Deccan Education Society's

FERGUSSON COLLEGE (AUTONOMOUS) PUNE-4

SYLLABUS

M.Sc. Zoology-NEP

Academic Year 2023-

2025 SEMESTER –

III & IV

Programme Structure

Sem.	Course Code	Course Title	Course	No. of credits
III	ZOO-601	Evolutionary Biology	Theory	04
	ZOO-602	Molecular Biology	Theory	04
	ZOO-603	Advanced Biostatistics/OR	Elective-I Theory	04
	ZOO-604	Histology and Histo-chemistry	Elective-II Theory	
	ZOO-605	Immunology	Theory	04
	ZOO-620	Zoology Practical-V	Practical	02
	ZOO-621	Zoology Practical-VI	Practical	02
		Total Credits		**(20)**
IV	ZOO-651	Developmental Biology	Theory	04
	ZOO-653	Biological Techniques and Bioinformatics	Elective-I Theory	04
	ZOO-654	Parasitology	Elective-II Theory	
	ZOO-670	Zoology Practical-VII	Practical	02
	ZOO-660	Research Project/ Proposal Writing		04
	ZOO-661	Research Project		06
		Total Credits		**(20)**

Program Outcomes (POs) for M.Sc Programme	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that form a part of a postgraduate Programme. Execute strong theoretical and practical understanding generated from the specific Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	**Research-related skills and Scientific temper:** Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research project/article/t/review/short communication/letter to editor/commentary while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge**: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence**: Perform independently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics**: Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability**: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Outcomes for M.Sc. Zoology	
PSO1	**Academic Competence:** (i) Describe fundamental concepts, principles and processes underlying the life sciences and its different disciplines. (ii) Capability for asking relevant/appropriate questions relating to issues and problems in the field of Zoology, and planning, executing and reporting the results of an experiment or investigation. (iii) Demonstrate a wide range of biochemical techniques, physiological processes, cellular activities, developmental and evolutionary processes, statistical methods and bioinformatics.
PSO2	**Personal and Professional competence:** (i) Demonstrate the competence in fundamental zoological skills/techniques and experimentation using various methods in animal models and their behaviour, cell and molecular biology, biochemistry, developmental biology and immunology. (ii) Illustrate methods in evolutionary biology, environmental science, biostatistics and bioinformatics and analyze biological data statistically. (iii) Formulation of ideas, scientific writing and authentic reporting, effective presentation and communication skills.
PSO3	**Research Competence:** (i) Analyse and interpret results obtained in cell biology, molecular biology, biochemistry, genetics, developmental biology, immunology, histology. (ii) Create biological data and skills to explore and authenticate data for experimental and research purpose. (iii) Capable of using computers for Biostatistics, Bioinformatics and computation and appropriate software for analysis of statistical data, genomics, proteomics and metabolomics data, and employing modern bioinformatics search tools to locate, retrieve, and evaluate location and biological annotation genes of different species.
PSO4	**Entrepreneurial and Social competence:** (i) Evaluate data of the societal relevance of biological systems and the processes and apply the knowledge of zoology in the different fields to address problems related to human kind. (ii) Collaborate in various zoological services with demonstration of true values of leadership, co-operation, hard work, teamwork etc. during the field works, surveys and field visits.

S.Y M.Sc. (Zoology) Semester III		
Title of the Course and Course Code	**Evolutionary Biology ZOO-601**	**Number of Credits -4**
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Understand the fundamental concepts of organic evolution. Identify the components of the modern synthetic theory of evolution. 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. 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

Unit No.	Title and Contents	No. of Credits
I	**Concept, evidences and theories of evolution** Concept of Evolution Basic Concept of Organic Evolution- Origin of Life, Chemogeny, Biogeny Theories of evolution- Pre-Darwinian ideas, Lamarckism, Modern synthetic theory of evolution. Evidences of Evolution Human evolution	**1**
II	**Polymorphism and speciation:** Origin of Polymorphism Polymorphism- Balanced polymorphism, Transient polymorphism, Concept of species as a real entity Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation – Anagenesis and Cladogenesis Basis of speciation – Isolating mechanisms	**1**

III	**Evolutionary Genetics** 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	**1**
IV	**Natural Selection in Action** Concept, salient features and nature of Natural Selection Heterozygous Advantage or Heterosis Balancing Selection r-Selection andk-Selection, Selection Pressure or Selection Intensity Selection and Variation, Selection and Adaptations (The Baldwin Effect) Camouflage and Mimicry	**1**

