

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
(Affiliated to Savitribai Phule Pune University, Pune)



Choice Based Credit System (CBCS)
Master of Science (M.Sc.)
Syllabus of
M. Sc. Part I (Zoology)

Implemented from
Academic year 2021 -22

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)

Board of Studies in Zoology

Sr. No.	Name	Designation
1.	Hon. Prof. A. K. Pandarkar	Chairman
2.	Hon. Dr. L. U. Kunjir	Member
3.	Hon. Prof. S. N. Pokale	Member
4.	Hon. Dr. A. D. Harkal	Member
5.	Hon. Prof. R. J. Chavan	Academic Council Nominee
6.	Hon. Prof. S. S. Nanware	Academic Council Nominee
7.	Hon. Dr. S. S. Teradalkar	Vice-Chancellor Nominee
8.	Hon. Prof. B. A. Pawar	Alumni
9.	Hon. Mrs. Manjushree Tadvalkar	Industry Expert
10.	Hon. Shri. M. S. Kasture	Member (co-opt)
11.	Hon. Mrs. S. P. Salve	Member (co-opt)

1. Prologue

Zoology is a major subject of Basic Sciences which deals with all aspects of animal biology. It includes an exciting range of highly diverse topics. The advancements in biological Sciences demand a zoology student to be a master of many areas in the subject. The Board of Studies has designed this Postgraduate degree program in Zoology of New Arts, Commerce and Science College, Ahmednagar (Autonomous), with a fundamental understanding of what is needed from zoologists and what zoologists need to pursue as a skilled career. It emulates the Benchmark Statement closely for Biosciences and the guidelines laid down by the University Grants Commission, New Delhi. This Newly designed curriculum is an appropriate blend of the classical aspects in Zoology, which has been the "backbone" knowledge required for all zoologists and the recent and specialized areas. The flexibility in the curriculum allows the students to choose their areas of interest, leading to enhanced employability. Students will be provided sufficient hours for their skill development through the Lab Courses and the Project component. The lab courses have different flavors and priorities to make a good zoologist. This degree offers specialization in areas like Animal Physiology and Genetics and a range of core courses like Cell Biology, Developmental Biology, Anatomy and Physiology of Non-chordates and Chordates, Ecology etc. In addition, various cross-cutting issues relating to Ecology have been aptly included to develop the students' sense of human wellbeing. The field trip/surveys and study tours are included to give the student an enticing taste of life, especially outside the classroom walls. Upon completing the programme, the students are expected to understand the key life processes of human and other animal groups and the functioning of molecules, cells, tissues, organs, and systems. Also, the students will gain increased confidence to use initiative and judgment to make decisions in complex and changeable situations, reflect critically and analytically on personal experience, and make informed decisions about further study, training, and employment opportunities. The Master of Science (M.Sc.) in Zoology is a Postgraduate program under the Faculty of Science and Technology of New Arts, Commerce and Science College, Ahmednagar (Autonomous).

The curriculum designed encompasses subjects like Histochemistry, Skills in Scientific Communication, Biochemical Techniques, Developmental Biology, Endocrinology, Biochemistry, Metabolic Biology, Evolutionary Biology, Neurophysiology, Population Genetics, Cytogenetics etc. In addition, to discipline-specific core courses (DSCC), which are compulsory, there are also Elective Courses. Elective Courses selected are from these two categories like Discipline Specific Elective Courses (DSEC) and Generic Elective (GE). Discipline-Specific Elective courses (DSEC) are Biochemistry/ Metabolic Pathways, Genetics/ Genetic Toxicology, Mammalian Reproductive Physiology/ Cytogenetics and Neural Physiology/ Population genetics. The Generic Elective (GE.) Courses are Economic Zoology, Ethology and Research Methodology. Both classical and applied subjects of Zoology have been rightly blended to offer a holistic understanding of the subject. The

Choice Based Credit System (CBCS) will be implemented through this curriculum. This curriculum would certainly facilitate students to develop a strong base of the fundamentals and specialize in the desired area of their fondness and abilities. In addition, the students pursuing this program would get the privilege to select optional subjects of their choice. A total of 210 hours for theory lectures and 180 hours for laboratory work have been prescribed in each semester, including a research project to inculcate the research culture amongst students. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments, planning and performing in the laboratory, and exercising critical judgment, independent thinking and problem-solving skills.

2. Programme Outcomes (POs)

Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities. In addition, they will have the opportunity to master the following objectives.

- i. Apply the knowledge of Zoology, Life Sciences, and allied subjects to understand complex life processes and phenomena.
- ii. Identify, review research literature, and analyze complex situations of living forms.
- iii. Design processes/ strategies that meet the specified needs with appropriate consideration for public health and safety and the cultural, social and environmental considerations.
- iv. Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, synthesis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.
- v. Create, select and apply appropriate techniques, resources and ICT tools for the understanding of the subject.
- vi. Apply to reason informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- vii. Understand the impact of the natural and anthropogenic activities in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development. Identify a range of Invertebrates and Vertebrates and justify their conservation.
- viii. Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/ research practice.
- ix. Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.
- x. Communicate effectively on complex life activities with the scientific community and society at large, such as comprehending and writing effective reports and design documentation, making effective presentations, and giving and receiving clear instructions.

- xi. Demonstrate knowledge and understanding of Zoology and management principles and apply these to one's work as a member and leader in a team.
- xii. Recognize the need for and prepare and engage in independent and life-long learning in the broadcast context of technological change.



Programme Structure and Course Titles

Sr. No.	Class	Semester	Course Code	Course Title	Credits
1.	M.Sc. I	I	MSC-ZO 111 T	Anatomy and Physiology of Non-chordates and Cell Biology	04
2.	M.Sc. I	I	MSC-ZO 112 T	Biochemical Techniques and Skills in Scientific Communication	04
3.	M.Sc. I	I	MSC-ZO 113 T	Molecular Biology	02
4.	M.Sc. I	I	MSC-ZO 114 P	Practicals in Anatomy and Physiology of Non-chordates and Cell Biology	02
5.	M.Sc. I	I	MSC-ZO 115 P	Practicals in Biochemical Techniques and Skills in Scientific Communication	02
6.	M.Sc. I	I	MSC-ZO 116 P	Practicals in Molecular Biology	02
7.	M.Sc. I	I	MSC-ZO 117 T (A)	Biochemistry*	02
8.	M.Sc. I	I	MSC-ZO 117 T (B)	Metabolic Pathways*	02
9.	M.Sc. I	I	MSC-ZO 118 P (A)	Practicals in Biochemistry*	02
10.	M.Sc. I	I	MSC-ZO 118 P (B)	Practicals in Metabolic Pathways*	02
11.	M.Sc. I	I	MSC-ZO 119 T	Economic Zoology	02
12.	M.Sc. I	II	MSC-ZO 211 T	Anatomy and Physiology of Chordates and Developmental Biology	04
13.	M.Sc. I	II	MSC-ZO 212 T	Endocrinology and Population Ecology	04
14.	M.Sc. I	II	MSC-ZO 213 T	Biostatistics and Bioinformatics	02
15.	M.Sc. I	II	MSC-ZO 214 P	Practicals in Anatomy and Physiology of Chordates and Developmental Biology	02
16.	M.Sc. I	II	MSC-ZO 215 P	Practicals in Endocrinology and Population Ecology	02
17.	M.Sc. I	II	MSC-ZO 216 P	Practicals in Biostatistics and Bioinformatics	02

18.	M.Sc. I	II	MSC-ZO 217 T (A)	Genetics*	02
19.	M.Sc. I	II	MSC-ZO 217 T (B)	Genetic Toxicology*	02
20.	M.Sc. I	II	MSC-ZO 218 P (A)	Practicals in Genetics*	02
21.	M.Sc. I	II	MSC-ZO 218 P (B)	Practicals in Genetic Toxicology*	02
22.	M.Sc. I	II	MSC-ZO 219 T	Ethology	02
23.	M.Sc. II	III	MSC-ZO 311 T (A)	Animal Physiology I*	04
24.	M.Sc. II	III	MSC-ZO 311 T (B)	Genetics I*	04
24.	M.Sc. II	III	MSC-ZO 312 T	Immunology and Evolution	04
25.	M.Sc. II	III	MSC-ZO 313 T	Histochemistry	02
26.	M.Sc. II	III	MSC-ZO 314 P (A)	Practical in Animal Physiology I*	02
27.	M.Sc. II	III	MSC-ZO 314 P (B)	Practical in Genetics I*	02
28.	M.Sc. II	III	MSC-ZO 315 P	Practical in Immunology and Evolution	02
29.	M.Sc. II	III	MSC-ZO 316 P	Practical in Histochemistry	02
30.	M.Sc. II	III	MSC-ZO 317 T (A)	Mammalian Reproductive Physiology*	02
31.	M.Sc. II	III	MSC-ZO 317 T (B)	Cytogenetics*	02
32.	M.Sc. II	III	MSC-ZO 318 P (A)	Practical in Mammalian Reproductive Physiology*	02
33.	M.Sc. II	III	MSC-ZO 318 P (B)	Practical in Cytogenetics*	02
34.	M.Sc. II	III	MSC-ZO 319 T	Research Methodology	02
35.	M.Sc. II	IV	MSC-ZO 411 T (A)	Animal Physiology II*	04
36.	M.Sc. II	IV	MSC-ZO 411 T (B)	Genetics II*	04
37.	M.Sc. II	IV	MSC-ZO 412 T	Freshwater Biology and Ichthyology	04
38.	M.Sc. II	IV	MSC-ZO 413 T	Forensic Entomology and Animal Tissue Culture	02
39.	M.Sc. II	IV	MSC-ZO 414 P (A)	Practical in Animal Physiology II*	02

