrs.**

**Max. Marks: 40**

<b>01</b>	<b>Major experiment</b> Squash preparation of onion root tips to study various stages of Mitosis.  OR  Mounting: Preparation of a whole mount of fish scale / Appendages of prawn.	<b>12 Marks</b>
<b>02</b>	<b>Minor Experiment</b> Study of types of silkworm species and life cycle of <i>Bombyx mori</i>  OR Social behaviour in termites – study of different castes.  OR Preparation of buccal smear for sex chromatin.  OR Mounting of mitochondria by using Janus green stain.	<b>08 Marks</b>
<b>03</b>	<b>Identification (A-E)</b> <b>A.</b> Study of permanent slides of Mitosis and Meiosis. <b>B.</b> Study of fresh water and marine fishes –Oil sardine, Indian mackerel, Seer fish, Indian salmon, Pomfret, Rohu, Catla, Mrigala, Tilapia, Wallago attu. <b>C.</b> Study of poultry breeds (Indigenous and Exotic breeds) and diseases. <b>D.</b> Study of Cattle and buffalo breeds. <b>E.</b> Study of Mimicry / Camouflage by using charts/models of Viceroy Butterfly, Spider tailed horned viper, Scarlet king snake, Stick insect/Leaf insect, Chameleon, Octopus.	<b>10 Marks</b>
<b>04</b>	Viva	<b>02 Marks</b>
<b>05</b>	Journal	<b>03 Marks</b>
<b>06</b>	Submission of visit / Study tour report	<b>05 Marks</b>
<b>TOTAL</b>		<b>40 MARKS</b>

## B.Sc Semester – V

### Skill Enhancement Course: SEC-2

#### CourseTitle: THE BEE KEEPING (Practical only)

Type of Course	Theory/ Practical	Credits	Instruction hour/week	Total No. of Practicals / Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
SEC-2	Practical	02	04	48 hrs	4 hrs	10	40	50

#### Course Outcomes (COs): At the end of the course students will be able to:

CO1: Explain what the prerequisite to get started in beekeeping.

CO2: Discuss the responsibilities of urban beekeepers.

CO3: Identify where to purchase equipment and demonstrate how to assemble it.

CO4: Name and identify major parts of the honeybee such as mouth parts, sting apparatus and mandibular parts.

CO5: Describe bee biology and anatomy from the perspective of managing bees.

CO6: Describe the importance and usage of honey and bee wax.

Expt No.	SEC-2: Course Title: The Bee Keeping - Practical	48 hrs/ Sem
1	Study of general characters and anatomy of honeybee	4
2	Systematic position and classification of honeybee	4
3	Study of life cycle of honeybee	4
4	Mounting of sting apparatus of honeybee	4
5	Study of castes in honeybees	4
6	Identification of honey bee species	4
7	Study of social organization in honeybees	4
8	Requirements of beekeeping: Hive, Protective gear, smoker, hive tool and other equipments (Charts)	4
9	Study of honeybee by-products and their uses (Charts)	4
10	Study of diseases of honeybees (Charts)	4
11	Study of pests of honeybees (Charts)	4
12	Field study of nearby Apiary/bee keeping unit and submit a report	4

**References:**

1. The Hive and the Honey Bee – Joe M. Graham (Ed.)
2. Beekeeping: A Practical Guide – R. K. Sharma
3. The ABC and XYZ of Bee Culture – Amos Ives Root
4. Beekeeping in India – S. Singh
5. A Textbook of Apiculture – G. K. Ghosh
6. Honey Bee Biology and Beekeeping – Mark L. Winston
7. The Biology of the Honey Bee – Mark L. Winston
8. Practical Manual of Apiculture – L. R. Verma
9. Beekeeping for Beginners – Adrian Waring & Claire Taylor
10. Beekeeping: Science and Practice – R. C. Mishra
11. Scientific Writing and Communication – Angelika H. Hofmann

**SCHEME OF PRACTICAL EXAMINATION.****V SEMESTER B.Sc ZOOLOGY – SEC-2****CourseTitle: THE BEE KEEPING****Duration: 4 hrs.****Max. Marks: 40**

Perform all the experiments as per the instructions in each question

<b>Semester end Examination for Practical</b>	
<b>Assessment</b>	<b>Distribution of Marks</b>
<b>1. Major Experiments</b> Mounting of sting apparatus of honeybee Or Study of life cycle of honeybee	<b>12</b>
<b>2. Minor Experiments</b> Study of castes in honeybees Or Study of social organization in honey bees	<b>08</b>
<b>3. Identifications (A-E) Any five</b>	<b>10</b>
<b>4. Viva</b>	<b>02</b>
<b>5. Journal</b>	<b>03</b>
<b>6. submission of Field visit report</b>	<b>05</b>
<b>Total</b>	<b>40 Marks</b>

