

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



**National Education Policy (NEP)  
Choice Based Credit System (CBCS)**

**Programme Skeleton and Syllabus of**

**M.Sc. Zoology**

**Implemented from**

**Academic Year 2023-24**

## 9.2 Distribution of credits

Type of Courses	Total Credits	Credits/ Semester
Discipline-Specific Core Courses (DSC)	54	14 /12
Discipline Specific Elective Courses (DSE)	16	04
Research Methodology (RM)	04	Semester I only
On-Job Training/ Internship (OJT/I	04	Semester II only
Project (PR)	10	Semesters III and IV only
Total	88	22

## 9.3 Master of Science (M.Sc.) Course Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	03	03	01	01	01*		00	22
M. Sc. I	II	01	09	03	03	01	01	00	01	00	22
M. Sc. II	III	01	07	02	02	01	01	00	00	01	22
M. Sc. II	IV	01	07	02	02	01	01	00	00	01	22

\* RM: Theory and Practical credits in RM paper shall be decided by the Department. The final marks/grade point shall be calculated by considering theory and practical marks.

## 9.4 Master of Science (M. Sc.) Credit Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internshi p etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	08	06	02	02	04*		00	22
M. Sc. I	II	01	09	08	06	02	02	00	04	00	22
<b>Exit Option: PG Diploma</b>											
M. Sc. II	III	01	07	08	06	02	02	00	00	04	22
M. Sc. II	IV	01	07	08	04	02	02	00	00	06	22
				<b>32</b>	<b>20</b>	<b>08</b>	<b>08</b>	<b>02</b>	<b>06</b>	<b>12</b>	<b>88</b>

### 9.5 Master of Science (M. Sc.) Distribution of Courses

Class	Semester	Course and their credits in the bracket			
		DSC	DSE	RM/OJT/ Internship etc.	Project *
M. Sc. I	I	DSC -01 (03)	DSE -01 (02)	RM-01(04)	NA
M. Sc. I	I	DSC -02 (03)	DSE -02 (02)		
M. Sc. I	I	DSC -03 (02)			
M. Sc. I	I	DSC -04 (02)			
M. Sc. I	I	DSC -05 (02)			
M. Sc. I	I	DSC -06 (02)			
M. Sc. I	II	DSC -07 (03)	DSE -03 (02)	OJT-01 (04)	NA
M. Sc. I	II	DSC -08 (03)	DSE -04 (02)		
M. Sc. I	II	DSC -09 (02)			
M. Sc. I	II	DSC -10 (02)			
M. Sc. I	II	DSC -11 (02)			
M. Sc. I	II	DSC -12 (02)			
M. Sc. II	III	DSC -13 (04)	DSE -05 (02)	NA	PR-01(04)
M. Sc. II	III	DSC -14 (04)	DSE -06 (02)		
M. Sc. II	III	DSC -15 (03)			
M. Sc. II	III	DSC -16 (03)			
M. Sc. II	IV	DSC -17 (04)	DSE -05 (02)	NA	PR-02(06)
M. Sc. II	IV	DSC -18(04)	DSE -06 (02)		
M. Sc. II	IV	DSC -19 (02)			
M. Sc. II	IV	DSC -20 (02)			

## Programme Framework (Courses and Credits): M. Sc. Zoology

Sr. No.	Year	Semester	Level	Course Type	Course Code	Title	Credits
1.	I	I	6.0	DSC-01	MS-ZO111T	Comparative Animal Physiology	03
2.	I	I	6.0	DSC-02	MS-ZO112T	Cell and Molecular Biology	03
3.	I	I	6.0	DSC-03	MS-ZO113T	Economic Zoology	02
4.	I	I	6.0	DSC-04	MS-ZO114P	Comparative Animal Physiology (P)	02
5.	I	I	6.0	DSC-05	MS-ZO115P	Cell and Molecular Biology (P)	02
6.	I	I	6.0	DSC-06	MS-ZO116P	Economic Zoology (P)	02
7.	I	I	6.0	DSE-01	MS-ZO117T	Biochemistry/ Metabolic Pathways	02
8.	I	I	6.0	DSE-02	MS-ZO118P	Biochemistry/ Metabolic Pathways (P)	02
9.	I	I	6.0	RM-01	MS-ZO119T/P	Research Methodology	04
10.	I	II	6.0	DSC-07	MS-ZO121T	Genetics and Biostatistics	03
11.	I	II	6.0	DSC-08	MS-ZO122T	Endocrinology and Bioinformatics	03
12.	I	II	6.0	DSC-09	MS-ZO123T	Developmental Biology	02
13.	I	II	6.0	DSC-10	MS-ZO124P	Genetics and Biostatistics (P)	02
14.	I	II	6.0	DSC-11	MS-ZO125P	Endocrinology and Bioinformatics (P)	02
15.	I	II	6.0	DSC-12	MS-ZO126P	Developmental Biology (P)	02
16.	I	II	6.0	DSE-05	MS-ZO127T	Ethology	02
17.	I	II	6.0	DSE-06	MS-ZO128P	Techniques in Zoology-I	02
18.	I	II	6.0	OJT-01	MS-ZO129P	On Job Training	04
19.	II	III	6.5	DSC-13	MS-ZO131T	Animal Physiology-I	04
20.	II	III	6.5	DSC-14	MS-ZO132T	Immunology and Evolution	04
21.	II	III	6.5	DSC-15	MS-ZO133P	Animal Physiology-I (P)	03
22.	II	III	6.5	DSC-16	MS-ZO134P	Immunology and Evolution (P)	03
23.	II	III	6.5	DSE-05	MS-ZO135T	Entomology/Freshwater Biology	02
24.	II	III	6.5	DSE-06	MS-ZO136P	Entomology/Freshwater Biology (P)	02
25.	II	III	6.5	PR-01	MS-ZO137P	Project-I	04
26.	II	IV	6.5	DSC-17	MS-ZO131T	Animal Physiology- II	04
27.	II	IV	6.5	DSC-18	MS-ZO132T	Mammalian Reproductive Physiology and Neural Physiology	04
28.	II	IV	6.5	DSC-19	MS-ZO133P	Animal Physiology- II (P)	02
29.	II	IV	6.5	DSC-20	MS-ZO134P	Mammalian Reproductive Physiology and Neural Physiology (P)	02
30.	II	IV	6.5	DSE-07	MS-ZO135T	Ecology/Evolutionary Biology	02
31.	II	IV	6.5	DSE-08	MS-ZO136P	Techniques in Zoology- II	02
32.	II	IV	6.5	PR-02	MS-ZO137P	Project- II	06

