



**Deccan Education Society's**  
**FERGUSSON COLLEGE (AUTONOMOUS)**

Learning Outcomes-Based Curriculum  
for 2 years M.Sc. Programme  
as per guidelines of  
**NEP-2020**

**S. Y. M. Sc. (Zoology)**

With effect from Academic Year  
**2024-2025**

### M. Sc. II Zoology Course Structure

| Semester            | Paper Code             | Paper Title                              | Credits |
|---------------------|------------------------|------------------------------------------|---------|
| III                 | ZOO-601                | Evolutionary Biology                     | 4       |
|                     | ZOO-602                | Molecular Biology                        | 4       |
|                     | ZOO-603                | Advanced Biostatistics                   | 4       |
|                     | OR                     |                                          |         |
|                     | ZOO-604                | Histology and Histo-chemistry            |         |
|                     | ZOO-605                | Immunology                               | 4       |
|                     | ZOO-620                | Zoology Practical-V                      | 2       |
|                     | ZOO-621                | Zoology Practical-VI                     | 2       |
|                     | Total Semester Credits |                                          | 20      |
| IV                  | ZOO-651                | Developmental Biology                    | 4       |
|                     | ZOO-653                | Biological Techniques and Bioinformatics | 4       |
|                     | OR                     |                                          |         |
|                     | ZOO-654                | Parasitology                             |         |
|                     | ZOO-670                | Zoology Practical-VII                    | 2       |
|                     | ZOO-660                | Research Project I                       | 4       |
|                     | ZOO-661                | Research Project II                      | 6       |
|                     | Total Semester Credits |                                          | 20      |
| Total PG-II Credits |                        |                                          | 40      |

| <b>S.Y M.Sc. (Zoology) Semester III</b>                                                           |                                                                                                                                                                                                                                                                                                                                                                |                                    |
|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| <b>ZOO-601</b>                                                                                    | <b>Evolutionary Biology</b>                                                                                                                                                                                                                                                                                                                                    | <b>Credits: 4<br/>Hours: 60</b>    |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                                                                                                                                                                                                | <b>Bloom's<br/>cognitive level</b> |
| CO1                                                                                               | Understand the fundamental concepts of organic evolution.<br>Identify the components of the modern synthetic theory of evolution.<br>Memorize the concepts of Chemogeny and biogeny in relation to the origin of life. Recall key milestones in the process of human evolution.                                                                                | 1                                  |
| CO2                                                                                               | Explain the different types of polymorphism, including balanced and transient polymorphism. Describe the concept of species as a real entity and the mechanisms of speciation. Interpret the basis of speciation, including isolating mechanisms.                                                                                                              | 2                                  |
| CO3                                                                                               | Analyze the impact of genetic drift and gene flow on specific populations.<br>Apply the principles of natural selection to understand adaptive processes in different environments.                                                                                                                                                                            | 3                                  |
| CO4                                                                                               | Differentiate r-selection and k-selection, founder effect and bottleneck phenomenon, balanced polymorphism and transient polymorphism and different theories of evolution. Analyze the mechanisms and patterns of speciation, including anagenesis and cladogenesis. Critically assess the role of camouflage and mimicry in the context of natural selection. | 4                                  |
| CO5                                                                                               | Evaluate the strengths and weaknesses of different lines of evidence supporting evolution.                                                                                                                                                                                                                                                                     | 5                                  |
| CO6                                                                                               | Synthesize information from different evolutionary theories to form a comprehensive understanding.                                                                                                                                                                                                                                                             | 6                                  |

| <b>Unit No.</b> | <b>Title of Unit and Contents</b>                                                                                                                                                                                                                                                                | <b>No. of<br/>Credits</b> |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| <b>I</b>        | <b>Concept, evidences and theories of evolution</b><br>Concept of Evolution<br>Basic Concept of Organic Evolution- Origin of Life, Chemogeny, Biogeny<br>Theories of evolution- Pre-Darwinian ideas, Lamarckism, Modern synthetic theory of evolution.<br>Evidences of Evolution Human evolution | <b>1</b>                  |

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|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>II</b> | <b>Polymorphism and speciation:</b><br>Origin of Polymorphism<br>Polymorphism- Balanced polymorphism, Transient polymorphism,<br>Concept of species as a real entity<br>Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation – Anagenesis and Cladogenesis<br>Basis of speciation – Isolating mechanisms | <b>1</b> |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|

|            |                                                                                                                                                                                                                                                                                                                            |          |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>III</b> | <b>Evolutionary Genetics</b> Genetic variation and its types Genetic Drift and Gene Flow Random Genetic Drift or Sewall Wright Effect Theories of Genetic Drift Salient Features of Genetic Drift Genetic Basis of Random Genetic Drift Founder Effect or Founder Principle, Bottleneck Phenomenon                         | <b>1</b> |
| <b>IV</b>  | <b>Natural Selection in Action</b> Concept, salient features and nature of Natural Selection Heterozygous Advantage or Heterosis Balancing Selection r-Selection and k-Selection, Selection Pressure or Selection Intensity Selection and Variation, Selection and Adaptations (The Baldwin Effect) Camouflage and Mimicry | <b>1</b> |

## SUGGESTED READINGS

### Classics

1. Darwin, C. 1859. On the Origin of Species. London: John Murray (always seek out the first edition, facsimile version, and avoid later editions).
2. Dobzhansky, T. 1937. Genetics and the Origin of Species. New York: Columbia Univ. Press (there are several later editions, and the title changed in the last).
3. Fisher, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press (there is a later edition).
4. Hennig, W. 1966. Phylogenetic Systematics. Urbana: Univ. Illinois Press (an English translation of a book published earlier in German).
5. Mayr, E. 1942. Systematics and the Origin of Species. New York: Columbia Univ. Press (there is a later edition, with a different title).
6. Schmalhausen, I. I. 1949. Factors of Evolution. Philadelphia: Blakiston (publication of this book, written in the early 1940's, was delayed because of war, and then the translation from Russian to English was also delayed; it has been reprinted by Univ. Chicago Press).
7. Simpson, G. G. 1944. Tempo and Mode of Evolution. New York: Columbia Univ. Press (again, there is a later edition, with a different title).