40.	M.Sc. II	IV	MSC-ZO 414 P (B)	Practical in Genetics II*	02
41.	M.Sc. II	IV	MSC-ZO 415 P	Practical in Freshwater Biology and Ichthyology	02
42.	M.Sc. II	IV	MSC-ZO 416 P	Practical in Forensic Entomology and Animal Tissue Culture	02
43.	M.Sc. II	IV	MSC-ZO 417 T (A)	Neural Physiology*	02
44.	M.Sc. II	IV	MSC-ZO 417 T (B)	Population Genetics*	02
45.	M.Sc. II	IV	MSC-ZO 418 P (A)	Practical in Neural Physiology*	02
46.	M.Sc. II	IV	MSC-ZO 418 P (B)	Practical in Population Genetics*	02
47.	M.Sc. II	IV	MSC-ZO 419 Pr	Project	02
	Total	04	47		88

***Elective Courses: Students need to select any one elective course.**



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Syllabus of M. Sc. Zoology I (Semester-I)
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Semester – I	Paper - I
Course Code: MSC-ZO 111 T	Title of the Course: Anatomy and Physiology of Non-chordates and Cell Biology
Credits: 04	Total Lectures: 60 Hrs.

Course Outcomes (COs)

1. Understand the anatomical features of Non-chordates
2. Understanding the physiological systems in Non-chordates
3. Understanding the structural features of cell and cellular mechanisms.
4. Understanding different pathways related to cell signaling and cancer.

Detailed Syllabus

Unit	Name of Topic	Lectures Allotted
1.	Nutrition and Digestion Nutrition in Non-chordates, amoeboid feeding, ciliary feeding, parasitic feeding (Protozoa and helminths) filter-feeding mechanism in Polychaeta, Mollusca, and Echinodermata, mechanism of digestion.	(03)
2.	Respiration Mechanism of ventilation, respiratory organs (Gills, Lophophores, Tracheae, lungs), respiratory pigments in Non-chordates, mechanism of respiration.	(03)
3.	Circulation Origin and types of circulation in Non-chordates (Annelida, Arthropoda, Mollusca)	(03)
4.	Excretion, Osmoregulation, and Ionic Regulation Excretory organs and mechanism of excretion in Platyhelminthes,	(03)

Aschelminthes, Annelida, Arthropoda, Mollusca, and Echinodermata, osmoregulation and ionic regulation in Non-chordates.

5. Locomotion and Movement: (03)

Amoeboid movement, molecular mechanism of ciliary and flagellar movement, hydrostatic movement in Coelenterata, Annelida and Echinodermata, flight mechanism in the insect.

6. Sensory system: (04)

Structural and functional organization of mechanoreceptors, chemoreceptors, and photoreceptors in Non-chordates. Evolution of photoreceptors in Non-chordates and mechanism of Photoreception.

7. Trends in Neural Evolution (03)

Primitive nervous system -Coelenterata and Echinodermata

Advanced nervous system- Annelida, Arthropoda(Crustacean and Insecta), and Mollusca (Cephalopoda)

8. Endocrine System: (05)

Introduction to endocrine system of Porifera, Cnidaria, Turbellaria, Nematoda, Annelida, Mollusca, Insects, Crustaceans, and Echinodermata.

Endocrine control of gametogenesis in Polychaeta, hormones and reproduction in Gastropoda, hormones and moulting in Insects, hormonal control of chromatophores in Crustaceans, sex hormones in insects

9. Reproduction: (03)

Protozoa: (Binary and multiple fission, Budding Plasmotomy, Conjugation, and syngamy). Porifera(regeneration, budding and branching, fission and fragmentation, reduction bodies and gemmules), other Metazoans (Budding, fragmentation, fission, parthenogenesis, hermaphroditism, sexual reproduction in insects, alternation of generation), larval forms in Non-chordates

10. Introduction to Cell Biology (02)

Cell theory, the general organization of cells and characteristics of living systems.

11. Plasma membrane (05)

Ultrastructure, membrane proteins; membrane transport channels, carriers and pumps; membrane potential and synaptic transmission,

cell communication, cell adhesion, gap junctions, extracellular matrix and integrins.

- 12. Endomembrane system: (04)**
Endoplasmic reticulum, Golgi complex, Lysosomes, Peroxisomes, glyoxysomes, Protein trafficking- secretory and endocytic pathways.
- 13. Mitochondria (03)**
Structure, genetic system, functions; protein import.
- 14. Nucleus (03)**
Ultrastructure and functions – nuclear envelope, nuclear lamina, nuclear pore complex and nucleolus.
- 15. Cytoskeleton (03)**
Role in cell architecture, motility, chemistry of microtubules, microfilaments, intermediate filaments, organization, associated proteins and their Role, ultrastructure and molecular organization of centriole, flagellum and cilium.
- 16. Cell Cycle (03)**
Phases, checkpoints, Mechanism of regulation, regulators of cell cycle progression – MPF, Cyclins and Cyclin-dependent kinases (CDKs).
- 17. Cancer (03)**
Types, development, causes, characteristics of cancer cell, virus-induced cancer, oncogene and tumor suppresser gene.
- 18. Cell signaling (04)**
Elements of cell signaling systems, types of membrane receptors, signaling through G-protein coupled receptors, secondary messenger system.

Suggested Reading:

- 1. Barrington.E. J. W. Thomas Nelson Invertebrate structure and function.;** & Sons Ltd. London
- 2. Barnes. R.D.Invertebrate Zoology,** III edition. ;
- 3. Hyman, L.H., The invertebrates.** Vol.1 to Vol.10., McGraw Hill Co., New York.,/li.
- 4. Evolution of Metazoan life cycle, Jagerstain, G.** Academic Press, New York & London.
- 5. Russel-Hunter, A Biology of higher invertebrates,** WD. McMillan Co. Ltd., London

6. **Sedgwick.A., Student Text Book of Zoology.** Vol. I.II and III. Central Book Depot, Allahabad
7. **Karp Gerald (2010) Cell Biology.** 6th Edition, John Wiley and Sons (Asia) Pte. Ltd.
8. **Cooper Geoffrey M. (1997) The Cell: A Molecular Approach.** ASM Press, Washington DC, USA.
9. **Alberts B., A. Johnson, J.Lewis, M. Raff, K. Roberts and P. Walter (2008) Molecular Biology of the Cell.** 5th Edition, Garland Science, New York, U.S.A.
10. **Lodish H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell (1995) Molecular Cell Biology.** Eds. 3, Scientific American and W. H. Freeman, New York.
11. **De Robertis E.D.P. and De Robertis E.M.E. (1987) Cell and Molecular Biology** 8th Edition, Lea and Febiger, Philadelphia.



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Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology

Semester – I	Paper-II
Course Code: MSC-ZO 112 T	Title of the Course: Biochemical Techniques and Skills in Scientific Communication
Credits: 04	Total Lectures: 60 Hrs.

Course Outcomes (COs)

1. Understand the basic principles and instrumentation of biological techniques
2. Understanding the working and applications of biological techniques.
3. Learn the basic communication skills in scientific writing.
4. Understanding types of scientific communications.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Colorimetry and Spectroscopy Basic principles of colorimetry, nature of electromagnetic radiation, Beer-Lambert's laws, colorimetric methods and instruments, principles of spectroscopy, types of Spectra- absorbance, emission, fluorescence and action spectra, single and double beam spectrophotometers, circular dichroism, applications of colorimetry and spectroscopy.	(05)
2.	Microscopy Basic principles, instrumentation, sample preparation methods for optical, phase contrast, inverted, fluorescence, confocal and electron microscopes and their applications.	(03)
3.	Chromatography Principle, working and applications of Adsorption chromatography Partition chromatography, Ion-exchange chromatography, Molecular exclusion chromatography, Affinity chromatography, Gas Chromatography, High-Performance Liquid Chromatography (HPLC).	(07)