**New Arts, Commerce and Science College, Ahmednagar  
(Autonomous)**

**Board of Studies in Zoology**

<b>Sr. No.</b>	<b>Name</b>	<b>Designation</b>
1.	Hon. Prof. Dr. S. N. Pokale	Chairman
2.	Hon. Dr. A. D. Harkal	Member
3.	Hon. Prof. R. J. Chavan	Academic Council Nominee
4.	Hon. Prof. S. S. Nanware	Academic Council Nominee
5.	Hon. Dr. S. S. Teradalkar	Vice-Chancellor Nominee
6.	Hon. Prof. B. A. Pawar	Alumni
7.	Hon. Ms. Manjushree Tadvalkar	Industry Expert
8.	Hon. Dr. B. K. Thorve	Member (co-opt)
9.	Hon. Ms. S. P. Salve	Member (co-opt)
10.	Hon. Shri. G. G. Wakchoure	Member (co-opt)
11.	Hon. Ms. G. R. Devdhe	Member (co-opt)
12.	Hon. Ms. S. S. Mote	Member (co-opt)
13.	Hon. Ms. P. N. Dongare	Member (co-opt)
14.	Hon. Ms. S. J. Wagh	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, Comparative Animal Physiology, 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 projects, 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, Research Methodology, Developmental Biology, Endocrinology, Biochemistry, Metabolic Biology, Evolutionary Biology, Neurophysiology, Entomology, Fresh water Biology, and Ecology etc. In addition, to discipline-specific core courses (DSC), which are compulsory, there are also Elective Courses. Elective Courses selected are from these two categories like Discipline Specific Elective Courses (DSE) and Project (PR). Discipline-Specific Elective courses (DSE) are Biochemistry/ Metabolic Pathways, Ethology, Entomology/ Freshwater Biology and Ecology/ Evolutionary Biology. The National Education Policy (NEP 2020) has introduced the compulsory Research Methodology (RM) course to inculcate the research aspects within the PG students. 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 240 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.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Comparative Animal Physiology								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-1	MS-ZO111T	03	00	03	45	30	70	100

**Learning Objectives:**

1. To introduce different physiological aspects among the students.
2. To compare and understand the physiological processes in animals.
3. To understand the mechanism of different physiological processes in animals.

**Course Outcomes:**

1. Understanding comparative study of digestion and respiration in animals.
2. Understanding comparative study of muscles, Excretion and acid base balance.
3. Understanding comparative study of circulation, thermoregulation, signaling and sensation.

Unit	Name of Topic	Lectures Allotted
1.	<b>Unifying Themes in Animal Physiology</b> Physics and Chemistry: The Basis of Physiology Form, Function, and Evolution Regulation and Homeostasis	<b>(03)</b>
2.	<b>Digestion and Nutrition:</b> Nutrients, Finding and Consuming Food, Digestive Systems and digestion, Assimilation, Regulating Digestive System.	<b>(04)</b>
3.	<b>Respiration:</b> Physics of Gases, Ventilation and Gas Exchange in Water, Ventilation and Gas Exchange in Air, Oxygen Transport (Respiratory Pigments, oxygen equilibrium curves), Carbon Dioxide Transport	<b>(05)</b>
4.	<b>Cellular Movement And Muscles</b> Cytoskeleton and Motor Proteins, structure and regulation of	<b>(05)</b>



muscle contraction. Sarcoplasmic reticulum and role of calcium in muscle contraction.

**5. Ion and Water Balance (05)**

Strategies for Ionic and Osmotic Regulation, Osmosis, Concepts of osmole, osmolarity, and tonicity, ionic regulation, Hyper- and hypo-osmotic regulators, Urosmotic regulators

**6. Excretion: (04)**

Kidney Structure and Function, Roles of the Kidney in Homeostasis, Variation in the Structure and Function of Excretory Systems, and Physiology of Excretion in different environments.

**7. Circulatory Systems (04)**

General Characteristics of Circulatory Systems, Circulatory Plans of the vertebrates

**8. Temperature: (05)**

Thermobiological Terminology, Thermal Strategies. Coping with a changing body temperature, Maintaining a constant body temperature.

**9. Cell Signaling and Endocrine Regulation (04)**

Types of signaling molecules, the biochemical basis of cell signaling, signal transduction pathways, Characteristics of Endocrine Systems

**10. Sense organ: (06)**

Classification of Sensory Receptors, Stimulus Encoding in Sensory Systems, Photoreception: Photoreceptors, Evolution of Eye, Structure, and Photoreception in Mammalian eye. Reflexes, Principles of neural integration.

**Suggested Readings/Material:**

1. **Introduction to Animal Physiology**, Ian Kay, 2000, Bios Scientific Publishers Limited.
2. **Textbook of Medical Physiology**, Guyton A. C. & Hall J. E., 2006, 11th Edition, Hecourt Asia Pvt. Ltd. / W. B. Saunders Company
3. **Principles of Anatomy & Physiology, 2006**, 11th Edition, Tortora G. J. & Grabowski S., John Wiley & sons, Inc.
4. **Haematology: De Gruchi.**
5. **Human physiology**, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical Applied Agency, Kolkata

6. **Text book of Animal Physiology**, 2008, 2nd Edn. Nagabhushanam, S. V. S. Rana, S. Kalavathy, Oxford University Press, India.
7. **Animal Physiology: Adaptation and Environment**, 1997, Schmidt-Nielsen, Knut, Cambridge University Press.
8. **General and Comparative Physiology**, 1983, 3rd Edn., Hoar W. S., Prentice Hall, UK.7.
9. **Medical Physiology**, 2006, Asis Das, Books and Allied Pvt. Ltd., Kolkata.
10. **Endocrinology**, 2005, Lohar P. S., M J P Publishers, Chennai.
11. **Vander, Sherman, Luciano's Human Physiology: The Mechanisms of Body Function**, 2003, 9 th Edn., Eric P. Widmaier, Hershel Raff, Kevin T. Strang, Mc Graw H.
12. **Tortora, G. J. and Derrickson, B. H. (2009) Principles of Anatomy and Physiology** (12th edition) John Wiley and Sons, Inc.
13. **Widmaier, E. P., Raff, H. and Strang, K. T. (2008) Vander's Human Physiology** (9th edition) McGraw Hill.
14. **Principles of Animal Physiology, (2009) T. H. Moyes.** Pearson Publication.