### General Books

8. Allendorf, F.w., and G. Luikart, 2007. Conservation and the Genetics of Populations. Blackwell, Oxford.
9. Crow, J. F. 1991. Basic Concepts in Population, Quantitative, and Evolutionary Genetics. New York: W. H. Freeman.
10. Falconer, D. S. 1981. Introduction to Quantitative Genetics, second ed. London: Longman.
11. Hartl, D. L. And A. G. Clark. 1989. Principles of Population Genetics, second, ed. Sunderland, MA: Sinauer.
12. Real, L. A. (ed.). 1994. Ecological Genetics. Princeton: Princeton Univ. Press (a collection of

**essays by many authors).**

13. Hall, B. J. (ed.). 1994. Homology, the Hierarchical Basis of Comparative Biology. San Diego: Academic Press (a collection of essays by many authors).
14. Keller, E. F. and E. A. Lloyd. 1992. Keywords in Evolutionary Biology. Cambridge, MA: Harvard Univ. Press.
15. Mayr, E. 1982. The Growth of Biological Thought: Diversity, Evolution and Inheritance. Cambridge, MA: Harvard Univ. Press.
16. Evolution by Mark Ridley © 2004 by Blackwell Science Ltd a Blackwell Publishing company
17. Organic Evolution (Evolutionary Biology) thirteenth edition By Veer Bala Rastogi publisher medtech a division of scientific international.

**Online Readings:-**

18. [Evolutionary principles and their practical application \(nih.gov\)](#)
19. [Biology and evolution of life science \(nih.gov\)](#)
21. [Evidence Supporting Biological Evolution - Science and Creationism - NCBI Bookshelf \(nih.gov\)](#)
22. [Selection of Models: Evolution and the Choice of Species for Translational Research - FullText - Brain, Behavior and Evolution 2019, Vol. 93, No. 2-3 - Karger Publishers](#)

| <b>S.Y M.Sc. (Zoology) Semester III</b>                                                           |                                                                                                                                                                                                                  |                                 |
|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-602</b>                                                                                    | <b>Molecular Biology</b>                                                                                                                                                                                         | <b>Credits: 4<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                                                  | Bloom's<br>cognitive level      |
| CO1                                                                                               | Describe the flow of genetic information. Discuss genome organization. Recall the differences in genomes and life processes of prokaryotes and eukaryotes.                                                       | 1                               |
| CO2                                                                                               | Compare various Molecular Biology processes like replication, transcription, translation in prokaryotes and eukaryotes, it's importance and regulation of replication, transcription and translation.            | 2                               |
| CO3                                                                                               | Illustrate different methods of DNA repair in prokaryotes and eukaryotes. Integrate the knowledge of different techniques in Molecular Biology such as Protein- DNA interaction in-vitro and in vivo techniques. | 3                               |
| CO4                                                                                               | Outline concept of Plasmids, its importance and explain different types of Plasmids in Prokaryotes. Describe their use and compare them. Explain post translational modifications. Explain types of RNA.         | 4                               |
| CO5                                                                                               | Explain enzymes involved in transcription in prokaryotes as well as in eukaryotes. Describe the post transcriptional modifications.                                                                              | 5                               |
| CO6                                                                                               | Integrate the knowledge of molecular mechanisms with research activities to understand and interpret the alterations happening in the cell structure and functions                                               | 6                               |

| <b>Unit No.</b> | <b>Title of Unit and Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>No. of<br/>Credits</b> |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| <b>I</b>        | <b>DNA Replication</b><br>DNA replication in E. coli, Origin of replication, types of E. coli DNA polymerases, details of replication process, prokaryotic regulation of replication, connection of replication to cell cycle. Different models of replication for linear and circular DNA, Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases, details of eukaryotic replication and eukaryotic regulation of replication.             | <b>1</b>                  |
| <b>II</b>       | <b>Transcription</b><br>Enzymes involved in transcription, Transcriptional Unit in prokaryotes and eukaryotes, role and significance of promoter, enhancer, silencer, Transcriptional factors, mechanism of prokaryotic gene transcription, structure of RNA polymerase, details of transcription process of both Eukaryote and Prokaryote, Post transcriptional modification.<br><b>Lambda phage:</b> Lytic and Lysogenic cycle. Role of CI, CII, Cro protein. | <b>1</b>                  |

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| <b>III</b> | <p><b>Translation</b><br/>Genetic code- properties and deciphering genetic code<br/>Requirement of translation, mRNA, tRNA and rRNA, structure of ribosomes and its biosynthesis, initiation, elongation and termination factors, aminoacyl tRNA synthetase, activation of amino acids, prokaryotic and eukaryotic translation, translation inhibitors, post translational modification.</p> <p><b>Gene Regulation in prokaryotes-</b> Concept of operon models, Structural organization, Positive and negative regulation of Lactose operon- Constitutional operator and super repressor, Tryptophan operon and Arabinose operon.</p>                                    | <b>1</b> |
| <b>IV</b>  | <p><b>DNA damage and repair system, Techniques in Molecular Biology</b><br/>DNA damage, DNA repair systems: Direct repair, Nucleotide excision repair, Base excision repair, mismatch repair, SOS Repair, Homologous and Non homologous end joining repair mechanism.</p> <p><b>Enzymes in rDNA Technology</b><br/>Introduction, DNA modifying and degrading enzymes used in recombinant DNA technology.</p> <p><b>Vectors in rDNA technology-</b><br/>Types of plasmids: R plasmid, col plasmid, F plasmid, Ti plasmid, etc.<br/>Cloning vectors – plasmid vectors, cosmids, BACs, YACs.</p> <p><b>Introduction to CRISPR Cas 9.</b><br/><b>Blue White Screening</b></p> | <b>1</b> |

### Suggested Readings:

1. Molecular Biology of the cell– Bruce Alberts – J.D. Watson et al Garland publishing Inc., N.Y. (1983) and recent edition.
2. Cell and Molecular Biology – De Robertis and Saunders (1980). B.I. Publication.
3. The cell – C.P. Swanson, Prentice Hall (1989)
4. Molecular biology by Lodish and Baltimore
5. Molecular biology of gene by J. D. Watson
6. Miller, J.H. (1972) Experiments in molecular genetics. Cold Spring Harbor Laboratory, Cold Spring Harbor, NY.
7. Genes IX, 9th edition (2008), Benjamin Lewin, Publisher – Jones and Barlett Publishers Inc.
8. Molecular Biology of the Gene, 5th Edition (2004), James D. Watson, Tania Baker
9. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick.
10. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. 26
11. Molecular Biology, 4th Edition (2007), Weaver R., Publisher-McGraw Hill Science.
12. Molecular Biology of the Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian
13. Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
14. Essential Cell Biology, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin,
15. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
16. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford

**University Press.**

17. Primrose S., Twyman R., Old D., Sixth Edition (2001) Principles of Gene Manipulation, Blackwell Science Ltd.
18. Prirose S., Twyman R., Third Edition (2003) Principles of genome analysis and genomics., Blackwell Science Ltd.
19. Alcamo I. Second Edition (2001) DNA Technology, the awesome skill, Harcourt Academic Press
20. Brown T.A., Third Edition (2007) Genomes 3, Garland Science, Taylor and Francis Group.

