



M. G. Science Institute, Ahmedabad

**Autonomous | Affiliated to Gujarat University, Ahmedabad
(Managed by the Ahmedabad Education Society)**

Department of Zoology

**Bachelor of Science (Hons.) in Zoology
(Effective from Academic Year 2026-27)**

Syllabus for B.Sc. (Hons.) Zoology

Semester-5

ZOM351T: Animal diversity (Non-chordates) and Cytology

Semester: V	Course Title:- Animal diversity (Non-chordates) and Cytology	Credit: 4
Course No.: 351T	Major-11(T)	Hours: 4/week

Course Outcomes: On successful completion of the course, the learner will be able to:

COs	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall classification, habit & habitat Cuttlefish and Starfish, Identify crustacean and Echinodermata larval forms. Recall structure & composition of Plasma Membrane. Identify polytene & lampbrush chromosomes.
CO 2	Understanding	Explain morphology & anatomy of Cuttlefish and Starfish, Describe shell, foot, and torsion-distortion. Explain TEM, SEM, fluorescence, PAGE. Explain fluid mosaic model & junctions, mitosis & meiosis.
CO 3	Applying	Illustrate digestive & respiratory systems of Cuttlefish, Demonstrate water vascular system of Starfish. Perform karyotyping and Chromatography. Demonstrate osmosis/transport
CO 4	Analyzing	Compare nervous & sensory systems with other molluscs. Compare reproductive system with deuterostomes. Interpret cytological results (karyotype, gels).
CO 5	Evaluating	Evaluate reproductive adaptations of Cuttlefish. Assess role of plasma membrane in communication. Evaluate somatic hybridization significance.
CO 6	Creating	Design basic experiment on differentiation.

CO-PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	1	1	2		1	1	1	
CO 2	3	1	1	2	2	1	1	2	1
CO 3	3	3		3	1	2		2	2
CO 4	3	3	1	2	2	2	1	3	
CO 5	3	3	3	2		2	2	3	3
CO 6	3	3	3	3	2	2	2	2	2

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Unit No.	Unit Contents	No. of Hours of Teaching
1	<p>ANIMAL DIVERSITY (Non-chordates) Type Study & General Topics: A. General structure & morphology with functional anatomy of Cuttlefish (<i>Sepia officinalis</i>)</p> <ul style="list-style-type: none"> • Classification • Habit & Habitat • External Characters • Digestive System • Respiratory system • Circulation system • Excretory system • Nervous system • Sense organs • Reproductive systems <p>B. General topics: Arthropoda:</p> <ul style="list-style-type: none"> • Crustacean larvae <p>Mollusca:</p> <ul style="list-style-type: none"> • Shell, • Foot, • Torsion - Detorsion. 	15
2	<p>ANIMAL DIVERSITY (Non-chordates) Type Study & General Topics: A. General structure & morphology with functional anatomy of Starfish (<i>Asterias rubens</i>)</p> <ul style="list-style-type: none"> • Classification • Habit & Habitat • External Characters • Body wall • Digestive system • Water vascular system • Reproductive system <p>B. General topics: Echinodermata:</p> <ul style="list-style-type: none"> • Larval forms <p>Minor phyla:</p> <ul style="list-style-type: none"> • General characters of Brachiopoda 	15

3	<p>CYTOLOGY (Tools and Techniques):</p> <ul style="list-style-type: none"> • Centrifugation • Electron Microscopes (TEM, SEM) • Fluorescence Microscope • Paper Chromatography (Ascending and Descending) • Thin Layer Chromatography • PAGE - Slab gel electrophoresis • Karyotyping and Karyotype 	15
4	<p>CYTOLOGY:</p> <p>1) Ultrastructure and functions of Plasma membrane:</p> <p>a) Brief introduction of chemical composition.</p> <p>b) Ultrastructure – ‘Fluid Mosaic model’ only.</p> <p>c) Specialized structures of plasma membrane.</p> <ul style="list-style-type: none"> • Specialization due to outpushings/evaginations. • Specialization due to inpushings/invaginations. • Specializations due to contact: <ul style="list-style-type: none"> - Desmosomes, - Hemi-desmosomes - Septate desmosomes - Tight junctions - Gap junctions - Terminal bars - Interdigitation. <p>d) Functions of plasma membrane:</p> <ul style="list-style-type: none"> - Permeability - Osmosis - Diffusion, - Facilitated transport - Active transport - Endocytosis - Exocytosis <p>2) Giant Chromosomes:</p> <ul style="list-style-type: none"> • Polytene Chromosome • Lampbrush Chromosome <p>3) Mitosis and Meiosis</p> <p>4) Cell differentiation:</p> <ul style="list-style-type: none"> • Hammerling’s experiment on Acetabularia • Bantook’s experiment on zygote of Mayetiola destructor • Spemann’s experiment on eggs of newt and Somatic hybridization 	15

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Reference books:

Non- Chordates:

1. Textbook of Invertebrates, R. L. Kotpal, Rastogi Publications, Meerut.
2. Manual of Zoology, E. K. Ayyer, Vol. I & II.
3. Invertebrate Zoology, Jordan and Verma, S. Chand & Company, Delhi.
4. Text book of practical zoology - Invertebrates, S. S. Lal Rastogi Publication, Meerut.

Cytology:

1. Cytology, P. S. Verma & V. K. Agarwal, S. Chand & Company, Delhi.
2. Cell Biology, C. B. Power, Himalaya Publishing House.
3. Cellular and Molecular Biology, De Robertis and De Robertis, Saunders Pub.
4. Essential Cell Biology, Bruce Alberts, et. al., Garland Pub.