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**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Cell and Molecular Biology								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-2	MS-ZO112T	03	00	03	45	30	70	100

**Learning Objectives:**

1. To develop students' interest in cell and molecular biology
2. To provide basic knowledge of the general organization of a cell
3. To help students understand the structure and functions of the plasma membrane, Endoplasmic reticulum, Golgi complex and mitochondria
4. To facilitate the learning of cell cycle and cell signaling
5. To help students understand the central dogma of molecular biology
6. To provide basic knowledge of gene editing

**Course Outcomes:**

1. Understanding the structural features of cell and cellular mechanisms.
2. Understanding different pathways related to cell signaling and cancer.
3. Understanding the structure and regulation of nucleic acids
4. Understanding of the mechanism of protein synthesis.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	<b>Introduction to Cell Biology</b> Cell theory, General organization of eukaryotic cell	(01)
2.	<b>Plasma membrane</b> Ultrastructure, Membrane proteins; Membrane transport channels (carrier proteins and channel proteins) Facilitated transport of glucose and water, Active transport (NA-K Pump); Cell adhesion molecules, Cell junctions	(06)
3.	<b>Endomembrane system</b> Vesicular traffic, secretion and endocytosis	(03)
4.	<b>Mitochondria</b> Structure, protein import	(02)
5.	<b>Cell Cycle</b> Phases, checkpoints, Mechanism of regulation, regulators of cell cycle progression – MPF, Cyclins and Cyclin-dependent kinases	(06)

- (CDKs).
6. **Cell signalling** (03)
  7. **DNA Replication** (06)  
DNA replication in Prokaryotes, origin of Replication, types of *E. coli*. DNA polymerase, factors and enzymes involved in replication  
Eukaryotic DNA replication, Multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC)
  8. **DNA damage and repair** (04)  
Different types of DNA damage, different DNA repair systems: Nucleotide Excision Repair, Base Excision Repair, Photo-reactivation repair
  9. **Transcription** (07)  
Prokaryotic transcription- RNA Polymerase, Transcription unit, Initiation- promoter recognition, Elongation, Termination- rho dependent and rho independent.  
Eukaryotic Transcription- RNA Polymerases I, II and III, Transcription unit for each polymerase, Transcription factors,
  10. **Processing of transcripts: capping, polyadenylation, splicing** (05)  
**Protein Synthesis (Translation)**  
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
  11. **Gene silencing/Editing** (02)  
RNA interference(RNAi)  
CRISPR-Cas9

**Suggested Readings/Material:**

1. **James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Molecular Biology of the Gene, 5<sup>th</sup> Edition (2004),** Publisher- Pearson Education, Inc. And Dorling Kindersley Publishing, Inc.
2. **Weaver R., Molecular Biology, 4<sup>th</sup> 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, 4<sup>th</sup> 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<sup>ne</sup> Edition (2003)** Publisher; Garland Publishing.
5. **Benjamin Lewin, Gene X, (2010),** Publishers- Jones and Barlett Inc.
6. **De Robertis and De Robertis, Molecular Biology.**
7. **Karp Gerald (2010) Cell Biology. 6<sup>th</sup> 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.** 5<sup>th</sup> 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** 8<sup>th</sup> Edition, Lea and Febiger, Philadelphia.

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**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Economic Zoology								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-3	MS-ZO113T	02	00	02	30	15	35	50

**Learning Objectives:**

1. To make students capable of preparing their own vermiculture, sericulture, apiculture units.
2. Students may learn rearing silkworms for product of silk for economic purposes.
3. To provide basic information regarding the importance of sericulture, apiculture, aquaculture and lac culture.
4. To provide the fundamental knowledge of the pests and their types.

**Course Outcomes:**

1. Understanding the processes of vermiculture, Aquaculture and Apiculture.
2. Understanding the processes of Sericulture, Dairy Management and Poultry.
3. Understanding the processes of Lac culture and Pest Management.

**Detailed Syllabus: Example**

Unit	Name of Topic	Lectures Allotted
1.	<b>Vermiculture-</b> Introduction and importance of vermiculture, uses of earthworm for biodegradation of organic waste materials; vermicompost, vermiwash.	(04)
2.	<b>Aquaculture-</b> Freshwater, marine water fish culture in India. Fish by products and its economic importance. Pearl culture, Prawn culture.	(04)
3.	<b>Apiculture:</b> Different species of honey bees and distribution, Equipment and tools Apiary management, by products of apiculture and their uses.	(04)
4.	<b>Sericulture:</b> Modern rearing methods of silkworms. Life cycle of silkworm. Silk production, its management, role in the rural economy of India.	(04)

5. **Dairy:** Importance and scope of Dairy. Principles and methods of breeding- inbreeding, outbreeding, cross breeding, artificial insemination. Dairy by products, preservation and uses. Dairy pathology vaccination programme. (04)
6. **Poultry:** Commercially important breeds, Techniques and methods of breeding, Poultry by products and its economic importance. (03)
7. **Lac culture-** External morphology, Life cycle, Rearing, economic importance. (03)
8. **Pest Management:** Life cycle, Damage and Control Measures: (04)  
Crop pests: Red Cotton Bug, Aphids  
House hold pests: Cockroach, House fly  
Store grain Pests: Rice weevil, pulse beetle.

**Suggested Readings/Material:**

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.

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**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Comparative Animal Physiology (P)								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-4	MS-ZO114P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To introduce different physiological aspects among the students.
2. To compare and understand the physiological processes in animals.
3. To understand the mechanism of different physiological processes in animals.

**Course Outcomes:**

1. Understanding comparative study of digestion and respiration in animals.
2. Understanding comparative study of muscles, Excretion and acid base balance.
3. Understanding comparative study of circulation, thermoregulation, signaling and sensation.