| <b>S.Y. M.Sc. Semester III</b>                                                                    |                                                                                                                                                                                                                                                                                                                                                                                   |                                 |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-603</b>                                                                                    | <b>Advanced Biostatistics</b>                                                                                                                                                                                                                                                                                                                                                     | <b>Credits: 4<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                                                                                                                                                                                                                   | Bloom's cognitive level         |
| CO1                                                                                               | Recall the fundamental importance of statistics in the field of biology.<br>Memorize and distinguish between different types of data and random sampling techniques. Define the basic concepts related to measures of central tendency, dispersion, and probability.                                                                                                              | 1                               |
| CO2                                                                                               | Summarize the key concepts of various diagrammatic representation methods. Describe the significance and characteristics of binomial and Poisson distributions. Interpret the principles behind correlation, linear regression, and the differences between them. Differentiate between discrete and continuous random variables.                                                 | 2                               |
| CO3                                                                                               | Illustrate descriptive statistical methods like Mean, Median and Mode, Measures of dispersion and Probability                                                                                                                                                                                                                                                                     | 3                               |
| CO4                                                                                               | Evaluate the strengths and limitations of correlation and regression analysis. Analyze and compare the implications of different probability distributions in various biological scenarios. Analyze the potential impact of Type-I and Type-II errors in a given biological context. Evaluate the appropriateness of using non-parametric tests based on dataset characteristics. | 4                               |
| CO5                                                                                               | Review Concepts used in Testing of Hypothesis and Probability                                                                                                                                                                                                                                                                                                                     | 5                               |
| CO6                                                                                               | Application of statistical methods and prepare a report on given statistical data and its analysis                                                                                                                                                                                                                                                                                | 6                               |

| <b>Unit No.</b> | <b>Title of Unit and Contents</b>                                                                                                                                                                                                                                                                                                                                                                                      | <b>No. of Credits</b> |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| <b>I</b>        | <b>Introductory Biostatistics, Data Representation, and Interpretation</b><br>Importance of Statistics in Biology.<br>Types of data, Random sampling (SRSWR and SRSWOR), Attributes and Variables, Collection and presentation of data, tabulation.<br>Diagrammatic representation (Simple bar diagram, sub-divided bar diagram and pie chart).<br>Graphical representation (Histogram and frequency polygon, boxplot) | <b>1</b>              |

|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <p><b>II</b></p>  | <p><b>Descriptive Statistics, Correlation and Linear Regression</b><br/> Measures of central tendency–Mean, Median, Mode. Geometric mean, Arithmetic mean, Quartile, Decile, Percentile.<br/> Measures of dispersion–Range, coefficient of Range, Quartile deviation, Standard deviation Variance and coefficient of variance.<br/> Measures of Skewness and Kurtosis<br/> Concept of correlation and its types. Coefficient of correlation.<br/> Concept of regression. Difference between correlation and regression.<br/> Regression lines and regression equations.</p> | <p><b>1</b></p> |
| <p><b>III</b></p> | <p><b>Probability and Probability Distribution</b><br/> <br/> Concept of Probability – classical definition, mutually exclusive events, independent events.<br/> Discrete and continuous random variable. Concept of density and mass function.<br/> Normal distribution. Properties of Normal distribution. Computing Normal curve probabilities.<br/> Binomial distribution, Poisson distribution. Computing Binomial and Poisson probabilities.</p>                                                                                                                      | <p><b>1</b></p> |
| <p><b>IV</b></p>  | <p><b>Testing of Hypothesis and Non-parametric tests</b><br/> The concepts of Null hypothesis, alternative hypothesis, significance level, Type-I and Type-II errors, <i>p</i>-value, one tailed and two tailed tests, degrees of freedom.<br/> Equality of two population means – large samples and t- test.<br/> Parametric tests- Paired t test.<br/> Non-parametric tests- <math>\chi^2</math> (Chi square) test –test for goodness of fit, independence of attributes (2X2 contingency table)<br/> ANOVA</p>                                                           | <p><b>1</b></p> |

**References:**

1. Goon, Gupta and Dasgupta Fundamentals of Statistics, World Press Kolkata
2. Gupta S. P. Statistical Methods, Sultan Chand & Sons Publisher, New Delhi
3. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics.
4. 3rdEd. Ukaaz, Publications, Hyderabad
5. Bernard Rosner Fundamentals of Biostatistics, 5thEd. Duxbury Thomson
6. Norman T.J. Bailey Statistical methods in biology, 3rdEd. Cambridge University Press

| <b>S.Y. M.Sc. Semester III</b>                                                                    |                                                                                                                                                                                                                                                                                                      |                                 |
|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-604</b>                                                                                    | <b>Histology and Histochemistry</b>                                                                                                                                                                                                                                                                  | <b>Credits: 4<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                                                                                                                                      | Bloom's<br>cognitive level      |
| CO1                                                                                               | Recall the principles of different types of microscopes: Light, Phase Contrast, SEM, and TEM.                                                                                                                                                                                                        | 1                               |
| CO2                                                                                               | Explain the structural organization of different mammalian tissues at the histological level. Understand the types and causes of morphological alterations in cells due to diseases. Comprehend the relationship between etiology, pathogenesis, and histopathological changes in specific diseases. | 2                               |
| CO3                                                                                               | Illustrate the process of permanent slide preparation, immunofluorescence technique, and mechanism for the Identification of total Proteins and Glycoproteins                                                                                                                                        | 3                               |
| CO4                                                                                               | Explain morphological alterations in cells due to diseases, such as cloud, hyaline, hydrophic, and fatty degeneration.                                                                                                                                                                               | 4                               |
| CO5                                                                                               | Review the application of immunohistochemistry and immunofluorescence techniques to localize proteins in endocrine cells (Pituitary cell types or islet of Langerhans).                                                                                                                              | 5                               |
| CO6                                                                                               | Specify and compile applications of Cryotechniques, Cryoultramicrotomy, microscope, Importance of Enzyme histochemistry, Application of Histochemical methods for the detection of various types of Carcinoma Immunofluorescent techniques.                                                          | 6                               |

| Unit No.  | Title of Unit and Contents                                                                                                                                                                                                                                                                                                                                                                                                                                      | No. of Credits |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>I</b>  | <b>Histology and its techniques</b><br>Microscopy: Principle, and applications of different types of microscopes Light, Phase Contrast, Electron: SEMUTEM Microtome: Types and applications. Collection & preservation of animal tissue – fixation, embedding, Sectioning, Staining.<br>Tissue preparation for light microscopy.<br>Cryotechniques: History and applications of Cryotechniques, Cryoultramicrotomy.                                             | <b>1</b>       |
| <b>II</b> | <b>Histology and Histopathology of Mammalian tissues:</b> Histology: Histological organization of stomach, intestine, lungs, kidney, spleen, thymus, Bone and bone marrow.<br>Histopathology: Morphological alterations in cells due to disease, types of degeneration cloudy, hyaline, hydrophic and fatty degeneration. Etiology, pathogenesis and histopathology of Liver cirrhosis and atherosclerosis, Neuropathology of alcoholism and methanol poisoning | <b>1</b>       |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |
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| <b>III</b> | <b>Immunohistochemistry</b><br>Principles and applications of Immunohistochemistry and immunofluorescence techniques for localization of proteins in endocrine cells (Pituitary cell types or islet of Langerhans) <i>In situ</i> hybridization of nucleic acids<br>Histochemical classification of Proteins<br>Principles and mechanism for the Identification of Total Proteins and Glycoproteins (Bromophenol Blue & Congo red method). | <b>1</b> |
| <b>IV</b>  | <b>Histochemistry</b><br>Cryostat and Importance of Enzyme histochemistry. Localization of enzymes in tissues, Alkaline and Acid phosphatases. Application of Histochemical methods for the detection of various types of Carcinomas.                                                                                                                                                                                                      | <b>1</b> |