- 4. Electrophoresis (05)**
Principle and types of electrophoresis and their applications for proteins, nucleic acids, including gradient gel and pulse-field gel electrophoresis, gel matrices-polyacrylamide and agarose, critical parameters for optimum separation and resolution, two-dimensional electrophoresis (IEF)
- 5. Biophysical Methods (04)**
Principle and working of pH meter, Grigor Muller Counter, Fluorescence, Nuclear Magnetic Resonance (NMR), Magnetic Resonance Imaging (MRI-fMRI) lasers in biology, X-ray crystallography, concept of biosensors
- 6. Molecular Biology Methods (04)**
DNA sequencing methods, Protein sequencing methods, RFLP, RAPD and AFLP techniques.
- 7. Centrifugation (02)**
Principles and types, simple and differential ultracentrifugation-preparative and analytical applications.
- 8. Language as a communication tool (02)**
Relationship among reading, writing, listening and speaking
- 9. Pragmatic competence (02)**
Co-operative principles and politeness principles
- 10. Organization of English language (03)**
Sentence structure, basic grammar, sequence and tenses, syntax, paragraphs, paraphrases and precis writing, synonyms and antonyms
- 11. Common errors in written and spoken English (02)**
Tautology, double negative, double-positive and superfluous words
- 12. Oral presentation (02)**
How to prepare a presentation, PowerPoint slides, use of communication and IT, voice, speed of delivery and obstacles in effective communication
- 13. Outline of a scientific research paper (14)**
Hypothesis, theory and concept
Title designing, framing abstract and keywords
Introduction: statement of the problem and justification; aim, objectives, need, significance and rationale of the study and literature review.
Materials and Methods: contents, the importance of measurements and reproducibility.
Observation and Results: text and data presentation, tables, graphs, histograms, diagrams, photographic plates, legends and captions
Discussion: logical sequence and critical analysis of evidence and data conclusion
References: finding references from journals, books and databases and Citation – styles of citation

- Summary, Acknowledgements
14. **Editing and correcting** (03)
proof-reading symbols, jargon and abbreviations
15. **Plagiarism** (02)
meaning, types, avoiding plagiarism.

Suggested Readings:

1. **Voet Donald and Voet Judith G. John Biochemistry, 3rd Ed. (2005)**, Publisher: Wiley and Sons, New York.
2. **Berg Jeremy, Tymoczko John, Stryer Lubert Biochemistry 6th Ed, (2007)**, Publisher: W. H. Freeman, New York.
3. **Nelson D. L. and Cox M. M. W. H. Freeman Lehninger's Principles of Biochemistry, 4th edition, (2005)** and Co. NY.
4. **Segel Irvin H. Biochemical Calculations, 2nd Ed., (1997)**, Publisher: John Wiley and Sons, New York.
5. **Enzymes: Biochemistry, Biotechnology and Clinical chemistry, (2001)** Palmer Trevor, Publisher: Horwood Pub. Co., England.
5. **Geoffrey Zubay, William C Brown Biochemistry, Pub; 4th edition (June 1999)**
6. **Keith Wilson and John Walker Principles and Techniques of Biochemistry and Molecular Biology, 6th edition (2008)**, Publisher—Cambridge University Press.
7. **Upadhyaya and Upadhyaya, Biophysical Chemistry**
8. **Leland J Cskeke et al. Handbook of molecular and cellular methods in biology**
9. **O'Conner M. and F.P. Woodford (1975) Writing Scientific papers in English.** Elsevier- Excerpta Medica-North Holland Publ., Amsterdam
10. **Trelease S.F. (1958) How to Write Scientific and Technical Papers.** Williams and Wilkins Co. Baltimore, U.S.A.
11. **Day Robert (1966) How to Write and Publish a Scientific Paper.** Cambridge University Press
12. **Mc Millan V. (1997) Writing Papers in the Biological Sciences.** Edn. 2, W.H. Freeman, New York.
13. **Winkler Anthony C. and Jo Ray McCuen-Metherell (2008) Writing the Research Paper, A Handbook. 7th Edition, Wadsworth Cengage Learning, Boston, M.A., USA.**
14. **Vijayalakshmi G. and C. Sivapragasam (2008) Research Methods - Tip and Techniques.** MJP Publishers, Chennai.
15. **Kothari C.R. (2009) Research Methodology: Methods and Techniques. 2nd Revised Edition, New Age International Publishers, New Delhi.**
16. **Levinson Stephen C. (2003) Pragmatics.** Cambridge University Press, Cambridge

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Syllabus of M. Sc. Zoology I (Semester-I)
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Semester – I	Paper - III
Course Code: MSC-ZO 113 T	Title of the Course: Molecular Biology
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understanding the structure and regulation of nucleic acids
2. Understanding of the mechanism of protein synthesis.
3. Understand the concept of gene regulation.
4. Understand the language of gene code and its applications.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Central Dogma; Detailed information on Nucleic Acids.	(07)
	Introduction to Central Dogma of Molecular Biology, Structure and topology of DNA, type of DNA (A, B, Z) structure of chromatin, nucleosomes, chromatin organization, higher-order organization, structure of Histone Protein, physical Properties of DNA, unusual DNA Structures, DNA motif.	
2.	DNA Replication, Recombination and Repair	(11)
	DNA replication in <i>E. coli.</i> , origin of Replication, types of <i>E. coli.</i> DNA polymerase, factors and enzymes involved in replication initiation, elongation and termination, Eukaryotic DNA replication, replication origin, factors and enzymes in replication, assembly of pre-replicative and replicative origin complexes, firing of replicating origin, elongation (leading and lagging strand synthesis, replication of telomeric sequences), proof-reading, different types of DNA damages,	

different DNA repair systems: nucleotide excision repair, base excision repair, mismatch repair, recombination repair, UV damage and photo-reactivation or light repair,

3. Transcription, Processing, Editing and Splicing (06)

Transcriptional unit in prokaryotes and eukaryotes, types and Role of RNA polymerase I, II, III., types of transcriptional factors, Mechanism of prokaryotic and eukaryotic gene transcription, processing: capping, polyadenylation, splicing, post-transcriptional processing of rRNA, tRNA and mRNA.

4. Protein Synthesis (Translation) and Processing (03)

Genetic code, aminoacylation of tRNA, aminoacyl tRNA synthetase, Prokaryotic Translation: initiation, elongation and termination. Eukaryotic Translation: Role of the ribosome, initiation complex formation, initiation factors and their regulation, elongation and elongation factors, termination, Protein trafficking.

5. Gene Regulation (03)

Prokaryotic gene regulation - Lactose, Arabinose and Tryptophan operons and eukaryotic gene regulation.

Suggested Readings:

1. **James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Molecular Biology of the Gene, 5th Edition (2004),. Publisher- Pearson Education, Inc. And Dorling Kindersley Publishing, Inc.**
2. **Weaver R., Molecular Biology, 4th Edition (2007), Publisher-McGraw Hill Science.**
3. **Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Molecular Biology of the Cell, 4th Edition (2004), Publisher: Garland Publishing.**
4. **Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Essential Cell Biology, 2^{ne} Edition (2003) Publisher; Garland Publishing.**
5. **Benjamin Lewin, Gene X, (2010), Publishers- Jones and Barlett Inc.**
6. **De Robertis and De Robertis, Molecular Biology.**

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Syllabus of M. Sc. Zoology I (Semester-I)
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Faculty of Science and Technology(Zoology)

Semester – I	Paper - IV
Course Code: MSC-ZO 114 P	Title of the Course: Practicals in Anatomy and Physiology of Non-chordates and Cell Biology
Credits: 02	Total Practicals: 60 Hrs.

Course Outcomes (COs)

1. Understand the physiological mechanisms in Non-chordates
2. Comparative study of anatomical structures in Non-chordates
3. Practical understanding of cell structure and cell division.
4. Practical understanding of techniques used in cell biology.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Determination of the heartbeat in the crab-effect of temperature & ions.	(01)
2.	Effect of eyestalk ablation on glucose in the hemolymph of the crab.	(01)
3.	Effect of background on integument chromatophores of the freshwater prawn.	(01)
4.	Effect of eyestalk removal on blood glucose level in crab/prawn.	(01)
5.	Dissection of Leech /Crab to study the digestive, Reproductive and Nervous systems. (D)	(01)
6.	Mounting of following – (a) Malpighian tubules b) Mouthparts and Spiracles of Cockroach, c) Cornea and Wings of Cockroach,	(02)
7.	Limits of cleanliness. (To check for microbial flora)	(02)
8.	Study of ultrastructure of cell organelles using electron micrographs.	(01)
9.	Study of different types of cells.	(01)
10.	Temporary preparation of human cheek epithelial cells or blood cells to show the presence of Barr body.	(01)
11.	Study of different stages of mitosis from a suitable material.	(01)

12. Study of meiosis in Grasshopper testes/ Onion flower buds/ *Aloe vera* (01)
with emphasis on all stages of Prophase I.
13. Cell fractionation- Nuclei, mitochondria and lysosomes, Nuclear count, (02)
Mitochondria confirmation by Janus Green B



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Faculty of Science and Technology

Semester – I	Paper – IV
Course Code: MSC-ZO 115 P	Title of the Course: Practicals in Biochemical Techniques and Skills in Scientific Communication
Credits: 02	Total Practical: 60 Hrs.