**Detailed Syllabus:**

Unit	Name of Topic	Practical Allotted
1.	Study of nitrogenous waste products of animals from different habitats.	(01)
2.	RBCs in different vertebrates and in different physiological conditions.	(01)
3.	Body size and oxygen consumption in aquatic animals (crab & fish).	(02)
4.	Preparation of standard graph	(01)
4.	Estimation of sugar in rat/crab/human blood.	(01)
5.	Effect of insulin on the blood sugar of rat.	(01)
6.	Estimation of lactate content of rat/crab/human blood.	(01)
7.	Determination of bleeding time & clotting time of human blood.	(01)
8.	Estimation of chloride content of rat/crab/human blood.	(01)
9.	Capillary circulation in the foot-web of frog/tail-fin of fish.	(01)
10.	Effect of load on muscle contraction in the frog/rat/fowl.	(01)
11.	Determination of the heart beat in the crab-effect of temperature & ions	(01)
12.	Effect of eye stalk ablation on chloride & glucose in the haemolymph of the crab.	(01)



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Title of the Course: Cell and Molecular Biology (P)								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-5	MS-ZO115P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To develop students' interest in cell and molecular biology
2. To provide basic knowledge of the general organization of a cell
3. To help students understand the structure and functions of the plasma membrane, Endoplasmic reticulum, Golgi complex and mitochondria
4. To facilitate the learning of cell cycle and cell signaling
5. To help students understand the central dogma of molecular biology
6. To provide basic knowledge of gene editing

**Course Outcomes:**

1. Practical understanding of cell structure and cell division.
2. Practical understanding of techniques used in cell biology.
3. Demonstrate the various methods of isolation of DNA from different sources.
4. Analysis of protein by SDS PAGE method

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	Absorption studies of DNA. ( $\lambda_{max}$ of DNA, Purity of DNA and Quantification of DNA) using UV spectrophotometer.	(01)
2.	Isolation of bacterial DNA and estimation by UV spectrophotometry.	(02)
3.	Demonstration of plasmid DNA in E. coli. and its characterization by UV spectrophotometry.	(02)
4.	Isolation of Liver DNA and its Agarose gel electrophoresis.	(02)
5.	Isolation of RNA and agarose gel electrophoresis.	(02)
6.	To separate proteins by SDS- PAGE.	(02)
7.	Spectrophotometric analysis of nucleotides and amino acids.	(02)
8.	Temporary preparation of human cheek epithelial cells to show the presence of Barr body.	(01)
9.	Study of different stages of mitosis from a suitable material.	(01)

10. Effect of colchicine on mitosis. (01)
11. Study of meiosis in Grasshopper testes/ Onion flower buds/ *Aloe vera*. (01)
12. Demonstration of separation of subcellular organelles by differential centrifugation (02)
13. Staining and visualisation of mitochondria by Janus green stain (01)
14. To Study Pinocytosis. (01)

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Economic Zoology (P)								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-6	MS-ZO116P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To make students capable of preparing their own vermiculture, sericulture, apiculture units.
2. Students may learn rearing silkworms for product of silk for economic purposes.
3. To provide basic information regarding the importance of sericulture, apiculture, aquaculture and lac culture.
4. To provide the fundamental knowledge of the pests and their types.

**Course Outcomes:**

1. Understanding the practical processes of vermiculture, Aquaculture and Apiculture.
2. Understanding the practical processes of Sericulture, Dairy Management and Poultry.
3. Understanding the practical processes of Lac culture and Pest Management.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	Insect traps and biological control agents	(01)
2.	Introduction to Indian breeds of cows and buffaloes	(01)
3.	Bee keeping methods, extraction of honey and its preservation	(01)
4.	Different species of silkworm, Rearing of silkworm and Diseases of silkworm.	(01)
5.	Study of different types silk moths, their distribution and varieties of silk produced by Mulberry, Tassar, Eri and Muga silk worms in India	(01)
6.	Economic importance of some freshwater fishes.	
7.	Harvesting of mulberry: a) Leaf plucking b) Branch cutting c) Whole shoot cutting.	(01)
8.	Preparation of waste mix for Vermicomposting	(02)
9.	Vermiwash preparation.	(01)
10.	Field visit- Agricultural Research Stations/ Sericulture Institutes/ Dairy Institute/ vermicomposting farm/artificial insemination centre.	(02)
11.	Life Cycle, Types of lacs, Culture Techniques and uses of Lac Insect	(01)
12.	Study of insecticide appliances	(01)

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Biochemistry								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-1	MS-ZO117T	02	00	02	30	15	35	50

**Learning Objectives:**

1. To understand the chemical unity due to biomolecules present in all living organisms.
2. To get the knowledge of proteins and amino acids responsible for living body formation.
3. To acquire the information about formation of derivatives of carbohydrates and amino acids.
4. To teach the enzyme related concepts and coenzyme, cofactor with example.
5. To make students able to understand the enzyme kinetics with their equations.

**Course Outcomes:**

1. Understanding the properties of carbohydrates, proteins, lipids.
2. Understanding the knowledge of macromolecules and their importance in biological systems.
3. Understanding the cofactor, coenzyme, catalysis.
4. Understanding the concept of enzyme kinetics, MM equation.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	<b>Introduction to General Biochemistry</b> 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.	(04)
2.	<b>Biomolecules and Biophysical chemistry</b> 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.	(05)
3.	<b>Amino acids, Peptides and Polypeptides</b> Different structures of the protein molecule (primary, secondary- $\alpha$ and $\beta$ sheet, tertiary and quaternary), domains, motif and folds, Ramchandran plot and its applications.	(04)
4.	<b>Enzymology</b>	(04)

Enzyme kinetics, Derivation of Michelis and Menten equation, types of Enzyme inhibition, Reversible and Irreversible Enzyme Inhibition, mechanism of enzyme action- active site, Factors affecting of Enzyme Activity, Structure and functions of coenzyme, substrate binding, transition state, lowering of activation energy and Isozymes.