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 Ridly © 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

S.Y M.Sc. (Zoology) Semester III		
Title of the Course and Course Code	**Molecular Biology ZOO-602**	**Number of Credits : 04**
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's 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

Unit No.	Title of Unit and Contents	No. of Credits
I	**DNA Replication** 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.	**1**
II	**Transcription** 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. **Lambda phage**: Lytic and Lysogenic cycle. Role of CI, CII, Cro protein.	**1**

III	**Translation** Genetic code- properties and deciphering genetic code 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. **Gene Regulation in prokaryotes-** Concept of operon models, Structural organization, Positive and negative regulation of Lactose operon- Constitutional operator and super repressor, Tryptophan operon and Arabinose operon.	**1**
IV	**DNA damage and repair system, Techniques in Molecular Biology** 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. **Enzymes in rDNA Technology** Introduction, DNA modifying and degrading enzymes used in recombinant DNA technology. **Vectors in rDNA technology-** Types of plasmids: R plasmid, col plasmid, F plasmid, Ti plasmid, etc. Cloning vectors – plasmid vectors, cosmids, BACs, YACs. **Introduction to CRISPR Cas 9.** **Blue White Screening**	**1**

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-McGrew 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,
10
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.

S.Y. M.Sc. Semester III		
Title of the Course and Course Code	**Advanced Biostatistics ZOO-603**	**Number of Credits : 04**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		Bloom's cognitive level
CO1	Recall the fundamental importance of statistics in the field of biology. 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

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

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

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

S.Y M.Sc. (Zoology) Semester III		
Title of the Course and Course Code	**Practical-V ZOO-620**	**Number of Credits -2**
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
Evolutionary Biology		
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
Biostatistics		
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

Zoology Practical-V ZOO-620		
Sr. No	**Title of The Practical**	
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

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. Any other practical set by the faculty.	

S.Y M.Sc. (Zoology) Semester III		
Title of the Course and Course Code	**Practical-VI ZOO-621**	**Number ofCredits -2**
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
Molecular Biology		
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
Biostatistics		
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

S.Y M.Sc. (Zoology) Semester III		
Zoology Practical-VI ZOO621		
Sr. No	**Title of The Practical**	
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
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. Any other practical set by the faculty.	

S.Y. M.Sc. Semester III		
Title of the Course and Course Code	**Histology and Histochemistry ZOO-604**	**Number of Credits : 04**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		Bloom's 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
I	**Histology and its techniques** 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. Tissue preparation for light microscopy. Cryotechniques: History and applications of Cryotechniques, Cryoultramicrotomy.	**1**

II	**Histology and Histopathology of Mammalian tissues:** Histology: Histological organization of stomach, intestine, lungs, kidney, spleen, thymus, Bone and bone marrow. Histopathology: Morphological alterations in cells due todisease, types of degeneration cloud, hyaline, hydrophic and fatty degeneration. Etiology, pathogenesis and histopathology of Liver cirrhosis and atherosclerosis, Neuropathology of alcoholismand methanol poisoning.	**1**
III	**Immunohistochemistry** Principles and applications of Immunohistochemistry and immunofluorescence techniques for localization of proteins in endocrine cells (Pituitary cell types or islet of Langerhans)*In situ* hybridization of nucleic acids Histochemical classification of Proteins Principles and mechanism for the Identification of Total Proteins and Glycoproteins (Bromophenol Blue & Congo redmethod).	**1**
IV	**Histochemistry** Cryostat and Importance of Enzyme histochemistry. Localization of enzymes in tissues, Alkaline and Acid phosphates. Application of Histochemical methods for the detection ofvarious types of Carcinomas.	**1**

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, 4th Edn. R. O. Greep and L. Weiss, McGraw Hill Int. Book Co. New York.
4. Hand book of Basic Mictotechnique, 1964, 3rd Edn. Peter Gray, McGraw Hill Book Co. New York.
5 Bailey's Textbook of Histology - Williams and Wilkins Baltmore and Scientific Book Agency, Culcutta Copenhaver W. M.
6. Essential Histology, 2001, 2nd Edition, David H. Cormack, Lippincott Williams & Wilkins, Philadelphia