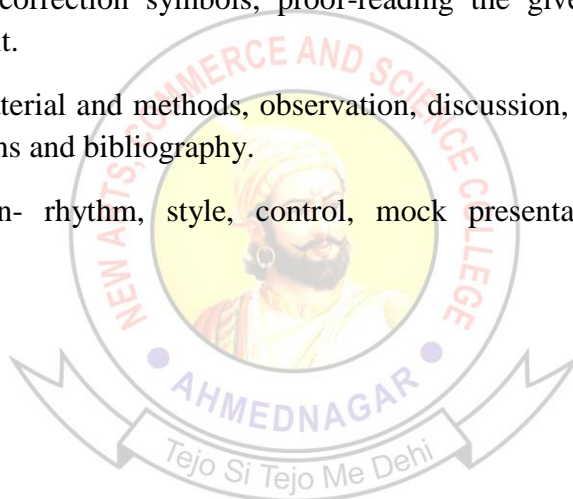
Course Outcomes (COs)

1. Practical understanding of principle and working of biochemical techniques.
2. Performing assay for quantification of biological molecules.
3. Understand how to write scientific paper.
4. Learning basics of scientific communication.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Principle and uses of different microscopes. (Phase contrast, Fluorescence and Electron Microscope)	(01)
2.	Working principle of Colorimeter, Spectrophotometer, Centrifuge machines, Electrophoresis, Column Chromatography etc.	(01)
3.	Protein estimation by using UV Spectrophotometer. (Lowry et al Method)	(01)
4.	To study the effect of different solvents for a given dye using thin-layer chromatography.	(01)
5.	Separation of amino acids by paper chromatography.	(01)
6.	Enzyme isolation and purification by fractionation methods.	(01)
7.	Determination of isoelectric pH of Casein	(01)

8. To find out the capacity and nature of a given ion-exchanger. Investigate the % retention and % elution of amino acids on a given ion exchanger. (01)
9. Separation of proteins using polyacrylamide gel electrophoresis (Native PAGE). (01)
10. English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, pronoun. (01)
11. Syntax, paraphrasing and precis writing, synonyms, antonyms, abbreviations. (01)
12. Outline of a scientific paper, preparation of a research project. (01)
13. Writing abstracts, conclusion/ summary and acknowledgments, keywords, and suggest a suitable title to the given abstract/ paper. (01)
14. Study of proof correction symbols, proof-reading the given text and correcting the text. (01)
15. How to write material and methods, observation, discussion, conclusion, summary, citations and bibliography. (02)
16. Oral presentation- rhythm, style, control, mock presentation of 10 minutes. (01)



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology

Semester – I	Paper – VI
Course Code: MSC-ZO 116 P	Title of the Course: Practicals in Molecular Biology
Credits: 02	Total Practical: 60 Hrs.

Course Outcomes (COs)

1. Demonstrate the various methods of isolation of DNA from different sources.
2. Analysis of protein by SDS PAGE method
3. Understand the various sterilization techniques used in the daily work of the laboratory.
4. Analysis of amino acids and nucleotides from the spectrophotometric method.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Lab safety Techniques and sterilization.	(01)
2.	Absorption studies of DNA. (λ_{max} of DNA, Purity of DNA and Quantification of DNA) using UV spectrophotometer.	(01)
3.	Isolation of bacterial DNA and estimation by UV spectrophotometry.	(02)
4.	Demonstration of plasmid DNA in <i>E. coli</i> . and its characterization by UV spectrophotometry.	(02)
5.	Isolation of Liver DNA and its Agarose gel electrophoresis.	(02)
6.	Isolation of RNA and agarose gel electrophoresis.	(02)
7.	To separate proteins by native PAGE and SDS- PAGE.	(02)
8.	Spectrophotometric analysis of nucleotides and amino acids	(02)
7.	DEAE cellulose column chromatography of	(01)
8.	Gene/Protein Expression study: Restriction Digestion and Ligation Study.	(02)

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology

Semester – I	Paper - VII
Course Code: MSC-ZO 117 T (A)	Title of the Course: Biochemistry
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understanding chemical and physical laws governing biochemistry.
2. Understand the structure and biological significance of biomolecules.
3. Understanding the biochemistry of metabolic pathways.
4. Understanding the concept of enzymes and their regulation.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Introduction to General Biochemistry Structure of water molecule, water as the universal solvent, pH and buffers, biological buffer system, laws of thermodynamics, free energy, entropy, covalent and non-covalent interactions in biological systems.	(05)
2.	Biomolecules and Biophysical chemistry Composition, structure and function of Carbohydrates, Lipids, Proteins and Nucleic acids. Concept of pH and pKa, Handerson and Hasselbalch's equation, reaction kinetics, colligative properties.	(06)
3.	Amino acids, Peptides and Polypeptides Different structures of the protein molecule (primary, secondary- α and β sheet, tertiary and quaternary), domains, motif and folds, Ramchandran plot and its applications.	(05)

4. Enzymology (04)

Enzyme kinetics, Derivation of Michelis and Menten equation, types of Enzyme inhibition, mechanism of enzyme action- active site, substrate binding, transition state, lowering of activation energy and Isozymes.

5. Metabolism of Carbohydrates, Proteins, Lipids and Nucleotides (08)

Glycolysis (Aerobic and Anaerobic), Pyruvate Dehydrogenase Complex (PDH Complex), TCA Cycle, gluconeogenesis, glycogenesis and glycogenolysis, β oxidation of fatty acids and synthesis of fatty acids (Cholesterol). Transamination and oxidative deamination of amino acids. Biosynthesis of purine and pyrimidine nucleotides.

6. Principles of Bioenergetics (02)

Electron Transport Chain (ETC) and Oxidative Phosphorylation

Suggested Readings:

1. **Voet Donald and Voet Judith G Biochemistry, 3rd Ed. (2005),** John, Publisher: Wiley and Sons, New York.
2. **Berg Jeremy, Tymoczko John, Stryer Lubert, Biochemistry 6th Ed, (2007)** Publisher: W. H. Freeman, New York.
3. **Nelson D. L. and Cox M. M. Lehninger's Principles of Biochemistry, 4th edition, (2005)** W. H. Freeman and Co. NY.
4. **Segel Irvin H., Biochemical Calculations, 2nd Ed., (1997)** Publisher: John Wiley and Sons, New York.
5. **Palmer Trevor, Enzymes: Biochemistry, Biotechnology and Clinical chemistry, (2001)** Publisher: Horwood Pub. Co., England.
6. **Geoffrey Zubay Biochemistry, 4th edition (June 1999),** William C Brown Pub;
7. **Mathews et al., Biochemistry 3rd edition** Benjamin/Cummings Publishing, 1990.
8. **John W Baynes and Marek H. Dominiczak, Medical Biochemistry, 2018-** Publisher- Elsevier; 5th edition.
9. **Victor W. Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony Weil, Harper's Illustrated Biochemistry, 2018,** McGraw-Hill; Illustrated edition.
10. **Gerhard Meisenberg, William H. Simmons, Principles of Medical Biochemistry-2016,** Elsevier; 4th edition.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
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Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology

Semester – I	Paper - VII
Course Code: MSC-ZO 117 T (B)	Title of the Course: Metabolic Pathways
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understanding chemical and physical laws governing biochemistry.
2. Understand the structure and biological significance of biomolecules.
3. Understanding the biochemistry of metabolic pathways.
4. Understanding the concept of enzymes and their regulation.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Introduction to General Biochemistry Laws of Thermodynamics, free energy, entropy, high energy bonds, Redox Potentials, high energy compounds,	(06)
2.	Concepts of metabolism Metabolic pathways-Catabolic and anabolic, regulation of metabolic pathways	(03)
3.	Carbohydrate Metabolism Glycolysis (Aerobic and Anaerobic way), regulation of Glycolysis, Metabolic flux and various metabolic interactions, PDH Complex, TCA Cycle, gluconeogenesis, glycogenesis, glycogenolysis, glyoxylate cycle, inborn errors of metabolism- Von- Gerkes disease, Tarui's disease, Galactosemia, Maple syrup urine	(11)
4.	Metabolism of Amino Acids, Peptides, Polypeptides and Lipids Amino Acid Metabolism, oxidative degradation of amino acids: transamination and oxidative phosphorylation, biosynthesis of purine and pyrimidine nucleotides, oxidation of even chain saturated fatty acids,	(08)

oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, omega (ω)- oxidation of fatty acids, ketogenesis. transport of fatty Acids.

5. Principles of Bioenergetics (02)

Electron Transport Chain (ETC) and Oxidative Phosphorylation

Suggested Readings:

1. **Voet Donald and Voet Judith G Biochemistry, 3rd Ed. (2005).** John, Publisher: Wiley and Sons, New York.
2. **Berg Jeremy, Tymoczko John, Stryer Lubert, Biochemistry 6th Ed, (2007)** Publisher: W. H. Freeman, New York.
3. **Nelson D. L. and Cox M. M. Lehninger's Principles of Biochemistry, 4th edition, (2005)** W. H. Freeman and Co. NY.
4. **Segel Irvin H., Biochemical Calculations, 2nd Ed., (1997)** Publisher: John Wiley and Sons, New York.
5. **Palmer Trevor, Enzymes: Biochemistry, Biotechnology and Clinical chemistry, (2001)** Publisher: Horwood Pub. Co., England.
6. **Geoffrey Zubay Biochemistry, 4th edition (June 1999),** William C Brown Pub;
7. **Mathews et al., Biochemistry 3rd edition** Benjamin/Cummings Publishing, 1990.
8. **John W Baynes and Marek H. Dominiczak, Medical Biochemistry, 2018-** Publisher- Elsevier; 5th edition.
9. **Victor W. Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony Weil, Harper's Illustrated Biochemistry, 2018,** McGraw-Hill; Illustrated edition.
10. **Gerhard Meisenberg, William H. Simmons, Principles of Medical Biochemistry-2016,** Elsevier; 4th edition.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
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Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology(Zoology)

Semester – I	Paper - VIII
Course Code: MSC-ZO 118 P (A)	Title of the Course: Practicals in Biochemistry
Credits: 02	Total Practicals: 60 Hrs.