- 5. Metabolism of Carbohydrates, Proteins, Lipids and Nucleotides (11)**  
Glycolysis (Aerobic and Anaerobic), Pyruvate Dehydrogenase Complex (PDH Complex), TCA Cycle, gluconeogenesis, glycogenesis and glycogenolysis,  $\beta$  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/Material:**

1. **Voet Donald and Voet Judith G Biochemistry, 3<sup>rd</sup> Ed. (2005),** John, Publisher: Wiley and Sons, New York.
2. **Berg Jeremy, Tymoczko John, Stryer Lubert, Biochemistry 6<sup>th</sup> Ed, (2007)** Publisher: W. H. Freeman, New York.
3. **Nelson D. L. and Cox M. M. Lehninger's Principles of Biochemistry, 4<sup>th</sup> edition, (2005)** W. H. Freeman and Co. NY.
4. **Segel Irvin H., Biochemical Calculations, 2<sup>nd</sup> 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, 4<sup>th</sup> edition (June 1999),** William C Brown Pub;
7. **Mathews et al., Biochemistry 3<sup>rd</sup> edition** Benjamin/Cummings Publishing, 1990.
8. **John W Baynes and Marek H. Dominiczak, Medical Biochemistry, 2018-** Publisher- Elsevier; 5<sup>th</sup> 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; 4<sup>th</sup> edition.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Metabolic Pathways								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-1	MS-ZO117T	02	00	02	30	15	35	50

**Learning Objectives:**

1. To understand the various types of metabolic reactions in organism
2. To know the cause of energy formation by metabolism using various Biomolecules.
3. To understand the bioenergetics of carbohydrate metabolism through glycolysis, TCA cycle.
4. To understand the anabolic and catabolic pathways for lipids proteins.

**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.	<b>Introduction to General Biochemistry</b> Laws of Thermodynamics, free energy, entropy, high energy bonds, Redox Potentials, high energy compounds,	(06)
2.	<b>Concepts of metabolism</b> Metabolic pathways-Catabolic and anabolic, regulation of metabolic pathways	(03)
3.	<b>Carbohydrate Metabolism</b> 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.	<b>Metabolism of Amino Acids, Peptides, Polypeptides and Lipids</b> Amino Acid Metabolism, oxidative degradation of amino acids:	(08)

transamination and oxidative phosphorylation, biosynthesis of purine and pyrimidine nucleotides, oxidation of even chain saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, omega ( $\omega$ )- oxidation of fatty acids, ketogenesis. transport of fatty Acids.

- 5. Principles of Bioenergetics** (02)  
Electron Transport Chain (ETC) and Oxidative Phosphorylation

**Suggested Readings/Material:**

1. **Voet Donald and Voet Judith G Biochemistry, 3<sup>rd</sup> Ed. (2005),** John, Publisher: Wiley and Sons, New York.
2. **Berg Jeremy, Tymoczko John, Stryer Lubert, Biochemistry 6<sup>th</sup> Ed, (2007)** Publisher: W. H. Freeman, New York.
3. **Nelson D. L. and Cox M. M. Lehninger's Principles of Biochemistry, 4<sup>th</sup> edition, (2005)** W. H. Freeman and Co. NY.
4. **Segel Irvin H., Biochemical Calculations, 2<sup>nd</sup> 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, 4<sup>th</sup> edition (June 1999),** William C Brown Pub;
7. **Mathews et al., Biochemistry 3<sup>rd</sup> 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**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Biochemistry/Metabolic Pathways (P)								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-2	MS-ZO118P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To understand the technique for pH measurement by using indicators.
2. To get the knowledge of buffer preparation of desired pH and molarity.
3. To acquire the information about plotting the titration curves and to find the pI values.
4. To perform the separation and identification of components in given mixtures by column chromatography.
5. Able to perform electrophoresis technique for nucleic acid separation.

**Course Outcomes:**

1. Understanding the properties of carbohydrates, proteins, lipids.
2. Understanding the knowledge of macromolecules and their importance in biological systems.
3. Understanding the cofactor, coenzyme, catalysis.
4. Understanding the concept of enzyme kinetics, MM equation.

**Detailed Syllabus:**

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 Biuret 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**  
**M.Sc. Zoology**

Title of the Course: Research Methodology								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
RM-1	MS-ZO119T/P	04	00	04	60	30	70	100

**Learning Objectives:**

1. To understand the basic concepts and terminology regarding the research methodology.
2. To understand the fundamentals of biological research.
3. To inculcate the research attitude and perception among the students.
4. To encourage the students for designing the research publication.

**Course Outcomes:**

1. Understand the fundamentals of biological research methodologies.
2. Understand the opportunities in research and development.
3. Understand the ethical aspects of research.
4. Learn the basic communication skills in scientific writing.
5. Understanding types of scientific communications.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	<b>Basic Concept of Research:</b> Purpose, Characteristics and Definition of Research, Types of Research: Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual and Empirical, Literature Review and its consolidation.	(03)
2.	<b>Meaning of Research in Biological Sciences</b> Process of Research, Defining objectives, Designing Hypothesis, Types of Hypotheses, Methods of testing Hypotheses, Research plan and its components, Methods of Research (Survey, Observation, Case study, experimental, historical and comparative methods), Difficulties in Biological research.	(03)
3.	<b>Identification and formation of the research problem. Elements in research methodology</b> Research design (CRD, RBD, LSD). Scientific database: Science	(03)

- Direct and Pubmed.
4. **Data Collection and Documentation of Observations** (06)  
Meaning, Methods and Tools of Data Collection, Data Processing, Analysis and Interpretation of Data.  
Maintaining laboratory record; Tabulation and generation of graphs.  
Imaging of tissue specimens and application of scale bars. The art of field photography.
  5. **Databases and research metrics** (05)  
Databases, Indexing databases, Citation databases: (Web of Science, Scopus, etc.) Research Metrics (Impact Factor of the journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score), Metrics: (h-index, g-index, i10 index, altmetrics)
  6. **Research Funding :** (04)  
Examinations for research fellowship in India, Agencies and Scheme in India: UGC, DBT, DAE, DRDO, ICMR, MoES ( at least 02 schemes of each agency)
  7. **Experimentation on animals** (04)  
Animal handling and ethics, Maintenance of animals, Various routes of injections and sample collection, CPCSEA guidelines; Institutional ethics committees, Ethical consideration in research on human beings
  8. **Working in Laboratory** (03)  
Good laboratory practice; Safety and bio- and radio- hazards, disposal of biological and chemical wastes, Accuracy of liquid transfer, Preparation of Reagents, chemicals, buffers, General safety and precautions, Handling of Instruments.
  9. **Ethics in research** (05)  
Ethics: Define Ethics, Moral philosophy and moral judgements with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Publication ethics (Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. ), Conflicts of interest, Publication misconduct.
  10. **Oral presentation** (04)  
How to prepare a presentation, PowerPoint slides, use of communication and IT, voice, speed of delivery and obstacles in effective communication
  11. **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

12. **Editing and correcting** (03)  
proof-reading symbols, jargon and abbreviations
13. **Plagiarism** (03)  
meaning, types, avoiding plagiarism.