## VI SEMESTER B.Sc (ZOOLOGY)

### PAPER I – BIOTECHNOLOGY, TECHNIQUES IN BIOLOGY AND REPRODUCTIVE HEALTH.

Paper Code: ZOODSCT 6.1

Type of Course	Theory / Practical	Credits	Teaching Hours per week	Total no.of teaching hours / semester	Duration of exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 6.1	Theory	03	04	60	03 Hrs	20	80	100

#### Course Outcomes: (COs)

After successful completion of the course, students will be able to:

- Understand the basic concepts and achievements of biotechnology and explain the cellular and molecular basis of biotechnology in prokaryotic and eukaryotic systems.
- Describe the structure and organization of DNA and explain the role of enzymes used in molecular biology such as restriction endonucleases, ligases, kinases, and nucleases.
- Explain and apply important molecular biology techniques including gel electrophoresis and blotting methods (Southern, Northern, and Western blotting).
- Demonstrate knowledge of genetic engineering techniques, methods of gene transfer, cloning vectors, and the development and applications of transgenic animals and animal cloning.
- Understand modern biological analytical techniques such as microscopy, spectroscopy, chromatography, and X-ray crystallography and their applications in biological research.
- Explain reproductive health issues and modern reproductive technologies, including assisted reproductive techniques, contraceptive methods, and prevention and management of sexually transmitted diseases.

#### UNIT - I

- 1. General introduction to biotechnology** **15 HOURS.**
- 1.1** Introduction and Achievements of biotechnology **3 Hrs.**
- 1.2** Cell and molecular basis of biotechnology: Prokaryotic and Eukaryotic cell, Structure and organisation of DNA in Prokaryotes and Eukaryotes. **5 Hrs.**
- 1.3** Gel electrophoresis, Southern blotting, Northern Blotting, Western Blotting. **4 Hrs.**
- 1.4** Restriction endonucleases, DNA ligases, Kinase, Phosphatase, Nucleases **3 Hrs.**

#### UNIT-II

- 2. Genetic engineering and Application of Animal Biotechnology** **15 HOURS.**
- 2.1** Methods of gene transfer – Microinjection, electroporation, lipofection and viral mediated gene transfer techniques **3 Hrs.**
- 2.2** Livestock improvement: Manipulation of reproduction in animals (Artificial insemination, multiple ovulations, in vitro fertilisation, Embryo transfer technology) **3 Hrs.**
- 2.3** Animal Cloning - Cloning in different animals with special reference to Dolly. Enzymes used in gene cloning Polymerases, Cloning vectors (Plasmids, Phages, Cosmids, Yeasts Shuttle vectors), viral vectors (SV40, Adenovirus and Baculovirus) used in Gene cloning. **5 Hrs.**

- 2.4** Transgenic animals and their Potential applications: models for various diseases / disorders, production of peptides (Monoclonal antibodies) and proteins of biopharmaceutical interest (molecular farming). **4 Hrs.**

### **UNIT-III**

## **3. Techniques in Biology 15 HOURS.**

- 3.1 Microscopy:** Principles and applications of Light, Fluorescent, Phase contrast, Electron microscopy **4 Hrs.**
- 3.2 Spectroscopy:** Beer-Lambert's Law, Principles and applications of UV-Vis Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Mass Spectroscopy **4 Hrs.**
- 3.3 Chromatography:** Principles and applications of Paper Chromatography, Column Chromatography, HPLC, Gas Chromatography **4 Hrs.**
- 3.4 Crystallography:** X-ray Diffraction crystallography **3 Hrs.**

### **UNIT-IV**

## **4. Reproductive Health 15 HOURS.**

- 4.1. Reproductive Health:** Infertility in male and female: causes, diagnosis and management. **4 Hrs.**
- 4.2. Assisted Reproductive Techniques:** Induction of ovulation, AI, sperm banks, frozen embryos, IVF, ET, GIFT, ZIFT, ICSI, and Surrogacy. **4 Hrs.**
- 4.3. Contraceptive methods in male and female:** Natural methods, Barrier methods, IUD's, Hormonal contraceptive, surgical methods used in family planning. **4 Hrs.**
- 4.4. Sexually transmitted diseases (STDs):** Gonorrhoea, Syphilis, Genital Herpes, HPV, HIV Causes, Symptoms, Prevention and Treatment. **3 Hrs.**