**References:**

1. Pearse, A.G.E. (1980): Histochemistry, theoretical and Applied, J & A, Churchill Ltd., London.
2. Rogers, A.W. (1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.
3. Histology, 1977, 4<sup>th</sup> Edn. R. O. Greep and L. Weiss, McGraw Hill Int. Book Co. New York.
4. Hand book of Basic Microtechnique, 1964, 3<sup>rd</sup> Edn. Peter Gray, McGraw Hill Book Co. New York.
5. Bailey's Textbook of Histology - Williams and Wilkins Baltimore and Scientific Book Agency, Culcutta Copenhagen W. M.
6. Essential Histology, 2001, 2<sup>nd</sup> Edition, David H. Cormack, Lippincott Williams & Wilkins, Philadelphia

| S.Y. M.Sc. Semester IV                                                              |                                                                                                                                                 |                         |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| ZOO-605                                                                             | Immunology                                                                                                                                      | Number of Credits : 04  |
| Course Outcomes (COs)<br>On completion of the course, the students will be able to: |                                                                                                                                                 | Bloom's cognitive level |
| CO1                                                                                 | Define and explain the historical perspective of immunology. Identify and describe the basic concepts in immunology.                            | 1                       |
| CO2                                                                                 | Explain the concept of immune tolerance and hypersensitivity reactions.                                                                         | 2                       |
| CO3                                                                                 | Illustrate the applications of immunology in the diagnosis and management of common diseases.<br>Outline the development and types of vaccines. | 3                       |
| CO4                                                                                 | Analyze the molecular techniques used in immunology research.                                                                                   | 4                       |
| CO5                                                                                 | Review the role of immunology in the diagnosis and management of common diseases.                                                               | 5                       |
| CO6                                                                                 | Specify the cells and organs of the immune system.                                                                                              | 6                       |

| Unit No.   | Title of Unit and Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | No.of Credits |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>I</b>   | Introduction, basic concepts in immunology, components of the immune system <ul style="list-style-type: none"> <li>• Historical perspective</li> <li>• Basic concepts in immunology</li> <li>• Cells and organs of the immune system</li> </ul>                                                                                                                                                                                                                                                                                                                                                        | <b>1</b>      |
| <b>II</b>  | <b>Innate and adaptive immunity:</b><br>Different lines and layers of defense, the complement system and its pathways, humoral and cell mediated: The structure of a typical antibody molecule, interaction between the antibody and specific antigen; Antigen processing and presentation. <ul style="list-style-type: none"> <li>• Pattern recognition receptors</li> <li>• Inflammatory responses</li> <li>• Antigen-presenting cells</li> <li>• B and T cell development and activation</li> <li>• Antibodies, its types and antigen recognition</li> </ul> Major histocompatibility complex (MHC) | <b>1</b>      |
| <b>III</b> | <b>Immune regulation and immunopathology</b><br>Cytokines, chemokines , growth factors and immunomodulation, Hypersensitivity and allergy, Immune system and infectious diseases, Autoimmune disorders <ul style="list-style-type: none"> <li>• Cytokines chemokines, growth factors and their functions</li> <li>• Immune tolerance</li> <li>• Regulatory T cells</li> <li>• Autoimmunity</li> <li>• Hypersensitivity reactions</li> <li>• Immunodeficiencies</li> </ul>                                                                                                                              | <b>1</b>      |

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>IV</b> | <b>Vaccines and advanced immunological techniques</b> Immunology of selected infectious diseases of public health importance, applications of immunology in diagnosis and management of common diseases <ul style="list-style-type: none"><li>• Vaccine development and types</li><li>• Immunotherapeutic approaches</li><li>• Emerging trends in immunotherapy</li><li>• Immunology and Cancer</li><li>• Flow cytometry</li><li>• ELISA and Blotting techniques</li></ul> Molecular techniques in immunology | <b>1</b> |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|

**References:**

1. Essential Immunology: - Ivan Roitt, Blackwell scientific publications, London Edinburgh Boston, Australia, 1997.
2. Immunology: Janis Kuby, W.H. Freeman and company, U.S.A.1992
3. Immunobiology: The immune system in health and disease: J. Travers, current biology pub, New York, 1997.
4. Vaccines Prospects and perspectives: Harmindar Sing, Rajesh Bhatia, Forward pub. Co., Delhi, 1993
5. Relevant documents and Suggested texts therein from the WHO website
6. WHO Technical Publications: Vaccines, Human Genetics Program series.  
Harrison's Principles of Internal Medicine 16th Ed.-2005

| <b>S.Y M.Sc. (Zoology) Semester III</b>                                                           |                                                                                                                                                                                           |                                 |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-620</b>                                                                                    | <b>Zoology Practical-V</b>                                                                                                                                                                | <b>Credits: 2<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                           | Bloom's<br>cognitive level      |
| <b>Evolutionary Biology</b>                                                                       |                                                                                                                                                                                           |                                 |
| CO1                                                                                               | Describe Geological time scale.                                                                                                                                                           | 1                               |
| CO2                                                                                               | Explain different theories of evolutionary biology                                                                                                                                        | 2                               |
| CO3                                                                                               | Illustrate variation in birds.                                                                                                                                                            | 3                               |
| CO4                                                                                               | Differentiate different stages in human evolution.                                                                                                                                        | 4                               |
| CO5                                                                                               | Review balanced polymorphism with the help of different examples                                                                                                                          | 5                               |
| CO6                                                                                               | Write a report on natural selection in nature                                                                                                                                             | 6                               |
| <b>Biostatistics</b>                                                                              |                                                                                                                                                                                           |                                 |
| CO1                                                                                               | Recall and identify key concepts related to data representation, probability distributions, hypothesis testing, and measures of central tendency in the context of data analysis using R. | 1                               |
| CO2                                                                                               | Explain the principles of probability distributions (Binomial, Poisson, and Normal), hypothesis testing, and measures of central tendency.                                                | 2                               |
| CO3                                                                                               | Apply R software to create a variety of diagrams, graphs, and statistical analyses, including probabilities for Binomial, Poisson, and Normal distributions.                              | 3                               |
| CO4                                                                                               | Analyze and evaluate the appropriateness of different graphical representations, probability distributions, and statistical tests for specific datasets and research questions.           | 4                               |
| CO5                                                                                               | Evaluate the results of hypothesis tests, probability calculations, and statistical analyses performed using R, considering their implications for decision- making.                      | 5                               |
| CO6                                                                                               | Design and create customized diagrams, graphs, and statistical models using R to effectively communicate data trends and analytical insights.                                             | 6                               |