Course Outcomes (COs)

1. Practical understanding of basic concepts in biochemistry.
2. Practical understanding of principle and working of techniques in biochemistry.
3. Performing assay for quantification of biological molecules.
4. Isolation of biomolecules using different techniques.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Preparation of Acid and Alkali solutions and acid-base titration	(01)
2.	To prepare Buffers of known pH and molarity and measurement of pH of various samples, Buffering capacity.	(01)
3.	Effect of substrate concentration and inhibitors on enzyme activity.	(02)
4.	Effect of pH and temperature on enzyme activity	(02)
5.	To find the saponification value of a given fat.	(01)
6.	Estimation of Sugar (Glucose) by Folin Wu method.	(01)
7.	Estimation of Sugar by DNSA method.	(01)
8.	Isolate proteins by salting out / by adjusting the isoelectric point.	(01)
9.	Isolation and estimation of starch from potato.	(01)
10.	Estimation of uric acid in-wall Lizard excreta/ Human blood any other suitable material.	(01)

11. To find the absorption spectrum of hemoglobin, BSA, Tyrosine. (01)
12. Estimation of Protein by Lowry et al. Method. (01)
13. To estimate free amino acids by Ninhydrin method (01)
14. Determine the concentrations of Vitamin C by titration method from various sources. (01)
15. To study the time course of the reaction catalyzed by alkaline phosphatase (02)



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology(Zoology)

Semester – I	Paper - VIII
Course Code: MSC-ZO 118 P (B)	Title of the Course: Practicals in Metabolic Pathways.
Credits: 02	Total Practicals: 60 Hrs.

Course Outcomes (COs)

1. Practical understanding of basic concepts in metabolic pathways.
2. Practical understanding of principle and working of techniques in metabolic pathways.
3. Performing assay for quantification of biological molecules.
4. Isolation of biomolecules using different techniques.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Preparation of Acid and Alkali solutions and acid-base titration	(01)
2.	To prepare Buffers of known pH and molarity and measurement of pH of various samples, Buffering capacity.	(01)
3.	Effect of substrate concentration and inhibitors on enzyme activity.	(02)
4.	Effect of pH and temperature on enzyme activity	(02)
5.	To find the saponification value of a given fat.	(01)
6.	Estimation of Sugar (Glucose) by Folin Wu method.	(01)
7.	Isolate proteins by salting out / by adjusting the isoelectric point.	(01)
9.	Estimation of Starch	(01)
10.	Estimation of uric acid from Wall Lizard excreta/ Birds/ Human blood any other suitable material.	(01)

11. To find the absorption spectrum of hemoglobin, BSA, Tyrosine. (01)
12. Estimation of Protein by Lowry et al. method. (01)
13. Estimation of Sugar by DNSA method. (01)
14. Determine the concentrations of Vitamin C by titration method from various sources. (01)
15. To estimate free amino acids by Ninhydrin method (01)
16. To study the time course of the reaction catalyzed by alkaline phosphatase (02)



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-I)
under
Faculty of Science and Technology

Semester – I	Paper - IX
Course Code: MSC-ZO 119 T	Title of the Course: Economic Zoology
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understand the aquaculture systems, conditioning factors and their manipulation.
2. Understand the environmental impacts on aquaculture.
3. Training related to poultry, dairy, piggery industries.
4. Construction of vermicompost unit.

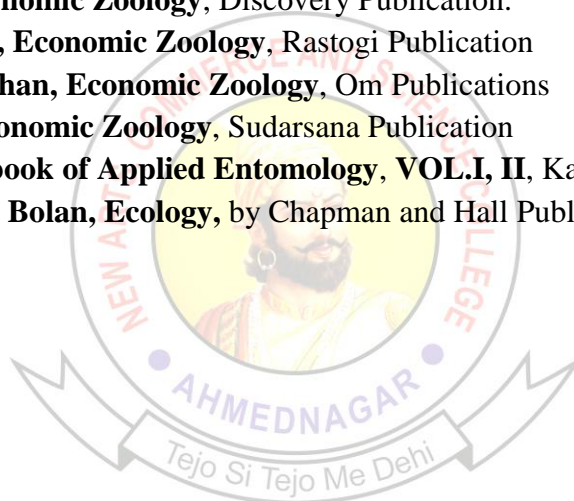
Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Livestock Management I Breeds of Poultry: Selection of breeds, Facilities and equipment, maintenance and health care, breeding stocks and products, vaccination programmes.	(03)
2.	Livestock Management II Breeds of Cattle: Selection of breeds, Facilities and equipment, maintenance and health care, breeding stocks and products, vaccination programmes.	(03)
3.	Livestock Management III Breeds of Pig: Selection of breeds, Facilities and equipment, maintenance and health care, breeding stocks and products, vaccination programmes.	(03)
4.	Livestock Management IV Breeds of Sheep: Selection of breeds, Facilities and equipment, maintenance and health care, breeding stocks and products, vaccination programmes.	(03)
2.	Aquaculture Freshwater fish culture, Prawn culture, Economic importance of Aquaculture	(05)

3. **Pest Management.** (04)
Introduction to pest management and its types, diseases caused by pests in domestic animals.
4. **Vermiculture** (04)
Selection of species for vermiculture, small and large scale vermiculture, Mechanism of the vermicomposting, economic importance of vermiculture and vermicomposting.
5. **Parasitic protozoans and their Role in human welfare, soil protozoan, and their role in agriculture.** (03)
6. **Model animals in the pharmaceutical industry.** (02)

Suggested Readings:

1. **A. A. Khan Encyclopedia of Economic Zoology**, Anmol publications.
2. **Manju Yadav, Economic Zoology**, Discovery Publication.
3. **Shukla, Upadhaya, Economic Zoology**, Rastogi Publication
4. **K. R. Ravindranathan, Economic Zoology**, Om Publications
5. **Venkitaraman ,Economic Zoology**, Sudarsana Publication
6. **Srivastava, A textbook of Applied Entomology, VOL.I, II**, Kalyani Publication.
7. **C. D. Edward, P.J. Bolan, Ecology**, by Chapman and Hall Publications.



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
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Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology(Zoology)

Semester – II	Paper - I
Course Code: MSC-ZO 211 T	Title of the Course: Anatomy and Physiology of Chordates and Developmental Biology
Credits: 04	Total Lectures: 60 Hrs.

Course Outcomes (COs)

1. Understand the anatomical features of Vertebrates.
2. Understanding the physiological systems in Vertebrates.
3. Understanding the concepts in developmental biology.
4. Understanding the developmental patterns/ forms in animals.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Integument Basic Structure, comparative overview of Vertebrate integument and its function.	(02)
2.	Digestion Diversity in the digestive tract and associated glands of Chordates, mechanism of digestion.	(03)
3.	Respiration Ventilation associated with gills and lungs, respiratory Pigments, mechanism of respiration (O ₂ transport, O ₂ Dissociation Curves, Co ₂ transport)	(03)
4.	Circulation Heart and its evolution, arterial channels and their modifications, venous channels and their modification.	(03)
5.	Urinogenital System Evolution of urinogenital system, process of urine formation in mammalian kidney, Renal Pressure system, comparative biochemistry of nitrogenous excretion.	(03)

- 6. Osmoregulation (03)**
Concepts in osmoregulation, Osmoregulatory mechanism in Chordates (Hyper and Hyposmotic regulators, Osmotic regulators), mechanism of ionic regulation at the cell level.
- 7. Thermoregulation (02)**
Concepts in Thermoregulation, thermoregulation in ectotherm and endotherms, heterotherms
- 8. Muscle (04)**
Structure of the skeletal muscle, proteins of the myofilaments, actin-myosin interaction; sarcoplasmic reticulum and role of Calcium in contraction.
- 9. Sense Organs (04)**
Classification and Properties of Sense organs, Photoreceptors (Diversity of rods and cones in vertebrates, structure of Vertebrate Eye, mechanism of Photoreception.)
- 10. Nervous System (03)**
Neuron Structure and Function, classification of Neurons (Structural and Functional), Neural Integration and Neural secretion.
- 11. Concepts of Developmental Biology (03)**
Potency, commitment, specification, induction, competence, determination, differentiation, trans-differentiation, communication, signaling, morphogenic gradients cell fate and cell lineages, stem cells, mutants and transgenics in the analysis of development.
- 12. Model Organisms (03)**
Invertebrate: *Drosophila melanogaster*, Pisces: Zebra Fish- *Danio rerio*, Amphibians: *Xenopus laevis*, Birds: Chick, Mammals: Mouse
- 13. Gametogenesis (02)**
Spermatogenesis: spermatogenesis, the structure of sperm, regulation of sperm motility (tail fiber complex and role of dynein ATPase), the role of pH and divalent cations. Oogenesis: structure of ovum, previtellogenesis, vitellogenesis and post-vitellogenesis.
- 14. Fertilization (04)**
Concept of fertilization, types of fertilization, species-specific sperm attraction, recognition of egg and sperm, acrosome reaction, signal transduction, molecular strategy to avoid polyspermy in fertilization.
- 15. Types of eggs (02)**
Based on the amount of distribution of yolk, Cleavage: types and significance.