S.Y. M.Sc. Semester IV		
Title of the Course and Course Code	**Immunology ZOO-605**	**Number of Credits : 04**
Course Outcomes (COs) **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. 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
I	Introduction, basic concepts in immunology, components of the immune system • Historical perspective • Basic concepts in immunology • Cells and organs of the immune system	**1**
II	**Innate and adaptive immunity:** 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. • Pattern recognition receptors • Inflammatory responses • Antigen-presenting cells • B and T cell development and activation • Antibodies, its types and antigen recognition Major histocompatibility complex (MHC)	**1**
III	**Immune regulation and immunopathology** Cytokines, chemokines , growth factors and immunomodulation, Hypersensitivity and allergy, Immune system and infectious diseases, Autoimmune disorders • Cytokines chemokines, growth factors and their functions • Immune tolerance • Regulatory T cells • Autoimmunity	**1**

	• Hypersensitivity reactions Immunodeficiencies	
IV	**Vaccines and advanced immunological techniques** Immunology of selected infectious diseases of public health importance, applications of immunology in diagnosis and management of common diseases • Vaccine development and types • Immunotherapeutic approaches • Emerging trends in immunotherapy • Immunology and Cancer • Flow cytometry • ELISA and Blotting techniques Molecular techniques in immunology	**1**

REFERENCES:

1. Essential Immunology: - Ivan Roitt, Blackwell scientific publications, London Edinburgh
2. Boston, Australia, 1997.
3. Immunology: Janis Kuby, W.H. Freeman and company, U.S.A.1992
4. Immunobiology: The immune system in health and disease: J. Travers, current biology pub,
5. New York, 1997.
6. Vaccines Prospects and perspectives: Harmindar Sing, Rajesh Bhatia, Forward pub. Co., Delhi,
7. 1993
8. Relevant documents and Suggested texts therein from the WHO website
9. WHO Technical Publications: Vaccines, Human Genetics Program series.
10. Harrison's Principles of Internal Medicine 16th Ed.-2005

S.Y. M.Sc. Semester IV		
Title of the Course and Course Code	**Developmental biology ZOO651**	**Number of Credits : 04**
Course Outcomes (COs) On completion of the course, the students will be able to:		
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 *Drosophila*, *Caenorhabditis elegans*, *Dictyostelium.* 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 *C. elegans*, aggregation and differentiation in *Dictyostelium.*	4
CO5	Review spermatogenesis and oogenesis. Determine theFunction of Genes during Development. Review ABC flower model in *Arabidopsis*.	5
CO6	Specify the process of sex determination. Design roleof genes in axis specification in Drosophila. Specify the process and types of Fertilization	6

Unit. No.	Title of Unit and Contents	No. of Credits
I	**Introduction to animal development-** Introduction to Developmental Biology. The Stages of Animal Development, Potency, commitment, specification, competence, determination and differentiation. Different types of growth. **Different types of Specification-** Autonomous, conditional and syncytial specification. Lewis Wolpert French Flag analogy.	**1**
II	**Gametogenesis, fertilization and early development:** Production of gametes, Spermatogenesis, Structure of mammalian sperm, oogenesis, structure of mammalian egg. **Fertilization-** External and Internal Fertilization. Fast block and slow block to polyspermy. Early development in *Xenopus*, Nieukoop center. Classification of eggs and cleavage. Early development: Zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals.	**1**
III	***Drosophila* Development –** Life cycle and early *Drosophila* development: Segmentation, Gap genes, pair rule genes, segment polarity genes, homeotic genes, realisator genes. 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. Dorsal ventral axis determination and study of loss and gain of function mutations.	**1**

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

References:

1. Gilbert, S.F. Developmental Biology. 10th Edition, Sinauer Associated Inc., Massachusetts
2. Balinsky, B.I. Introduction to Embryology. Saunders, Philedelphia
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 Publicatiions, India. First Edition, 1979.