| <b>Sr. No</b> | <b>Title of The Practical</b>                                     |    |
|---------------|-------------------------------------------------------------------|----|
| 1             | Study of human evolution with the help of charts /models.         | 1p |
| 2             | Study variation in birds from same genus                          | 2p |
| 3             | Prepare a paper model of Geological time scale                    | 1p |
| 4             | Study of different theories of evolutionary biology               | 1p |
| 5             | Study of paleontological evidences in favour of evolution.        | 1p |
| 6             | Explore human evolution through the analysis of skulls and models | 1p |
| 7             | Study the concepts of homologous and analogous structures.        | 2p |

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|----|-----------------------------------------------------------------------------------------------|----|
| 8  | Investigate the role of geography in species distribution and evolution.                      | 1p |
| 9  | Experimental verification of balanced Polymorphism through examples.                          | 1p |
| 10 | Experimental verification of transient Polymorphism through examples.                         | 1p |
| 11 | Report submission on study of natural selection in nature with the help of different examples | 1p |

|    |                                                                                         |    |
|----|-----------------------------------------------------------------------------------------|----|
| 12 | Identify the following pictograms and describe the type of Speciation                   | 1p |
| 13 | Study of connecting/ missing links with the help of suitable example                    | 1p |
| 14 | Study the concepts of camouflage and mimicry with examples.                             | 1p |
| 15 | Visit to wildlife sanctuary, coastal area. (Report of Visit)                            | 2p |
| 16 | Diagrammatic and graphical representation of data in R software.                        | 1p |
| 17 | Computing probabilities for Binomial, Poisson and Normal distributions using R software | 1p |
| 18 | Hypothesis testing and application of t -test and chi square test using R               | 1p |
| 19 | Computing measures of central tendency using R                                          | 1p |
| 20 | Determination of correlation and regression using R                                     | 1p |
|    | Any 10 practicals will be conducted.<br>Any other practical set by the faculty.         |    |

| <b>S.Y M.Sc. (Zoology) Semester III</b>                                                           |                                                                                                                                                             |                                 |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-621</b>                                                                                    | <b>Zoology Practical-VI</b>                                                                                                                                 | <b>Credits: 2<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                             | Bloom's cognitive level         |
| <b>Molecular Biology</b>                                                                          |                                                                                                                                                             |                                 |
| CO1                                                                                               | Recall the fundamentals of microbial culture. Recall different types of PCR.                                                                                | 1                               |
| CO2                                                                                               | Explain the Agarose Gel Electrophoresis of DNA and molecular size determination.                                                                            | 2                               |
| CO3                                                                                               | Demonstrate and isolate the RNA and DNA from bacteria/plant/yeast source/mammalian source.                                                                  | 3                               |
| CO4                                                                                               | Differentiate and demonstrate PCR technique.                                                                                                                | 4                               |
| CO5                                                                                               | Validate the concepts of Dialysis, reverse Dialysis and membrane filtration, antibioticsusceptibility.                                                      | 5                               |
| CO6                                                                                               | Perform the experiment for preparation of Plasmid DNA.                                                                                                      | 6                               |
| <b>Biostatistics</b>                                                                              |                                                                                                                                                             |                                 |
| CO1                                                                                               | Recall and list the key features of a dataset, including its size, data types, and basic descriptive statistics.                                            | 1                               |
| CO2                                                                                               | Explain the rationale behind using various sampling methods and understand their applications in different contexts.                                        | 2                               |
| CO3                                                                                               | Apply different sampling methods to specific scenarios, considering their advantages and limitations.                                                       | 3                               |
| CO4                                                                                               | Analyze and interpret visualizations of quantitative data distributions, identifying trends and patterns.                                                   | 4                               |
| CO5                                                                                               | Evaluate the appropriateness of measures of central tendency and dispersion for specific datasets, considering the nature of the data.                      | 5                               |
| CO6                                                                                               | Design and conduct correlation and regression analyses to explore relationships between variables in a dataset, interpreting and communicating the results. | 6                               |

| <b>Sr. No</b> | <b>Title of The Practical</b>                                                         |    |
|---------------|---------------------------------------------------------------------------------------|----|
| 1             | Study of streaking/pouring technique for microbial culture by using Laminar air flow. | 1p |
| 2             | Study of Antibiotic susceptibility in microbial culture.                              | 2p |
| 3             | Isolation and estimation of genomic DNA from prokaryotic organism (bacteria)          | 2p |
| 4             | Isolation and estimation of DNA from animal cell (Goat liver)                         | 2p |
| 5             | Isolation and estimation of DNA from plant cell (Spinach leaves)                      | 2p |

|    |                                                                               |    |
|----|-------------------------------------------------------------------------------|----|
| 6  | Separation of DNA by using Agarose gel electrophoresis.                       | 2p |
| 7  | Study of subcellular fractionation by centrifugation.                         | 1p |
| 8  | Study of principle, working and applications of PCR technique.                | 1p |
| 9  | Study of different types of PCR techniques.                                   | 1p |
| 10 | Dialysis, reverse dialysis and membrane filtration.                           | 1p |
| 11 | Investigate DNA restriction enzyme digestion patterns.                        | 1p |
| 12 | Study of different methods of DNA sequencing.                                 | 1p |
| 13 | Study of recombinant DNA technology and different protein expression systems. | 1p |