## VI SEMESTER B.Sc (ZOOLOGY)

### ECOLOGY AND BIostatISTICS

#### Paper Code: ZOOSCT 6.2

Type of Course	Theory / Practical	Credits	Teaching Hours per week	Total no. of teaching hours / semester	Duration of exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 6.2	Theory	03	04	60	03 Hrs	20	80	100

#### Course Outcomes (Cos)

After successful completion of this course, the student will be able to:

- Understand the fundamental concepts of ecology, including habitat, ecological niche, abiotic factors, energy flow, and ecosystem productivity.
- Explain population and community ecology, including population attributes, growth patterns, dispersion, and various interspecific interactions.
- Describe ecological succession and climax communities, and interpret examples such as hydrosere and xerosere.
- Analyze major environmental issues such as global warming, greenhouse effect, acid rain, and ozone layer depletion, along with their causes, impacts, and control measures.
- Evaluate environmental toxicology and resource management, including pesticides, heavy metals, biomagnification, integrated pest management, renewable energy resources, and wildlife conservation strategies.
- Apply basic biostatistical methods such as measures of central tendency, dispersion, probability, correlation, regression, and tests of significance for analyzing biological data.

#### UNIT: I ENVIRONMENTAL BIOLOGY (Ecology)

15 HOURS.

##### a) Fundamentals of Ecology:

6 Hrs.

- i. Sub-divisions and Scope of Ecology.
- ii. Concept of habitat: Micro-habitat and Macro-habitat.
- iii. Concept of Ecological Niche: Spatial, Trophic and Multidimensional.
- iv. Abiotic factors: Light, Temperature and Soil.
- v. Energy Flow in the Ecosystem: First and Second law of thermodynamics.
- vi. Primary and Secondary productivity in an ecosystem.

##### b) Population Ecology: Density, Natality, Mortality, Age distribution, Growth, Dispersion and Biotic Potential.

3 Hrs.

##### c) Community Ecology: Interspecific interactions – Negative (Ammensalism, Competition) and Positive (Commensalism, Proto co-operation and Mutualism).

3 Hrs.

##### d) Ecological succession: Definition, Causes, Types, Examples – Hydrosere and Xerosere. Concept of climax – Monoclimax theory, Polyclimax theory and Climax pattern hypothesis.

3 Hrs.

#### UNIT II CURRENT ENVIRONMENTAL ISSUES

15 HOURS.

##### a) Greenhouse effect and Global warming: Introduction, Greenhouse gases and their main anthropogenic sources, Global warming and its impact on climate change (sea level change, crop yield, water balance) and human health, control measures.

5 Hrs.

- b) **Acid rain:** Introduction, Nature of acid rain, Impact of acid rain on human health, aquatic environment, terrestrial environment, and the historical monuments in India, control measures. **5 Hrs.**
- c) **Ozone layer depletion:** Introduction, Ozone layer depletion process, Consequence of Ozone layer depletion– human health, terrestrial ecosystem, aquatic ecosystem and climate, control measures. **5 Hrs.**

### UNIT III TOXICOLOGY

**15 HOURS.**

- a) Definition, Toxins–Types: Insecticides (Chlorinated hydrocarbons, Organophosphates and Carbamate), Rodenticides, Herbicides, Fungicides and Heavy metals (Lead, Mercury, Cadmium & Arsenic), Concept of Biomagnification and Biotransformation. **5 Hrs.**
- b) **Integrated pest management (IPM):** Definition and types.  
**Energy Resources:** Types: renewable and non-renewable, Non-Conventional renewable sources of energy: Solar, Tidal, Wind, Geothermal, Biogas, Biodiesel, Hydrogen –the fuel of future.  
**Nuclear energy:** Definition, advantages and disadvantages of nuclear power plants. **5 Hrs.**
- c) **Solid waste management:** Disposal and recovery (Collection centres, Land filling, Incinerations, Recycling of Wastes and construction of Sanitary Latrines).  
**Wild life conservation and its management:** Red data book. In situ conservation: Wild life sanctuaries, National parks and Biosphere reserves. Ex situ conservation: Zoological gardens.  
**Remote sensing:** Definition, types (Satellite remote sensing and Microwave remote sensing) and applications.  
**Geographic information system (GIS):** Definition, components and applications. **5 Hrs.**