Unit No.	Title of Unit and Contents	No. of Credits

S.Y. M.Sc. Semester IV		
Title of the Course and Course Code	**Biological Techniques and Bioinformatics ZOO653**	**Number of Credits : 04**
Course Outcomes (COs) On completion of the course, the students will be able to:		
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 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. 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

I	**Chromatography** Principles and applications of: Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography, Molecular exclusion chromatography, thin layer chromatography, HPLC, RPLC, etc. **Centrifugation** Principle, basic theory of ultracentrifuge, molecular weight determination and its applications **Blotting** Types of blotting - Southern, Northern and Western, Dot blots	**1**
II	**DNA and protein sequencing** Sangers and Maxam Gilbert method of sequencing, Protein sequencing methods, **Introduction to Next Gen Sequencing** **Spectroscopy** UV and visible spectrophotometry- Principle, instrumentation and applications **Electrophoretic techniques:** General principles, Support media – agarose, paper, cellulse-acetate electrophoresis, polyacrylamide gels. Nucleic acids- Agarose gel electrophoresis, DNA sequencing gels Electrophoresis of proteins – SDS-PAGE, native PAGE	**1**
III	**Introduction to Bio-informatics:** Introduction and definition, History and Scope, Applications of Bioinformatics in various fields. **Nucleic Acid Sequence Databases:** Nucleic acid sequence databases (GenBank, EMBL, DDBJ), Keyword-based search at Entrez Search Engine at NCBI. Sequence Submission tools at NCBI, EMBL etc. **Protein Databases:** Protein sequence Database – UniProtKB / Swiss – Prot	**1**
IV	**Basic concepts of sequence analysis**: Global Pairwise Sequence Alignment Local Pairwise Sequence Alignment 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. **Databases Searches:** BLAST, FASTA **Concept of Phylogeny:** Molecular Phylogeny Various Methods of Phylogenetic Tree Construction **Scoring matrices:** Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSSUM series.	**1**

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.

Title of the Course and Course Code	Parasitology ZOO654	Number of Credits : 04
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Define different terminologies related to host parasite system. Recall Parasitic adaptations, interrelationships between host and parasite.	1
CO2	Discuss the life cycle of *Trypanosoma brucei, Trypanosoma cruzi, Leishmania donovoni, Leishmania tropica, Leishmania braziliensis*	2
CO3	Demonstrate physiology, structure and cell biology of parasites.	3
CO4	Explain classification, geographical distribution, morphology of *Schistosoma haematobium, Schistosoma mansoni, Schistosoma japonica, Echinococcus granulosus*	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
I	**Host Parasite System** Basic concept and overview: Overview of Host: Parasite relationship. Parasitic adaptations, interrelationships between host and parasite. Pre-adaptation to infectiousness, Parasitism, Symbiosis, Altruism Transmission-conspecific and its types, heterospecific and its types	**1**
II	**Type Study** Classification, geographical distribution, morphology, life-cycle, transmission, pathogenicity, treatment, diagnosis, control and prophylaxis of Protozoa: *Trypanosoma brucei, Trypanosoma cruzi, Leishmania donovoni, Leishmania tropica, Leishmania braziliensis, Plasmodium falciparum* Platyhelminthes: *Schistosoma haematobium,Schistosoma mansoni, Schistosoma japonicum, Echinococcus granulosus* Nematoda: *Ancylostoma duodenale, Dracunculus medinensis*	**1**
III	**Genomes & their genes**: Antigenic variation in Trypanosomes Specialized & unique molecular features. Physiology, structure and cell biology of parasites.	**1**
IV	**Myiasis** –concept and classification according to tissue type, vector specific, accidental and its importance. Manipulation of host behavior, parasitic effects benefitting the host	**1**

References:

• Anderson RM, May RM. (1985) Helminth infections of humans: mathematical models, population dyna

mics, 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.
• Ivens AC et al. (2005) The genome of the kinetoplastid parasite, Leishmania major. Science. 309:436-42.
• LS Garcia, DA Bruckner (1997) Diagnostic medical Parasitology.

S.Y M.Sc. (Zoology) Semester IV		
Title of the Course and Course Code	**Practical-VII ZOO670**	**Number of Credits -2**
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
Immunology		
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
Developmental Biology		
CO1	Describe larval stages of *Drosophila*. Recall the life cycle of *Drosophila*	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 *Drosophila*.	6
	Biological Techniques and Bioinformatics	
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

S.Y M.Sc. (Zoology) Semester IV		
Practical-VII ZOO670		
Sr. No	**Title of The Practical**	

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 *Drosophila*.	
16	Mounting of 72 and 96 hours chick embryo.	
17	Mounting of imaginal disc in *Drosophila*	
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 *Drosophila melanogaster*	
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.	