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|----|------------------------------------------------------------------------------------------------------------|----|
| 14 | To study different protein purification methods and chromatography techniques. (Thin Layer Chromatography) | 1p |
| 15 | Spectrophotometric analysis of nucleotides and amino acids.                                                | 1p |
| 16 | Denaturing agarose gel electrophoresis                                                                     | 1p |
| 17 | Isolation of plasmid DNA from E. coli.                                                                     | 2p |
| 18 | Restriction Endonuclease digestion and mapping                                                             | 1p |
| 19 | Purification of plasmid DNA                                                                                | 1p |
| 20 | SDS-Polyacrylamide gel electrophoresis.                                                                    | 1p |
| 21 | To set Restriction digestion reaction of pBR322 DNA                                                        | 1p |
| 22 | Isolation, purification and electrophoresis of RNA                                                         | 2p |
| 23 | Extraction and estimation of mitochondrial DNA and mapping by restriction endonuclease digestion           | 2p |
| 24 | Visit to Biological research institute.                                                                    | 1p |
| 25 | Describe and summarize key features of a dataset.                                                          | 1p |
| 26 | Learn and apply various sampling methods.                                                                  | 1p |
| 27 | Visualize the distribution of quantitative data.                                                           | 1p |
| 28 | Measures of Central Tendency.                                                                              | 1p |
| 29 | Measures of Dispersion.                                                                                    | 1p |
| 30 | Measures of Skewness and Kurtosis.                                                                         | 1p |
| 31 | To find Correlation and Regression from the given data.                                                    | 1p |
| 32 | Problems based on Quartile, Decile and Percentile.                                                         | 1p |
|    | Any 10 practicals will be conducted.<br>Any other practical set by the faculty.                            |    |

| S.Y. M.Sc. Semester IV                                                                            |                                                                                                                                                                                                           |                                 |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-651</b>                                                                                    | <b>Developmental Biology</b>                                                                                                                                                                              | <b>Credits: 4<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                                           |                                 |
| CO1                                                                                               | Define different terminologies related to development. Recall the stages of animal development. Enlist different types of specifications.                                                                 | 1                               |
| CO2                                                                                               | Discuss the life cycle of <i>Drosophila</i> , <i>Caenorhabditis elegans</i> , <i>Dictyostelium</i> . Explain the segment formation and anterior- posterior bodyplan, the role of homeotic selector genes. | 2                               |
| CO3                                                                                               | Demonstrate the role of environment on animal development. Illustrate the process of fertilization, cleavage, gastrulation.                                                                               | 3                               |
| CO4                                                                                               | Explain dorsal ventral axis determination, anterior posterior axis formation, vulva formation in <i>C. elegans</i> , aggregation and differentiation in <i>Dictyostelium</i> .                            | 4                               |
| CO5                                                                                               | Review spermatogenesis and oogenesis. Determine the Function of Genes during Development. Review ABC flower model in <i>Arabidopsis</i> .                                                                 | 5                               |
| CO6                                                                                               | Specify the process of sex determination.<br>Design role of genes in axis specification in <i>Drosophila</i> . Specify the process and types of Fertilization                                             | 6                               |

| Unit. No.  | Title of Unit and Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | No. of Credits |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>I</b>   | <b>Introduction to animal development-</b> Introduction to Developmental Biology. The Stages of Animal Development, Potency, commitment, specification, competence, determination and differentiation. Different types of growth.<br><b>Different types of Specification-</b> Autonomous, conditional and syncytial specification. Lewis Wolpert French Flag analogy.                                                                                                                                     | <b>1</b>       |
| <b>II</b>  | <b>Gametogenesis, fertilization and early development:</b> Production of gametes, Spermatogenesis, Structure of mammalian sperm, oogenesis, structure of mammalian egg.<br><b>Fertilization-</b> External and Internal Fertilization. Fast block and slow block to polyspermy.<br>Early development in <i>Xenopus</i> , Nieukoop center. Classification of eggs and cleavage.<br>Early development: Zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals. | <b>1</b>       |
| <b>III</b> | <b>Drosophila Development</b> – Life cycle and early <i>Drosophila</i> development: Segmentation, Gap genes, pair rule genes, segment polarity genes, homeotic genes, realiser genes.<br>Anterior-posterior axis determination: Role of bicoid, nanos, hunchback and caudal and study of its mutants. Hedgehog and Wingless signaling. Mutations in Homeotic genes: Antennapedia and Ultrabithorax gene.<br>Dorsal ventral axis determination and study of loss and gain of function mutations.           | <b>1</b>       |

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| <b>IV</b> | <b>Morphogenesis and organogenesis in animals:</b> Cell aggregation, differentiation and life cycle <i>Dictyostelium</i> ; Organogenesis –Early development, cell lineage and vulva formation in <i>Caenorhabditis elegans</i> and study of its mutants.<br>Insect metamorphosis- Ametabolous, Hemimetabolous and Holometabolous metamorphosis.<br>Sex Determination- Chromosomal sex determination- XX-XY, XX- XO, ZZ-ZW System, environmental factors, genic balance in <i>Drosophila</i> . | <b>1</b> |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|

**References:**

1. Gilbert, S.F. Developmental Biology. 10th Edition, Sinauer Associated Inc., Massachusetts
2. Balinsky, B.I. Introduction to Embryology. Saunders, Philadelphia
3. Berril, N.J. and Karp, G. Development Biology. McGraw Hill, New York
4. Hamburger V and Hamilton HL. Handbook of chick developmental stages. Saunders Publications. 1965.
5. Berril, N.J. and Karp, G. Development Biology. McGraw Hill, New York
6. Embryology-An Introduction to Developmental Biology—Stanley Shostak
7. Muthukaruppan and Pitchappan. Animal development – a laboratory guide. CoSIP-ULP Publications, India. First Edition, 1979.

| S.Y. M.Sc. Semester IV                                                                            |                                                                                                                                                                                                                                           |                                 |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-653</b>                                                                                    | <b>Biological Techniques and Bioinformatics</b>                                                                                                                                                                                           | <b>Credits: 4<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                                                                           |                                 |
| CO1                                                                                               | Recall basic concepts of separation and purification techniques along with their applications.                                                                                                                                            | 1                               |
| CO2                                                                                               | Articulate concepts, parameters, mechanism and applications of different types of chromatography<br>Classify different types of Biological databases and structure prediction methods. Use the basics of sequence alignment for analysis. | 2                               |
| CO3                                                                                               | Illustrate the types of electrophoresis, applications and principles underlying the techniques. Apply the knowledge for biomolecules separation.                                                                                          | 3                               |
| CO4                                                                                               | Explain electrophoretic techniques for nucleic acid and proteins.                                                                                                                                                                         | 4                               |
| CO5                                                                                               | Review and explain different types of blotting.<br>Plan the study of various databases and tools for in silico analysis and data mining                                                                                                   | 5                               |
| CO6                                                                                               | Design experiments using different biochemical techniques. Specify the working mechanisms and applications of basic spectroscopic techniques.                                                                                             | 6                               |