### Suggested Readings/Materials:

1. **O'Conner M. and F.P. Woodford (1975) Writing Scientific papers in English.** Elsevier-Excerpta Medica-North Holland Publ., Amsterdam
2. **Trelease S.F. (1958) How to Write Scientific and Technical Papers.** Williams and Wilkins Co. Baltimore, U.S.A.
3. **Day Robert (1966) How to Write and Publish a Scientific Paper.** Cambridge University Press
4. **Mc Millan V. (1997) Writing Papers in the Biological Sciences.** Edn. 2, W.H. Freeman, New York.
5. **Winkler Anthony C. and Jo Ray McCuen-Metherell (2008) Writing the Research Paper, A Handbook.** 7<sup>th</sup> Edition, Wadsworth Cengage Learning, Boston, M.A., USA.
6. **Vijayalakshmi G. and C. Sivapragasam (2008) Research Methods - Tip and Techniques.** MJP Publishers, Chennai.
7. **Kothari C.R. (2009) Research Methodology: Methods and Techniques.** 2<sup>nd</sup> Revised Edition, New Age International Publishers, New Delhi.
8. **Levinson Stephen C. (2003) Pragmatics.** Cambridge University Press, Cambridge
9. **Dawson, C. (2002). Practical research methods.** UBS Publishers, New Delhi.
10. **Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual.** West Africa Rice Development Association, Hong Kong.
11. **Kothari, C.R. (1985): Research Methodology: Methods and Techniques,** Wiley Eastern.
12. **Dominowski, R.L. (1980): Research Methods,** Prentice Hall Inc., New Jersey.
13. **Mishra, R.P. (1980): Research Methodology,** Handbook Concept Publishing Company, New Delhi. 4. IIPS (1996): Research Methodology, IIPS, Mumbai.
14. **Research and Writings – By-P. Ramdas , A.Wilson srunai M.J.Publisher (2009).**
15. **Scientific thesis writings and Paper presentations-N.Gurumani. M.J.Publisher (2010).**

16. **Anderson, Durston&Polle 1970: Thesis and assignment**, writing Wiley Eastern Limited  
M. Sc. [II] Zoology Savitribai Phule Pune University 23
17. **G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip & Techniques**, MJP Publishers, Chennai. [WWW.mjppublishers.com](http://WWW.mjppublishers.com)
18. **Malter K, 1972: Statistical analysis in Biology**, Chapman Hall, London. 1
19. **Cohen, L. Lawrence, M., & Morrison, K. (2005). Research Methods in Education** (5th edition). Oxford: Oxford University Press.
20. **Leedy, P. D. (1980). Practical Research: Planning and design**. Washington: Mc Millan Publishing Co., Inc.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Genetics and Biostatistics								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-7	MS-ZO121T	03	00	03	45	30	70	100

**Learning Objectives:**

1. To include basic terminologies in inheritance biology.
2. To understand the deviations of mendelian inheritance .
3. To understand the basics of human genetics with respect to genetic disorders.
4. Basic concepts of biostatistics and its applications.

**Course Outcomes:**

1. Understanding basic concepts in genetics.
2. Understand the deviations of mendelian genetics and their applications
3. Understand the patterns of microbial and human genetics
4. Understand the basic concepts of biostatistics and its applications in biology.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	<b>Eukaryote Model Systems for Genetic Analysis</b> Life cycle and importance of <i>Drosophila</i> and <i>C. elegans</i> in genetics.	(02)
2.	<b>Mendelian Analysis of Inheritance and introduction of Extension to Mendel's Laws</b> Recapitulation of Mendelian principles of inheritance, Allelic interactions and non-allelic gene interactions (Incomplete dominance, codominance, Epistasis, Multiple allelism with examples)	(03)
3.	<b>Linkage and crossing over</b> 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.	<b>Cytoplasmic inheritance</b> The maternal effect, Mitochondrial Inheritance, Interaction between nuclear and cytoplasmic genes.	(02)
5.	<b>Population Genetics</b> 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 **Introduction to General Statistics** (01)  
Definition Statistics and Biostatistics, Population, Sample and Sampling, Sample types, Applications and Uses of Statistics.
11. **Data Analysis Methods** (07)  
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,
- 12.. **Measures of Dispersion** (04)  
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.
- 13.. **Statistical Methods** (03)  
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).

**Suggested Readings/Material:**

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.
6. **Dr. J.V. Dixit Principles and Practice of Biostatistics**
7. **Snedecor G.W. and Cochran W.G. Statistical Methods:** Snedecor G.W. and Cochran W.G.
8. **Marc M. Triola, Mario F. Triola, Jason Roy Biostatistics for the Biological and Health Sciences**, 2nd Edition by, Published by Pearson Copyright © 2018
9. **Wayne W. Daniel Biostatistics: Basic Concepts and Methodology for the Health Sciences**, 10ed, ISV by, Wiley Publication
10. **Bataschelelet Introduction to mathematics for life sciences** By, E. Springer-Verlag, Berlin



**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Endocrinology and Bioinformatics								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-8	MS-ZO122T	03	00	03	45	30	70	100

**Learning Objectives:**

1. Students will understand endocrine glands and their functions
2. To understand the mechanism of hormone action and its regulation.
3. To Understand the physiological implications of hormones.
4. To understand the basic concepts of bioinformatics.