- | | |
|--|-------------|
| 16. Morphogenesis | (04) |
| Blastulation, Gastrulation and Neural development- Frog, Chick | |
| 17. Pattern formation | (04) |
| Setting up the body axis, Dorsal, ventral axis: Amphibians
Antero-posterior axis: Drosophila – Role of bicoid and Nanos as morphogen gradients and regulation of hunchback. | |
| 18. Organizers | (02) |
| Spemann and Mangold: Primary embryonic induction, Functions of an organizer, | |
| 19. Regeneration | (04) |
| Epimorphic regeneration in Salamander limb, morpholactic regeneration in Hydra and compensatory regeneration in mammalian liver. | |
| 20. Apoptosis, aging and senescence. | (02) |

Suggested Reading:

1. **C. D. Moyes and P. M. Schulte, Principles of Animal Physiology (2006).** Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc. •
2. **A. C. Guyton and J. E. Hall. Textbook of Medical Physiology 10th edition (2001),** Publisher - W. B. Saunders Company, Philadelphia. –
3. **Kingslay J.S, Outlines of Comparative anatomy of vertebrates,** Central Book Depot, Allahabad.
4. **Young J.Z. Life of Mammals** Oxford University Press, London.
5. **Colbert E.H. Evolution of Vertebrates** John Wiley and Sons Inc. New York.
6. **Kent C.J. Comparative anatomy of Vertebrates.**
7. **S.F. Gilbert, Developmental Biology, 9th edition (2010).** Publisher- Sinauer, Associates Inc.
8. **Lewis Wolpert, Principles of Development, 3rd edition (2007),** Publisher Oxford, University Press.
9. **BI. Balinsky, An Introduction to Embryology, 5th edition (2004).** Publisher – ThomasAsia Pvt. Ltd.
10. **R.M.Twyman, Developmental Biology,(2001),** Publisher- Bios Scientific, Publishers LTD.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology(Zoology)

Semester – II	Paper-II
Course Code: MSC-ZO 212 T	Title of the Course: Endocrinology and Population Ecology
Credits: 04	Total Lectures: 60 Hrs.

Course Outcomes (COs)

1. Understanding the types of hormones and their mechanism of action.
2. Learning physiological significance of hormones.
3. Understand the structure and regulation of the population.
4. Understand the models of prey-predator relationship and ecological modeling.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Introduction to Endocrinology Endocrine glands and their hormones, chemical nature of hormones, Hormone Secretions (apocrine, holocrine, and merocrine), Hormone Delivery, hormonal feedback mechanisms	(02)
2.	Mechanism of Hormone Action Protein, peptide hormone action (receptors, secondary messengers and signal transduction), steroid hormones, synthesis and Mechanism of action, permissive additive synergistic actions of hormones, termination of hormone actions.	(03)
3.	Hypothalamo-Hypophysial System Anatomy and hormones of pituitary glands, Endocrine hypothalamus: structure and functions of endocrine hypothalamus, Hypophysiotropic hormones, control of hypothalamic hormone secretion	(05)

- Neurohypophysis: Structure and function of neurohypophysis, control of neurohypophysial secretion and their physiological functions
 Adenohypophysial hormones: Chemistry and physiological roles of Somatotropin and Prolactin, Glycoprotein hormones (FSH, LH and TSH), Opio melanocortins and their functions
- 4. Hormonal control of calcium homeostasis (03)**
 Parathromone, PTHrP, Calcitonin, Vitamin D and Calcium homeostasis
- 5. Gastrointestinal Hormone (03)**
 Source, chemistry and physiological Role of gastrointestinal hormone (gastrin, secretin, CCK, GIP, GIP1, VIP, Neurotensin, substance P, GRP, motilin and ghrelin)
- 6. Pancreatic hormone and metabolic regulation: (03)**
 Endocrine pancreas (synthesis and action of insulin, glucagon, other pancreatic peptide hormones) control of pancreatic islets functions.
- 7. Growth Hormones (03)**
 Growth and cellular proliferation, growth hormones and somatomedins, growth factors.
- 8. Thyroid Hormones (03)**
 Biosynthesis of thyroid hormones, Control of secretion, Physiological roles
- 9. Adrenal steroid hormones (03)**
 Hormones of adrenal cortex and medulla, Control of mineralocorticoid and glucocorticoid secretions, Physiological roles of glucocorticoid and mineralocorticoid, Catecholamine biosynthesis, release and its physiological roles.
- 10. Endocrine Role of the pineal gland (02)**
 Melatonin synthesis and secretion and its physiological Role
- 11. Demography (02)**
 Life tables, Generation time, Net reproductive rate, Reproductive value
- 12. Population growth (05)**
 Growth of organisms with non-overlapping generations
 Exponential growth, Verhulst-Pearl logistic growth model, Case studies (field and laboratory). Stochastic and time lag models of population growth, stable age distribution, Population growth projection using Leslie Matrix
- 13. Life history strategies (05)**
 Evolution of life-history traits, Longevity and theories of aging, Energy apportionment between somatic growth and reproduction, Parental investment and offspring, Reproductive strategies - ecology and evolution

- of sex and mating systems, optimal body size' r-and K-selection
- 14. Predation (04)**
Models of prey-predatory dynamics, Optimal foraging theory (patch choice, diet choice, prey selectivity, foraging time), Role of predation in nature
- 15. Competition and Niche theory (03)**
Intraspecific and interspecific competition, History of niche concepts
Theory of limiting similarity
- 16. Mutualism (03)**
Evolution of mutualism, Plant-pollinator and animal - animal interactions, Basic models
- 17. Population regulation (03)**
Extrinsic and intrinsic mechanisms
- 18. Case studies in population dynamics (03)**
One or two examples from areas such as Fisheries, Wildlife, and biological control of agricultural pests.
- 19. Ecological Modeling (02)**
Fundamentals of constructing models and testing them.

Suggested Readings:

1. **Hadley: Endocrinology**, Prentice hall. International Edition. 2000
2. **Norris: Vertebrate Endocrinology (2nd ed.)** Les and Febriger.1997
3. **Brooks and Marshall: Essentials of Endocrinology**, Blackwell Science.1995
4. **Turner and Bagnara: General Endocrinology**, W.B. Saunders Company Philadelphia.1984
5. **Larson: Williams text Book of Endocrinology**, 10th edition . W.B. Saunders Company, Philadelphia.2002
6. **Larry L. Rockwood, Introduction to population ecology, 2nd edition, Wiley-Blackwell Publication, 2015.**
7. **John H. Vandermeer and Deborah E. Goldberg, Population Ecology- first principles, second edition, August, 2013.**

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
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Syllabus of M. Sc. Zoology I (Semester-II)
under
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Semester – II	Paper - III
Course Code: MSC-ZO 213 T	Title of the Course: Biostatistics and Bioinformatics
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understand the statistical techniques in biology.
2. Understanding the statistical tools for analysis of biological data.
3. Know the applications and limitations of different bioinformatics.
4. Perform and interpret biological data using tools available in bioinformatics..

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Introduction to General Statistics Definition Statistics and Biostatistics, Population, Sample and Sampling, Sample types, Applications and Uses of Statistics.	(01)
2.	Data Analysis Methods Classification of Data, General introduction to terms (Class, Frequency, Class-limits, Class-width), Mean, Mode and Median, Geometric mean, Harmonic mean, the sample mean and population mean, Frequency distribution methods, Cumulative frequency, Graphical representation of data (Histogram, Pie-Diagram, Ogive-Curve) Normal curve,	(07)
3.	Measures of Dispersion Concept of Measures of Dispersion, Absolute and Relative measures, Range and Deviation, Absolute deviation and mean absolute deviation, Variance. Coefficient of mean deviation, Coefficient of Standard deviation and Coefficient of variation, Standard deviation and standard error.	(04)
4.	Statistical Methods t-test, student t-test, Chi-Square t-test, Their importance and uses, Null hypothesis, Levels of significance, Correlation and Regression, Types of correlation, Analysis of Variance (ANNOVA).	(03)