| Unit No.  | Title of Unit and Contents                                                                                                                                                                                                                                                                                                                                                                                                                                         | No. of Credits |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>I</b>  | <b>Chromatography</b><br>Principles and applications of: Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography, Molecular exclusion chromatography, thin layer chromatography, HPLC, RPLC, etc.<br><b>Centrifugation</b><br>Principle, basic theory of ultracentrifuge, molecular weight determination and its applications<br><b>Blotting</b><br>Types of blotting - Southern, Northern and Western, Dot blots | <b>1</b>       |
| <b>II</b> | <b>DNA and protein sequencing</b><br>Sangers and Maxam Gilbert method of sequencing, Protein sequencing methods, <b>Introduction to Next Gen Sequencing</b><br><br><b>Spectroscopy</b><br>UV and visible spectrophotometry- Principle, instrumentation and applications<br><b>Electrophoretic techniques:</b><br>General principles, Support media – agarose, paper, cellulose-                                                                                    | <b>1</b>       |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|            | acetate electrophoresis, polyacrylamide gels.<br>Nucleic acids- Agarose gel electrophoresis, DNA sequencing gels<br>Electrophoresis of proteins – SDS-PAGE, native PAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |
| <b>III</b> | <b>Introduction to Bio-informatics:</b><br>Introduction and definition, History and Scope, Applications of Bioinformatics in various fields.<br><b>Nucleic Acid Sequence Databases:</b><br>Nucleic acid sequence databases (GenBank, EMBL, DDBJ),<br>Keyword-based search at Entrez Search Engine at NCBI.<br>Sequence Submission tools at NCBI, EMBL etc.<br><b>Protein Databases:</b><br>Protein sequence Database – UniProtKB / Swiss – Prot                                                                                                                                                                                       | <b>1</b> |
| <b>IV</b>  | <b>Basic concepts of sequence analysis:</b><br>Global Pairwise Sequence Alignment Local<br>Pairwise Sequence Alignment<br>Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties, use of pairwise alignments for analysis of Nucleic acid and Protein sequences and interpretation of results.<br><b>Databases Searches:</b><br>BLAST, FASTA<br><b>Concept of Phylogeny:</b><br>Molecular Phylogeny Various Methods of Phylogenetic Tree Construction<br><b>Scoring matrices:</b><br>Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSSUM series. | <b>1</b> |

**References:**

1. Bioinformatics Databases, Tools and Algorithms: Orpita Bosu, Simminder Kaur Thukral.
2. Bioinformatics Sequence and Genome Analysis: David Mount.
3. Introduction to bioinformatics, 2001. AH wood, T.K. Parry smith DJ, Pearson education Asia.
4. Bioinformatics: A practical guide to the analysis of genes and proteins – 2001 – AD Baxevanis & BFF Ouellette – Wiley Interscience – New York.
5. Bioinformatics: Methods and Protocols – 2000 – Stephen Misener & Stephen A. Krawetz, Humana Press, New Jersey.
6. Bioinformatics: Sequence, structure and databanks – 2000 – Des Higgins & Willie Taylor – Oxford University Press.
7. Physical Biochemistry by D. Freifelder IInd Edition Freeman publication (1982)
8. Biochemical techniques by Wilson and Walker.
9. Introduction to Bioinformatics. Arthur M. Lesk (3rd ed.). Oxford University Press.
10. Bioinformatics: Sequence and Genome Analysis. David Mount (2nd ed.). Cold Spring Harbor Laboratory Press.
11. Bioinformatics for Geneticists: A Bioinformatics Primer for the Analysis of Genetic Data. Michael R. Barnes (2nd ed.). John Wiley & Sons Inc.
12. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition (2008), Keith Wilson and John Walker, Publisher–Cambridge University Press.
13. Light Microscopy in Biology: A Practical Approach, 2nd edition (1999), Alan J. Lacey, Publisher– Oxford University Press.
14. Electron Microscopy: Principles and Techniques for Biologists, (1992), Lonnie D. Russell, Publisher- Jones & Bartlett.

| S.Y. M.Sc. Semester IV                                                                            |                                                                                                                                                                                             |                                 |
|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| <b>ZOO-654</b>                                                                                    | <b>Parasitology</b>                                                                                                                                                                         | <b>Credits: 2<br/>Hours: 60</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                                                                                             |                                 |
| CO1                                                                                               | Define different terminologies related to host parasite system. Recall Parasitic adaptations, interrelationships between host and parasite.                                                 | 1                               |
| CO2                                                                                               | Discuss the life cycle of <i>Trypanosoma brucei</i> , <i>Trypanosoma cruzi</i> , <i>Leishmania donovoni</i> , <i>Leishmania tropica</i> , <i>Leishmania braziliensis</i>                    | 2                               |
| CO3                                                                                               | Demonstrate physiology, structure and cell biology of parasites.                                                                                                                            | 3                               |
| CO4                                                                                               | Explain classification, geographical distribution, morphology of <i>Schistosoma haematobium</i> , <i>Schistosoma mansoni</i> , <i>Schistosoma japonica</i> , <i>Echinococcus granulosus</i> | 4                               |
| CO5                                                                                               | Review manipulation of host behavior, parasitic effects benefitting the host                                                                                                                | 5                               |
| CO6                                                                                               | Specify the Diagnosis and control of parasites.                                                                                                                                             | 6                               |

| Unit No.   | Title of Unit and Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No. of Credits |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>I</b>   | <b>Host Parasite System</b><br>Basic concept and overview: Overview of Host: Parasite relationship.<br>Parasitic adaptations, interrelationships between host and parasite.<br>Pre-adaptation to infectiousness, Parasitism, Symbiosis, Altruism<br>Transmission-conspecific and its types, heterospecific and its types                                                                                                                                                                                                                                                           | <b>1</b>       |
| <b>II</b>  | <b>Type Study</b><br>Classification, geographical distribution, morphology, life- cycle, transmission, pathogenicity, treatment, diagnosis, control and prophylaxis of Protozoa: <i>Trypanosoma brucei</i> , <i>Trypanosoma cruzi</i> , <i>Leishmania donovoni</i> , <i>Leishmania tropica</i> , <i>Leishmania braziliensis</i> , <i>Plasmodium falciparum</i> Platyhelminthes: <i>Schistosoma haematobium</i> , <i>Schistosoma mansoni</i> , <i>Schistosoma japonicum</i> , <i>Echinococcus granulosus</i> Nematoda: <i>Ancylostoma duodenale</i> , <i>Dracunculus medinensis</i> | <b>1</b>       |
| <b>III</b> | <b>Genomes &amp; their genes:</b><br>Antigenic variation in Trypanosomes Specialized & unique molecular features.<br>Physiology, structure and cell biology of parasites.                                                                                                                                                                                                                                                                                                                                                                                                          | <b>1</b>       |
| <b>IV</b>  | <b>Myiasis</b> –concept and classification according to tissue type, vector specific, accidental and its importance.<br>Manipulation of host behavior, parasitic effects benefitting the host                                                                                                                                                                                                                                                                                                                                                                                      | <b>1</b>       |