### UNIT IV BIOSTATISTICS

**15 HOURS.**

#### a) Biostatistics I

- Measures of central tendency: Mean, Median, Mode. **3 Hrs.**
- Data summarizing: Frequency distribution, Graphical presentation - bar diagram, pie diagram, histogram. **3 Hrs.**
- Elementary idea of probability and its applications. **2 Hrs.**

#### b) Biostatistics II

- Measures of dispersion: Range, Standard Deviation, Variance. **3 Hrs.**
- Correlation and Regression. **1 Hr.**
- Tests of significance: F-test, ANOVA, t-test and Chi square test. **3 Hrs.**

## **References:**

1. Fundamentals of Ecology — Eugene P. Odum & Gary W. Barrett.
2. Ecology: From Individuals to Ecosystems — Michael Begon, Colin R. Townsend & John L. Harper.
3. Environmental Biology and Toxicology — P. D. Sharma.
4. Environmental Science: A Global Concern — William P. Cunningham & Barbara Woodworth Saigo.
5. Environmental Science — Jonathan Turk & Amos Turk.
6. Elements of Ecology by Clarke (2015).
7. Environmental Biology: Principles of Ecology — P. S. Verma & V. K. Agarwal.
8. Concepts of Ecology — Edward J. Kormondy.
9. Biostatistics — P. N. Arora & P. K. Malhan.
10. Statistical Methods — George W. Snedecor & William G. Cochran.
11. Elements of Biostatistics — S. G. Prasad.
12. Introduction to Biostatistics by Dr. Pranab Kumar Banerjee (2004)

## VI SEMESTER B.Sc ZOOLOGY (PRACTICAL)

### BIOTECHNOLOGY, TECHNIQUES IN BIOLOGY, REPRODUCTIVE HEALTH, ECOLOGY AND BIOSTATISTICS.

Type of Course	Theory / Practical	Credits	Teaching Hours per week	Total no. of teaching hours / semester	Duration of exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
<b>DSC – 6</b>	<b>Practical</b>	<b>02</b>	<b>04</b>	<b>48</b>	<b>04 Hrs</b>	<b>10</b>	<b>40</b>	<b>50</b>

1. Isolation of DNA from an animal/plant source
2. Electrophoretic separation of DNA
3. Estimation of dissolved oxygen by Winkler's method.
4. Estimation of free carbon dioxide in different water samples
5. Chromatographic separation of pigments from animal/plant source
6. Estimation of chlorides in different water samples
7. Study of Light and Electron Microscopes through charts/models
8. Examination of water samples from nearby ponds and tanks for the identification of phytoplankton and zooplankton.
9. Study of transgenic animals used in molecular farming through charts/models
10. Study of Ecological Adaptations by using charts/models: Arenicola and Chaetopterus, Dentalium, Sea anemone and Lepas, Exocoetus, Draco, Bat, Phrynosoma and Hyla
11. Study of species interaction by using charts/models: Mutualism, Commensalism, Ammensalism, Competition, Predation and Parasitism with one example each.
12. Biostatistics : Problem on Graphical presentation of Data with suitable example

**SCHEME OF PRACTICAL EXAMINATION.**  
**VI SEMESTER B.Sc ZOOLOGY**  
**BIOTECHNOLOGY, TECHNIQUES IN BIOLOGY, REPRODUCTIVE HEALTH,**  
**ECOLOGY AND BIostatISTICS.**

**Paper Code: ZOODSCP 6**

**Duration: 4 hrs.**

**Max. Marks: 40**

<b>01</b>	Major Experiments: Isolation of the given sample DNA. <p style="text-align: center;">OR</p> Electrophoretic separation of DNA. <p style="text-align: center;">OR</p> Estimation of dissolved oxygen by Winkler's method. <p style="text-align: center;">OR</p> Estimation of carbon dioxide in different water samples.	<b>12 Marks</b>
<b>02</b>	<b>Minor experiments:</b> Separation of pigments from the given sample using paper chromatography. <p style="text-align: center;">OR</p> Estimation of <b>chloride</b> in different water samples. <p style="text-align: center;">OR</p> Biostat: Problem on Graphical presentation of Data with suitable example.	<b>08 Marks</b>
<b>03</b>	Identification (A – E) A) Microscopy- Phase contrast microscope / Electron microscope / Fluorescent microscope. B) Examination of water samples from nearby ponds and tanks for the identification of phytoplankton and zooplankton. C) Transgenic Animals- Transgenic Mice / Transgenic cow. D) Study of Ecological Adaptations by using charts / models: Arenicola and Chaetopterus, Dentalium, Sea anemone and Lepas, Exocoetus, Draco, Bat, Phrynosoma and Hyla E) Study of species interaction by using charts/models: Mutualism, Commensalism, Ammensalism, Competition, Predation and Parasitism with one example each.	<b>10 Marks</b>
<b>04</b>	Viva	<b>05 Marks</b>
<b>05</b>	Journal	<b>05 Marks</b>
<b>TOTAL</b>		<b>40 MARKS</b>