- 5. Introduction to Bioinformatics (01)**
Basics of Computers (CPU, I/O units) and Operating systems, Bioinformatics web resource (NCBI, E.B.I., ExPASy, PubMed, OMIA) and applications of Bioinformatics
- 6. Computer Networking (01)**
Internet and E-mail, the concept of home pages and websites, World Wide Web (WWW), Uniform Resource Locators (URL).
- 7. Data Archiving Systems (04)**
Biological databases, primary sequence databases, nucleic acid sequence databases (GenBank, EMBL-EBI, DDBJ), protein sequence databases (UniProtKB, PIR, PDB), Secondary sequence databases, derived databases - PROSITE, BLOCKS, Pfam/ Prodom, structure databases and bibliographic databases.
- 8. Sequence alignment methods (04)**
BLAST, FASTA, significance of sequence alignment, pairwise sequence alignment (Needleman and Wunsch, Smith and Waterman methods), multiple sequence alignment (PRAS, CLUSTALW)
- 9. Predictive applications using DNA and protein sequences (05)**
Evolutionary studies:
Concept of phylogenetic trees, Parsimony and Bayesian approaches, synonymous and non-synonymous substitutions, convergent and parallel evolution.
Pharmacogenomics: Discovering a drug, target identification protein, chips and functional proteomics, different types of protein chip, detecting and quantifying; applications of proteomics metabolomics: concept and applications

Suggested Readings:

1. **Dr. J.V. Dixit Principles and Practice of Biostatistics**
2. **Snedecor G.W. and Cochran W.G. Statistical Methods:** Snedecor G.W. and Cochran W.G.
3. **Marc M. Triola, Mario F. Triola, Jason Roy Biostatistics for the Biological and Health Sciences,** 2nd Edition by, Published by Pearson Copyright © 2018
4. **Wayne W. Daniel Biostatistics: Basic Concepts and Methodology for the Health Sciences,** 10ed, ISV by, Wiley Publication
5. **Bataschelelet Introduction to mathematics for life sciences** By, E. Springer-Verlag, Berlin
6. **S.C. Rastogi, Bioinformatics - Concepts, Skills, and Applications;** CBS. Publishing; 2003.

7. **Andreas D Baxevanis and BF Francis, Bioinformatics - A practical guide to analysis of Genes and Proteins;** John Wiley; 2000.
8. **T K Attwood, D J ParrySmith, Introduction to Bioinformatics;** 1st Edition; Pearson Education, 11th Reprint; 2005.
9. **C S V Murthy, Bioinformatics;** 1st Edition; Himalaya Publishing House; 2003
10. **David W. Mount, Bioinformatics sequence and genome analysis;** Cold spring harbor laboratory press; 2004



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology(Zoology)

Semester – II	Paper – IV
Course Code: MSC-ZO 214 P	Title of the Course: Practicals in Anatomy and Physiology of Chordates and Developmental Biology
Credits: 02	Total Practical: 60 Hrs.

Course Outcomes (COs)

1. Understand the physiological mechanisms in chordates
2. Comparative study of anatomical structures in chordates
3. Practical understanding of developmental stages in chick embryo and method of mounting.
4. Understanding the developmental stages using model animals in developmental biology.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Study of Vertebrate Integument	(02)
2.	Comparative study of Heart and Aortic Arches in vertebrates	(01)
3.	Estimation of Blood glucose by the o-toluidine method.	(01)
4.	Study of nitrogenous waste products of animals from different habitats.	(02)
5.	Study of RBCs in different vertebrates and different physiological conditions.	(01)
6.	Study of relation of body size and oxygen consumption in aquatic animals (Fish)	(01)
7.	Determination of bleeding time & clotting time of human blood.	(01)
8.	Mounting of chick embryos and preparation of permanent mounts.	(01)
9.	Filter paper ring method for <i>in vitro</i> culturing of chick embryo and observation.	(01)
10.	Gross anatomy and histology of chick embryo up to 72 hours - brain, heart, eye development.	(02)
11.	Study of embryonic and post-embryonic development using frog egg as a model system.	(01)
12.	Study of the life cycle of <i>Drosophila melanogaster</i> .	(01)

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| 13. | Study of early developmental stages of any freshwater snail. | (01) |
| 14. | Demonstration of cell death in chick embryo by vital stain | (01) |
| 15. | Study of regeneration in Hydra/ Planaria. | (01) |
| 16. | Study of the imaginal disc in the larva of <i>Drosophila</i> | (01) |



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper - V
Course Code: MSC-ZO 215 P	Title of the Course: Practicals in Endocrinology and Population Ecology
Credits: 02	Total Practical: 60 Hrs.

Course Outcomes (COs)

1. Understanding the histological structure of endocrine glands with the help of slides.
2. Understanding the effect of removal of endocrine organs.
3. Practical understanding of population ecology.
4. Interpretation of population dynamics with the help of problems.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Histology of invertebrate and vertebrate neurosecretory and endocrine structures.	(02)
2.	Blood sugar regulation in the crab- Role of the eyestalk.	(01)
3.	Study of retrocerebral complex of the cockroach.	(01)
4.	Introduction of alloxan diabetes in the mouse/rat/human.	(01)
5.	Gonadectomy in the mouse/ rat.	(02)
6.	Pancreatectomy in the mouse/ rat.	(01)
7.	Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human.	(01)
8.	Thyroidectomy in the rat	(01)
9.	Study of an animal population by using different methods (Field or Simulation).	(01)
10.	Determination of density, frequency and abundance of population	(01)
11.	Problems in population Ecology: Population growth and Age	(01)
12.	Problems in population Ecology: Surviving and Fertility	(01)
13.	Problems in population Ecology: Predator-Prey relationship	(01)

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14. Problems in population Ecology: Competitive Exclusion (01)
15. Problems in population Ecology: Diversity Indices (01)



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New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper – VI
Course Code: MSC-ZO 216 P	Title of the Course: Practicals in Biostatistics and Bioinformatics
Credits: 02	Total Practical: 60 Hrs.

Course Outcomes (COs)

1. Understand the statistical techniques in biology.
2. Understanding the statistical tools for analysis of biological data.
3. Know the applications and limitations of different bioinformatics.
4. Perform and interpret biological data using tools available in bioinformatics..

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Calculate mean, mode and median, variance standard deviation, coefficient of variance and standard error from the given data. (By SPSS)	(02)
2.	Calculate mean, standard deviation, coefficient of variance and standard error from the given data by using MS Excel	(01)
3.	Examples based on t-test (By SPSS)	(01)
4.	Statistical problem solving based on Student's 't' test and χ^2 test (By SPSS)	(02)
5.	Analysis of variance on the given data (ANNOVA) (By SPSS)	(01)
6.	Representation of data by various graphical methods (By SPSS)	(01)
7.	Determination of Karl – Pearson's coefficient of correlation from the given data. (By SPSS)	(01)
8.	Measures of Dispersion. (By SPSS)	(02)
9.	Concept of the biological database, gene and protein search by BLASTA and FASTA.	(02)
10.	Construction of phylogenetic tree for DNA and Protein	(01)
11.	Handling and interpretation of Nucleic acid and protein databases	(01)
12.	Sequence retrieval from databases	(01)
13.	Sequence homology and gene annotation. Translation of nucleotide	(02)

sequence and selection of the correct reading frame of the polypeptide from the output sequences.

- 14.** Comparative analysis of different databases in metabolomics **(01)**



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper - VII
Course Code: MSC-ZO 217 T (A)	Title of the Course: Genetics
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understanding the concepts of heredity and variation in living organisms.
2. Understanding the process of genetic recombination and chromosomal mapping.
3. Understanding the patterns of inheritance in populations
4. Understanding the human genetic disorders and genetic counseling

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Eukaryote Model Systems for Genetic Analysis Life cycle and importance of <i>Drosophila</i> and <i>C. elegans</i> in genetics.	(02)
2.	Mendelian Analysis of Inheritance and introduction of Extension to Mendel's Laws Recapitulation of Mendelian principles of inheritance, Allelic interactions and non-allelic gene interactions (Incomplete dominance, codominance, Epistasis, Multiple allelism with examples)	(03)
3.	Linkage and crossing over Linkage, linkage groups, types of crossing over, sex linkage, sex-limited and sex influenced characters, Recombination, recombination maps in diploids for 2 points and 3-point test cross (determination of gene order with suitable examples)	(03)
4.	Cytoplasmic inheritance The maternal effect, Mitochondrial Inheritance, Interaction between nuclear and cytoplasmic genes.	(02)
5.	Population Genetics Population structure, Gene pool, estimation of gene and genotype	(03)

- frequencies for biallelic, multiple allelic and X- linked loci, Hardy-Weinberg principle, Establishment of law for a) autosomal biallelic loci b) multiple allelic loci c) X-linked loci, Factors affecting HWE: Mutation, Selection, Migration, Genetic drift, Effective population size.
- 6. Quantitative inheritance (03)**
Multiple Factor Hypothesis, Polygenic Inheritance, Quantitative traits, Continuous variation, Inheritance of quantitative traits, Heritability and its measurement, QTL mapping.
- 7. Structure of Prokaryotic and Eukaryotic Genes (03)**
Structure of prokaryotic genes, Organization of prokaryotic genes into operons, the structure of eukaryotic genes (introns, exons, UTRs, core & proximal promoters, enhancers), Types of Eukaryotic genes.
- 8. Human genetics (05)**
Normal Human Karyotype, Genetic Diseases and Inheritance Pattern: Autosomal Inheritance-Dominant (Adult polycystic kidney) Autosomal inheritance- Recessive (Sickle cell Anaemia), X-linked – Recessive (Duchenne muscular dystrophy-DMD), X-linked- Dominant: (Xg blood group), Y-linked inheritance: Holandric gene (Ex. Testes determining factor), Symbols used in pedigree studies, Pedigree analysis and construction, Pedigree analysis for the inheritance pattern of genetic diseases, Genetic Counselling (History and pedigree construction, Examination, Diagnosis, Counselling, Follow up)
- 9. Microbial genetics (02)**
Methods of genetic transfers – transformation, conjugation, transduction
- 10. Eukaryote Model Systems for Genetic Analysis (02)**
Life cycle and importance of *Drosophila* and *C. elegans* in genetics.
- 11. Mendelian Analysis of Inheritance and introduction of Extension to Mendel's Laws (02)**
Recapitulation of Mendelian principles of inheritance, Allelic interactions and non-allelic gene interactions (Incomplete dominance, codominance, Epistasis, Multiple allelism with examples)