**References:**

- Anderson RM (1985). Helminth infections of humans: mathematical models, population dynamics, and control. *Adv Parasitol.*:1-101.
- Cox F. E. G. (1993) *Modern Parasitology: A Textbook of Parasitology.*
- Chatterjee (1967) K. D. *Parasitology: Protozoology & Helminthology.*
- Gardner MJ et al (2002) Genome sequence of the human malaria parasite *Plasmodium falciparum* *Nature* 419:498-511.
- lastid parasite, *Leishmania major*. *Science*. 309:436-42.
- LS Garcia, DA Bruckner (1997) *Diagnostic medical Parasitology.*

| S.Y M.Sc. (Zoology) Semester IV                                                                   |                                                                                                                    |                         |
|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------|
| ZOO-670                                                                                           | Zoology Practical-VII                                                                                              | Number of Credits -2    |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                                                                                                                    | Bloom's cognitive level |
| <b>Immunology</b>                                                                                 |                                                                                                                    |                         |
| CO1                                                                                               | Describe how specific blood cells contribute to immune responses                                                   | 1                       |
| CO2                                                                                               | Interpret histological slides of lymphoid organs.                                                                  | 2                       |
| CO3                                                                                               | Illustrate aseptic techniques in cell culture and explain the importance of maintaining sterility in cell culture. | 3                       |
| CO4                                                                                               | Analyze the principles underlying ELISA.                                                                           | 4                       |
| CO5                                                                                               | Review the functions of different cell types within lymphoid organs.                                               | 5                       |
| CO6                                                                                               | Perform experiment to identify ABO blood groups and Rh.                                                            | 6                       |
| <b>Developmental Biology</b>                                                                      |                                                                                                                    |                         |
| CO1                                                                                               | Describe larval stages of <i>Drosophila</i> . Recall the life cycle of <i>Drosophila</i>                           | 1                       |
| CO2                                                                                               | Illustrate of different stages in Chick embryo (13 -72 hr).                                                        | 2                       |
| CO3                                                                                               | Examine a temporary mounting of 24, 48, 72 and 96 hours chick embryo.                                              | 3                       |
| CO4                                                                                               | Explain angiogenesis in chick embryo.                                                                              | 4                       |
| CO5                                                                                               | Evaluate the effects of teratogen on chick embryo development.                                                     | 5                       |
| CO6                                                                                               | Prepare a temporary slide of imaginal disc in <i>Drosophila</i> .                                                  | 6                       |
| <b>Biological Techniques and Bioinformatics</b>                                                   |                                                                                                                    |                         |
| CO1                                                                                               | List and identify different bioinformatics tools and softwares.                                                    | 1                       |
| CO2                                                                                               | Compare the performance of sequence analysis tools such as BLAST, ClustalW, and MUSCLE                             | 2                       |
| CO3                                                                                               | Outline the use of molecular docking techniques.                                                                   | 3                       |
| CO4                                                                                               | Analyze and discuss ethical issues in bioinformatics                                                               | 4                       |
| CO5                                                                                               | Evaluate the suitability of different techniques for specific research goals.                                      | 5                       |
| CO6                                                                                               | Synthesize information from biological databases and perform efficient sequence retrieval.                         | 6                       |

| Sr. No | Title of The Practical                                                                                                                                                  | No. Of Hours |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1      | Introduction to biosafety and demonstration of aseptic techniques in cell culture.                                                                                      | 1p           |
| 2      | Sorting and characterization of specific cell populations.                                                                                                              | 1p           |
| 3      | Study of various blood cells of the immune system (PBMCs Isolation from whole human blood using density gradient method and cell count using trypan-blue- if possible). | 1p           |
| 4      | Study of histology of lymphoid organs- Skin, Spleen, Thymus, Ileum, Lymph node, Bone marrow                                                                             | 1p           |
| 5      | Comparison of direct and indirect ELISA.                                                                                                                                | 1p           |
| 6      | Study of DOT ELISA.                                                                                                                                                     | 1p           |
| 7      | Study of antigen capture ELISA.                                                                                                                                         | 1p           |
| 8      | Interpretation of Western blot results.                                                                                                                                 | 1p           |
| 9      | Verification of antibody specificity and affinity.                                                                                                                      | 1p           |
| 10     | Analysis of blood group with reference to cross matching.                                                                                                               | 1p           |
| 11     | Study of Radial immunodiffusion assay.                                                                                                                                  | 1p           |
| 12     | Estimation of antigen concentration using rocket immunoelectrophoresis.                                                                                                 | 1p           |
| 13     | Correlation of cytokine levels with specific immunological conditions.                                                                                                  | 1p           |
| 14     | Analysis of major histocompatibility complex (MHC) diversity.                                                                                                           | 1p           |
| 15     | Study of larval stages of <i>Drosophila</i> .                                                                                                                           |              |
| 16     | Mounting of 72 and 96 hours chick embryo.                                                                                                                               |              |
| 17     | Mounting of imaginal disc in <i>Drosophila</i>                                                                                                                          |              |
| 18     | Study of angiogenesis in chick embryo.                                                                                                                                  |              |
| 19     | Effect of teratogen on chick embryo development.                                                                                                                        | 1p           |
| 20     | Study of different stages in Chick embryo (13 -72 hr).                                                                                                                  | 1p           |
| 21     | Mounting of 24/48 hours chick embryo.                                                                                                                                   | 1p           |
| 22     | Study of life cycle of <i>Drosophila melanogaster</i>                                                                                                                   |              |
| 23     | Ouchterlony technique of agar gel diffusion.                                                                                                                            |              |
| 24     | Study of Immunoelectrophoresis.                                                                                                                                         |              |
| 25     | Ethical considerations and regulations in animal experimentation.                                                                                                       | 1p           |
| 26     | Sequence analysis with popular sequence analysis tools such as BLAST, ClustalW, and MUSCLE.                                                                             | 1p           |
| 27     | Sequence Retrieval and Database Search                                                                                                                                  | 1p           |
| 28     | Explore protein-ligand interactions through molecular docking exercises using software like AutoDock.                                                                   | 1p           |
| 29     | Ethical considerations in bioinformatics, including data privacy, security, and responsible conduct of research.                                                        | 1p           |
| 30     | Construct and analyze PPI networks using tools like Cytoscape.                                                                                                          | 1p           |
| 31     | Demonstration and explanation of principle of Flow cytometry.                                                                                                           | 1p           |
|        | Any 10 practicals will be conducted. Any other practical set by the faculty                                                                                             |              |

| S.Y M.Sc. (Zoology) Semester IV                                                                   |                           |                             |
|---------------------------------------------------------------------------------------------------|---------------------------|-----------------------------|
| <b>ZOO-660</b>                                                                                    | <b>Research Project I</b> | <b>Number of Credits -4</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                           | Bloom's cognitive level     |

| S.Y M.Sc. (Zoology) Semester IV                                                                   |                            |                             |
|---------------------------------------------------------------------------------------------------|----------------------------|-----------------------------|
| <b>ZOO-661</b>                                                                                    | <b>Research Project II</b> | <b>Number of Credits -6</b> |
| <b>Course Outcomes (COs)</b><br><b>On completion of the course, the students will be able to:</b> |                            | Bloom's cognitive level     |