**Course Outcomes:**

1. Understanding the various endocrine glands and their functions in animals.
2. Understanding the mechanism of hormone actions and its regulation.
3. Understanding the hormone synthesis and their regulation.
4. Understanding the importance of information technology in Biology.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	<b>Introduction to Endocrinology</b> Endocrine glands and their hormones, chemical nature of hormones, Hormone Secretions (apocrine, holocrine, and merocrine), Hormone Delivery, hormonal feedback mechanisms	(02)
2.	<b>Mechanism of Hormone Action</b> 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.	<b>Hypothalamo-Hypophysial System</b> Anatomy and hormones of pituitary glands, Endocrine hypothalamus: structure and functions of endocrine hypothalamus, Hypophysiotropic hormones, control of hypothalamic hormone secretion Neurohypophysis: Structure and function of neurohypophysis, control of neurohypophysial secretion and their physiological functions Adenohypophysial hormones: Chemistry and physiological roles of	(04)

- Somatotropin and Prolactin, Glycoprotein hormones (FSH, LH and TSH),  
Melanocortins and their functions
4. **Hormonal control of calcium homeostasis** (02)  
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. **Endocrine glands and hormones in invertebrates** (02)
  12. **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
  13. **Computer Networking** (01)  
Internet and E-mail, the concept of home pages and websites, World Wide Web (WWW), Uniform Resource Locators (URL).
  14. **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.
  15. **Sequence alignment methods** (04)  
BLASTA, FASTA, significance of sequence alignment, pairwise sequence alignment (Needleman and Wunsch, Smith and Waterman methods), multiple sequence alignment (PRAS, CLUSTALW)

16. **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/Material:**

1. **Hadley: Endocrinology**, Prentice hall. International Edition. 2000
2. **Norris: Vertebrate Endocrinology (2<sup>nd</sup> 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**, 10<sup>th</sup> edition . W.B. Saunders Company, Philadelphia.2002
2. **S.C. Rastogi, Bioinformatics - Concepts, Skills, and Applications**; CBS. Publishing; 2003.
3. **Andreas D Baxevanis and BF Francis, Bioinformatics - A practical guide to analysis of Genes and Proteins**; John Wiley; 2000.
4. **T K Attwood, D J ParrySmith, Introduction to Bioinformatics**; 1st Edition; Pearson Education, 11th Reprint; 2005.
5. **C S V Murthy, Bioinformatics**; 1st Edition; Himalaya Publishing House; 2003
6. **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**  
**M.Sc. Zoology**

Title of the Course: Developmental Biology								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-9	MS-ZO123T	02	00	02	30	15	35	50

**Learning Objectives:**

1. To develop students' interest in the field of Developmental Biology.
2. To provide learning experiences in developmental processes like gametogenesis, fertilization, cleavage till morphogenesis.
3. To provide basic knowledge of pattern formation.
4. To help students understand regeneration and apoptosis in animals.

**Course Outcomes:**

1. Understanding the concepts in developmental biology.
2. Understanding the developmental patterns/ forms in animals.
3. Understanding the molecular mechanisms of animal development.

**Detailed Syllabus:**

Unit	Name of Topic	Lectures Allotted
1.	<b>Concepts of Developmental Biology</b> Cell commitment: Specification and Determination, Differentiation, Induction and Competence, Potency, Stem Cells	(03)
2.	<b>Model Organisms</b> <i>Drosophila melanogaster</i> , <i>Danio rerio</i> , <i>Xenopus laevis</i> , <i>Mus musculus</i>	(03)
3.	<b>Gametogenesis</b> Spermatogenesis, The structure of Sperm, Regulation of Sperm Motility (Tail Fibre Complex and role of Dynein ATPase), The role of pH and Divalent Cations. Structure of ovum, Oogenesis, pre-vitellogenesis, vitellogenesis and post- vitellogenesis.	(04)
4.	<b>Fertilization</b> Concept of fertilization, types of fertilization, species-specific sperm attraction, recognition of egg and sperm, acrosome reaction, molecular strategy to avoid polyspermy in fertilization.	(05)
5.	<b>Types of eggs</b> Based on the amount of distribution of yolk, Cleavage: types and significance.	(02)

6. **Morphogenesis** (03)  
Blastulation, Gastrulation and Neural development- Frog, Chick
7. **Pattern formation** (03)  
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.
8. **Sex determination** in *Drosophila* and mammals (02)
9. **Organizers** (01)  
Spemann and Mangold: Primary embryonic induction, Functions of an organizer
10. **Regeneration** (02)  
Epimorphic regeneration in Salamander limb, morpholactac regeneration in *Hydra* and compensatory regeneration in mammalian liver.
11. **Apoptosis**: Intrinsic and extrinsic pathways and Aging (02)

**Suggested Readings/Material:**

1. **S.F. Gilbert, Developmental Biology, 9<sup>th</sup> edition (2010)**. Publisher- Sinauer, Associates Inc.
2. **Lewis Wolpert, Principles of Development, 3<sup>rd</sup> edition (2007)**, Publisher Oxford, University Press.
3. **BI. Balinsky, An Introduction to Embryology, 5<sup>th</sup> edition (2004)**. Publisher – ThomasAsia Pvt. Ltd.
4. **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**  
**M.Sc. Zoology**

Title of the Course: Genetics and Biostatistics (P)								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-10	MS-ZO124P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To include basic terminologies in inheritance biology.
2. To understand the deviations of mendelian inheritance.
3. To understand the basics of human genetics with respect to genetic disorders.
4. Basic concepts of biostatistics and its applications.

**Course Outcomes:**

1. Understanding basic concepts in genetics.
2. Understand the deviations of mendelian genetics and their applications.
3. Understand the patterns of microbial and human genetics.
4. Understand the basic concepts of biostatistics and its applications in biology.

**Detailed Syllabus:**

Unit	Name of Topic	Practicals Allotted
1.	Study of <i>D. melanogaster</i> - Culture, Morphology (Sexual Dimorphism, Wings, Sex comb, genital 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.	(01)
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.	(01)
10.	Culturing <i>E. coli</i> on solid and liquid media.	(01)
11.	Problems based on bacterial transformation and transduction	(01)

12. Calculate mean, mode and median, variance standard deviation, coefficient of variance and standard error from the given data. (By SPSS) **(02)**
13. Calculate mean, standard deviation, coefficient of variance and standard error from the given data by using MS Excel **(01)**
14. Examples based on t-test (By SPSS) **(01)**
15. Statistical problem solving based on Student's 't' test and  $\chi^2$  test (By SPSS) **(01)**
16. Analysis of variance on the given data (ANNOVA) (By SPSS) **(01)**
17. Representation of data by various graphical methods (By SPSS) **(01)**
18. Determination of Karl – Pearson's coefficient of correlation from the given data. (By SPSS) **(01)**
19. Measures of Dispersion. (By SPSS) **(02)**

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Endocrinology and Bioinformatics (P)								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-11	MS-ZO125P	00	02	02	60	15	35	50

**Learning Objectives:**

1. Students will understand endocrine glands and their functions
2. To understand the mechanism of hormone action and its regulation.
3. To Understand the physiological implications of hormones.
4. To understand the basic concepts of bioinformatics.