Suggested Readings:

1. **A.J.F. Griffiths, J. Doebley, C. Peichel, D.A. Wassarman An Introduction to Genetic Analysis** – (12th ed.) W.H. Freeman Publ. 2020.
2. **W.S. Klug and M.R. Cummings, Concepts of Genetics** –(12th ed.) Pearson Publ. 2019.
3. **BA. Pierce, Genetics: A conceptual approach** – (6th ed.) W.H. Freeman Publ. 2016.
4. **E.J. Gardner, M.J. Simmons, D.P. Snustad, Principles of Genetics** – (8th ed.) John Wiley & Sons 2006.
5. **D.L. Hartl and E.W. Jones, Genetics: Analysis of Genes and Genomes** – (6th ed.) Jones & Bartlett Publ. 2004.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper - VII
Course Code: MSC-ZO 217 T (B)	Title of the Course: Genetic Toxicology
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Learn genotoxicity test systems.
2. Understand basic toxicological principles and describe how different chemicals are taken up by, processed in and eliminated from the body
3. Understanding the physical and chemical genotoxic agents being exposed in his/her environment
4. Acquire the knowledge of physical and chemical genotoxic agents.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Toxicology Definition and its subdivisions, scope and significance of genetic toxicology.	(03)
2.	Mutation Mutations at molecular, functional and chromosomal levels. Mechanisms of Mutagenesis Endpoint mutations and their function, carcinogenicity and transformation. Biological significance of mutagenesis.	(07)
3.	Mutagenic Effect Mutagenic agents in the human environment. Applications of genetic toxicology to human and environmental monitoring.	(05)
4.	Methods for detection of Mutation Methodologies used in the detection of mutation, functional, cytogenetic effects. Use of Ames test, mammalian systematics, Drosophila etc.	(05)
5.	Genotoxic Properties Screening chemicals for genotoxic properties: Screening tests, hazard assessment, Risk analysis tests. Common assays used for testing mutagenic activity using bacteria, yeasts, insects, plants, animals.	(07)
6.	Genetic toxicology and its Role in study of congenital malformations	(03)

Suggested Readings:

1. **Hollander, A, Chemical mutagens- principles and methods for their detection, Ed..**
Vol. 1-5, Plenum press
2. **Vogel, F. and Rohtborn, G., Chemical mutagenesis in mammals and men. Eds.**
Springer Verlag
3. **Suttoa, H.E. and Harris, M.I., Mutagenic effects of Environmental contaminants, Eds.**
Academic press
4. **Mutation research** (section on genetic toxicology testing)
5. **Parry J.M., Parry E.M., Genetic Toxicology: Principles and methods, (eds) Springer**
Publ. (2012)
6. **David Brusick, Principles of Genetic Toxicology, Second Edition, Springer**
Science+Business Media New York



Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper – VIII
Course Code: MSC-ZO 218 P (A)	Title of the Course: Practicals in Genetics
Credits: 02	Total Practical: 60 Hrs.

Course Outcomes (COs)

1. Practical handling of *Drosophila*
2. Understanding genetic problems related to patterns of inheritance.
3. Applications of statistics in genetics.
4. Skills in microbial genetics.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Study of <i>D. melanogaster</i> - Culture, Morphology (Sexual Dimorphism, Wings, Sex comb, genetical plate and bristles).	(01)
2.	Monohybrid and Dihybrid crosses in genetics	(01)
3.	Applications of Statistics in Genetics: Probability, Chi-Square (Monohybrid and Dihybrid crosses)	(01)
4.	Applications of Statistics in Genetics: Student' t' distribution, Histogram (Quantitative traits)	(01)
5.	Determination of gene distances and gene order for a given three-point test cross.	(02)
6.	Polytene chromosomes of <i>Drosophila</i> or Chironomous-examination of puff and bands.	(01)
7.	Study of Mitotic chromosomes from the brain of <i>D. melanogaster</i>	(01)
8.	Estimation of allelic frequencies, heterozygote frequencies in human populations.	(01)
9.	Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive.	(02)
10.	Culturing <i>E. coli</i> on solid and liquid media.	(02)
11.	Problems based on bacterial transformation and transduction	(01)

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper – VIII
Course Code: MSC-ZO 218 P (B)	Title of the Course: Practicals in Genetic Toxicology
Credits: 02	Total Practical: 60 Hrs.

Course Outcomes (COs)

1. Learn genotoxicity test systems.
2. Understand basic toxicological principles and describe how different chemicals are taken up by, processed in and eliminated from the body
3. Understanding the physical and chemical genotoxic agents being exposed in his/her environment
4. Acquire the knowledge of physical and chemical genotoxic agents.

Detailed Syllabus: (Any 12)

Unit	Name of Topic	Practicals Allotted
1.	Dominant lethal test in <i>Drosophila</i> .	(02)
2.	Sex-linked recessive lethal test in <i>Drosophila</i> .	(02)
3.	Micronucleus test in mouse.	(02)
4.	Bone marrow chromosome analysis in the mouse.	(02)
5.	Auxotroph mutation induction in Bacteria.	(02)
6.	Ame's test	(02)
7.	Preparation of <i>Drosophila</i> culture and study of <i>Drosophila</i> mutants.	(02)
8.	DNA analysis using electrophoretic technique.	(02)
9.	Temporary stained preparation of blood smear.	(01)

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus of M. Sc. Zoology I (Semester-II)
under
Faculty of Science and Technology

Semester – II	Paper – IX
Course Code: MSC-ZO 219 T	Title of the Course: Ethology
Credits: 02	Total Lectures: 30 Hrs.

Course Outcomes (COs)

1. Understanding the types of animal behaviour.
2. Understanding mechanisms of behavioural patterns.
3. Understanding effect of various factors on animal behaviour.
4. Understanding the role of behaviour in sustenance of species.

Detailed Syllabus:

Unit	Name of Topic	Lectures Allotted
1.	Introduction to Animal Behaviour Ethology as a branch of biology, Animal psychology - classification, of behavioral patterns, analysis of behavior (ethogram).	(02)
2.	Innate behavior and its types.	(02)
3.	Perception of the environment Mechanical, Electrical, Chemical, Olfactory, Auditory, Visual.	(03)
4.	Neural and hormonal control of behaviour	(02)
5.	Genetic and environmental components in the development of behavior	(02)
6.	Communication Chemical, Visual, Light, Audio, Species specificity of songs, evolution of language (primates)	(03)
7.	Ecological aspects of behaviour Habitat selection, food selection; optimal foraging theory, anti-predator defenses, Aggression, homing; territoriality; dispersal and dispersion, Host-parasite relations	(04)
8.	Social behaviour Aggregations-schooling in fishes, flocking in birds, herding in mammals	(04)

- Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, Social organization in insects and primates.
- 9. Reproductive behaviour (02)**
Evolution of sex and reproductive strategies, Mating systems, Courtship, Sperm competition, Sexual selection, Parental care
- 10. Biological rhythm (02)**
Circadian and circannual rhythms, Orientation and navigation
Migrations of fish, turtles and birds
- 11. Learning and memory (02)**
Conditioning
- 12. Habituation (02)**
Insight learning, Association learning, Reasoning, Cognitive skills

Suggested Readings:

1. **Alcock: Animal Behaviour- An evolutionary approach**, (7th ed.) Sinaur Associates, Inc. 2001.
2. **Drickamer and Vessey: Animal Behaviour- Concepts, Processes and methods** (2nd ed.) Wadsworth, 1986.
3. **Gadagkar: Survival Strategies- Cooperation and Conflict in Animal Societies.** University Press., 1998.
4. **Goodenough et al.: Perspectives on Animal Behaviour**, Wiley, 1993.
5. **Grier: Biology of Animal Behaviour**, Mosby, 1984.
6. **Halliday and Slate: Animal Behaviour** (vols. I-3) Blackwell Scientific Publ., 1983
7. **Krebs and Davis: Behavioural Ecology**, (3rd ed.) Blackwell, 1993.
8. **Lehner: Hand Book of Ethological Methods.** (2nd ed.) Garland, 1996.
9. **Manning and Dawkins: An Introduction to Animal Behaviour** (5th ed.) Cambridge Univ. Press, 1998.
10. **Slater and Halliday: Behaviour and Evolution**, (1st ed.) Cambridge Univ. Pres., 1994.
11. **J. P. Shukla: Fundamentals of Animal Behavior** (1st ed.) Atlantic Publishers and Distributors, 2010.