**B.Sc.Semester–VI****Skill Enhancement Course: SEC-3****Course Title: MICROBIOLOGY (Practical Only)**

Type of Course	Theory/ Practical	Credits	Instruction hour/week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
SEC-3	Practical	02	04	48 hrs	4 hrs	10	40	50

**Course Outcomes (COs):**

After successful completion of this course, the students will be able to:

- CO1: Understand and operate a compound microscope and prepare wet mounts for observing microorganisms.
- CO 2: Perform basic staining techniques, including simple staining and Gram staining, to differentiate bacterial cells.
- CO3: Prepare culture media and apply sterilization techniques commonly used in microbiology laboratories.
- CO 4: Demonstrate microbial inoculation techniques such as the streak plate method and isolate microorganisms from different sources.
- CO 5: Isolate and study microbes from environmental samples such as soil, water, and air, and observe microbial colony morphology.
- CO 6: Carry out basic biochemical tests and analyze microbial growth patterns, including interpretation of microbial growth curves.

Expt. No.	SEC-3: Course Title: MICROBIOLOGY	48 hrs / Sem
1	Study of Compound Microscope	4
2	Preparation of Wet Mount and simple staining	4
3	Gram staining of Bacteria	4
4	Preparation of Culture media for micro organisms	4
5	Sterilization Techniques used in Microbiology	4
6	Inoculation of micro organisms by Streak plate method	4
7	Isolation of Microbes from Soil by Serial method	4
8	Isolation of Microbes from Water	4
9	Isolation of Microbes from Air	4
10	Study of microbial colony morphology	4
11	Biochemical Tests for identification of microbes (Indole test and Methyl test)	4
12	Spotters: Hot Air Oven, autoclave, Pressure cooker, agar plate, Inoculation needle, Laminar Air Flow. Common Microbes : Bacteriophage, Lactobacillus, E. coli, Yeast, Rhizopus and Entamoeba	4

**Reference books and Manuals**

1. Microbiology: A Laboratory Manual – James G. Cappuccino & Chad T. Welsh
2. Basic Microbiology: An Illustrated Laboratory Manual – B. K. Khuntia
3. Laboratory Methods in Microbiology – W. F. Harrigan & Margaret E. McCance
4. Practical Manual of Modern Microbiology – Arup Kumar Mitra & Kasturi Sarkar
5. Laboratory Manual in Microbiology – Balkrishna M. Sandikar & Shaileshkumar V. Mamdapure
6. Microbiology Practical Manual – Amita Jain, Jyotsna Agarwal & Vimala Venkatesh
7. Handbook on Practical Microbiology – Palanisamy Senthilkumar et al.
8. Laboratory Practical Manual for Medical Microbiology and Parasitology – Samuel Iheanacho Nwadioha et al.
9. Practical Manual of Pharmaceutical Microbiology – Kiran Sharma
10. Laboratory Manual of Microbiology – A. K. Roy & M. M. Prasad

**SCHEME OF PRACTICAL EXAMINATION.****VI SEMESTER B.Sc ZOOLOGY – SEC 3****MICROBIOLOGY****Duration: 4 hrs.****Max. Marks: 40**

Perform all the experiments as per the instructions in each question

<b>Semester end Examination for Practical</b>	
<b>Assessment</b>	<b>Distribution of Marks</b>
<b>1. Major Experiments</b> Gram staining of Bacteria OR Preparation of Wet Mount and simple staining.	<b>12</b>
<b>2. Minor Experiments</b> Preparation of Culture media for micro organisms OR Study of microbial colony morphology.	<b>08</b>
<b>3. Identifications (A-E) : Mainly chosen from Pract No. 12</b>	<b>10</b>
<b>4. Viva</b>	<b>05</b>
<b>5. Journal</b>	<b>05</b>
<b>Total</b>	<b>40 Marks</b>