**Course Outcomes:**

1. Understanding the various endocrine glands and their functions in animals.
2. Understanding the mechanism of hormone actions and its regulation.
3. Understanding the hormone synthesis and their regulation.
4. Understanding the importance of information technology in Biology.

**Detailed Syllabus:**

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.	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	(02)



13. Sequence homology and gene annotation. Translation of nucleotide sequence and selection of the correct reading frame of the polypeptide from the output sequences. **(02)**
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**  
**M.Sc. Zoology**

Title of the Course: Practical in Developmental Biology								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-12	MS-ZO126P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To develop students' interest in the field of Developmental Biology.
2. To provide learning experiences in developmental processes like gametogenesis, fertilization, cleavage till morphogenesis.
3. To provide basic knowledge of pattern formation.
4. To help students understand regeneration and apoptosis in animals.

**Course Outcomes:**

1. Understanding the concepts in developmental biology.
2. Understanding the developmental patterns/ forms in animals.
3. Understanding the molecular mechanisms of animal development.

**Detailed Syllabus:**

Unit	Name of Topic	Practicals Allotted
1.	Mounting of chick embryos and preparation of permanent mounts.	(01)
2.	Filter paper ring method for <i>in vitro</i> culturing of chick embryo and observation.	(01)
3.	Gross anatomy and histology of chick embryo up to 72 hours - brain, heart, eye development.	(02)
4.	Study of embryonic and post-embryonic development using frog egg as a model system.	(01)
5.	Study of the life cycle of <i>Drosophila melanogaster</i> .	(01)
6.	Study of early developmental stages of any freshwater snail.	(01)
7.	Demonstration of cell death in chick embryo by vital stain	(01)
8.	Study of regeneration in Hydra/ Planaria.	(01)
9.	Study of the imaginal disc in the larva of <i>Drosophila</i>	(01)
10.	Isolation of Zebrafish embryo	(01)
11.	Teratogenic effects of lithium chloride on development of snail/fish	(01)
12.	Effect of fruit ripening agents on <i>Drosophila</i> development	(01)

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
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**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Ethology								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-3	MS-ZO127T	02	00	02	30	15	35	50

**Learning Objectives:**

1. To understand the fundamental concepts of animal behavior.
2. To understand the various aspects related with social behaviour of animals.
3. To understand the interrelation and behavior of animals according to the surrounding environment.

**Course Outcomes:**

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.	<b>Introduction</b> Ethology as a branch of biology Animal psychology- Classification of behavioral patterns, analysis (Ethogram)	(02)
2.	<b>Perception of the Environment</b> Mechanical, Electrical, Chemical, Olfactory, Auditory, visual	(04)
3.	Neural and hormonal control of behavior, Genetic and Environmental components of development of behavior	(04)
4.	<b>Communication</b> Chemical, Visual, Light, Audio, Species specificity of songs in birds, Evolution of language in primates	(05)
5.	<b>Social Behavior</b> Aggregation- Schooling in fishes, flocking in birds, herding in mammals Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness Social organization in insects and primates	(05)
6.	<b>Ecological Aspects of behavior</b> Habitat selection, food selection, optimal foraging theory, anti-predator	(05)

defenses,  
homing, territoriality, dispersal

7. **Reproductive Behavior** (05)  
Evolution of sex and reproductive strategies  
Mating systems, courtship, sperm competition, sexual selection, parental care

**Suggested Readings/Material:**

1. **Alcock: Animal Behaviour- An evolutionary approach**, (7<sup>th</sup> ed.) Sinaur Associates, Inc. 2001.
2. **Drickamer and Vessey: Animal Behaviour- Concepts, Processes and methods** (2<sup>nd</sup> 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**, (3<sup>rd</sup> ed.) Blackwell, 1993.
8. **Lehner: Hand Book of Ethological Methods.** (2<sup>nd</sup> ed.) Garland, 1996.
9. **Manning and Dawkins: An Introduction to Animal Behaviour** (5<sup>th</sup> ed.) Cambridge Univ. Press, 1998.
10. **Slater and Halliday: Behaviour and Evolution**, (1<sup>st</sup> ed.) Cambridge Univ. Pres., 1994.
11. **J. P. Shukla: Fundamentals of Animal Behavior** (1<sup>st</sup> ed.) Atlantic Publishers and Distributors, 2010.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: Techniques in Zoology-I								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-4	MS-ZO128P	00	02	02	60	15	35	50

**Learning Objectives:**

1. To understand the advanced techniques used in Zoology.
2. To Understand the principle and working of various rechniques used in biological science.
3. To understand the applications of biological techniques in Zoology.

**Learning Outcomes:**

1. Practical understanding of principle and working of biochemical techniques.
2. Performing assay for quatification of biological molecules.
3. Understanding the techniques used in Zoology

**Detailed Syllabus:**

Unit	Name of Topic	Practicals Allotted
1.	Principle and uses of different microscopes. (Phase contrast, Fluroscence and Electron Microscope)	(01)
2.	Working principle and applications of Colorimeter, Spectrophotometer, Centrifuge machines.	(01)
3.	Working principle and applications of Electrophoresis, Column Chromatography etc	
4.	Protein estimation by using UV Spectrophotometer. (Lowry et al Method)	(02)
5.	To study the effect of different solvents for a given dye using thin-layer chromatography.	(01)
6.	Separation of amino acids by paper chromatography.	(01)
7.	Enzyme isolation and purification by fractionation methods.	(01)
8.	Determination of isoelectric pH of Casein	(01)
9.	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.	(02)
10.	Separation of proteins using polyacrylamide gel electrophoresis (Native PAGE).	(02)

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's  
**New Arts, Commerce and Science College, Ahmednagar**  
**(Autonomous)**  
**Syllabus**  
**M.Sc. Zoology**

Title of the Course: On Job Training								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
OJT-1	MS-ZO129P	00	04	04	120	30	70	100

NOTE: The norms and regulations for On Job Training will be centrally decided in the Academic council by the college.