ZOM352T: Animal Biochemistry, Molecular biology and Biotechniques

Semester: V	Course Title:- Animal Biochemistry, Molecular biology and Biotechniques	Credit: 4
Course No.: 352T	Major-12 (T)	Hours: 4/week

Course Outcomes: On successful completion of the course, the learner will be able to:

COs	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall definition, classification & biological significance of Carbohydrates, Recall amino acids, peptide bonds, protein structures, Recall DNA & RNA types, and Recall principles of tissue culture, blotting & PCR.
CO 2	Understanding	Explain isomerism, mutarotation & monosaccharide formulae, Explain classification, properties & significance of proteins, Explain DNA replication, polymerases, ligases & topoisomerases
CO 3	Applying	Illustrate structures of mono-, di-, and polysaccharides, Demonstrate peptide bond formation & naming, Illustrate semiconservative replication (Meselson & Stahl), outline basic tissue culture techniques
CO 4	Analyzing	Differentiate glycosidic linkages & optical isomers, Compare primary, secondary, tertiary & quaternary structures of proteins, Differentiate A, B, Z-DNA.
CO 5	Evaluating	Evaluate structural & functional roles of carbohydrates in organisms, Evaluate role of bonds (H, disulfide, ionic, hydrophobic) in stability, Evaluate role of PCR & DNA fingerprinting in diagnostics & forensics.
CO 6	Creating	Design simple peptide/protein models, Design experimental approach for protein synthesis study.

CO-PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	1	1	1	1	1	1	1	1
CO 2	3	2	1	2	2	1	1	2	1
CO 3	3	3	1	3		2	2	2	2
CO 4	3	3	1	2	2	2	1	3	2
CO 5	3	3		2	3	2	2	3	3
CO 6	3	3	3	2	2	3		3	3

Unit No.	Unit Contents	No. of Hours of Teaching
1	<p>CARBOHYDRATES:</p> <ul style="list-style-type: none"> • Introduction • Definition • Biological significance and classification of carbohydrates • Asymmetry • Isomers • Optical isomerism • Mutarotation • Formulation of Monosaccharides (Fischer and Haworth formula) <p>Monosaccharides:</p> <ul style="list-style-type: none"> • Definition • General formula • Classification upto Hexoses <p>Disaccharides:</p> <ul style="list-style-type: none"> • Definition • Classification based upon the type of glycosidic linkages • Occurrence • Formation • Structure • Properties • Hydrolysis of Sucrose, Lactose and Maltose <p>Polysaccharides:</p> <ul style="list-style-type: none"> • Definition • Classification based upon the structures and functions. • Occurrence • Structure • Properties and Hydrolysis of Homopolysaccharides (Starch, Glycogen, Cellulose and Chitin) and Heteropolysaccharides (Mucopolysaccharides, Hyaluronic acid and Heparin) 	15
2	<p>PROTEINS:</p> <ul style="list-style-type: none"> • Introduction • Definition • Biological significance <p>Amino Acids:</p> <ul style="list-style-type: none"> • General structure 	15

	<ul style="list-style-type: none"> • Classification based upon the composition of the side chain/ R group & based upon the number of amino and carboxylic groups • Non protein amino acids <p>Peptides:</p> <ul style="list-style-type: none"> • Formation of peptide • N- and C- terminals • Naming of peptide chains <p>Primary and Secondary bonds:</p> <ul style="list-style-type: none"> • Peptide bond • Disulfide • Hydrogen • Hydrophobic • Ionic <p>Protein Configuration :</p> <ul style="list-style-type: none"> • Primary structure • Secondary structure • Tertiary structure • Quaternary structure <p>Classification of proteins :</p> <ul style="list-style-type: none"> • Based upon shape • Based upon composition and solubility. <p>Physical properties:</p> <ul style="list-style-type: none"> • Colour & taste, Shape & Size, Molecular weight, Solubility, Colloidal nature, Denaturation, Amphoteric nature. <p>Chemical properties:</p> <ul style="list-style-type: none"> • Hydrolysis, Reaction with alkalis, Reaction with formaldehyde 	
3	<p>MOLECULAR BIOLOGY:</p> <p>DNA Synthesis :</p> <ul style="list-style-type: none"> • Basic idea of DNA polymerases • Primer DNA • Template DNA • Proof-reading by polymerases • Continuous & Discontinuous synthesis • DNA ligases • DNA helicases • DNA- binding proteins • DNA topoisomerases 	15

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	<p>Types of DNA Replication:</p> <ul style="list-style-type: none">• Semiconservative (Meselson and Stahl's experiment)• Conservative• Dispersive <p>Types of DNA:</p> <ul style="list-style-type: none">• A-DNA• B-DNA• Z-DNA <p>Types of RNA:</p> <ul style="list-style-type: none">• m RNA• t RNA• r RNA• sn RNA <p>Protein Synthesis</p>	
4	<p>BIOTECHNIQUES:</p> <p>Advantages and disadvantages of animal Tissue Culture</p> <ul style="list-style-type: none">• Tissue Culture techniques and related equipments (Brief account of Laminar flow hood, Autoclave, CO₂ Incubator).• Organ Culture techniques.• Whole Embryo Culture technique• Southern Blotting Technique• Northern Blotting Technique• Polymerase Chain Reaction (PCR)• DNA Fingerprinting	15

Reference books:

Biochemistry:

1. Elementary Biochemistry, J. L. Jain, S. Chand & Company, Delhi.
2. Biochemistry, I. Stryer, Freeman.
3. Harper's Biochemistry, Lange, McGraw-Hill.
4. Principles of Biochemistry, Lehninger, CBS Publications.

Molecular Biology & Genetics:

1. Molecular Cell Biology, Lodish et. al., Scientific American Books.
2. Cell Biology, C. B. Powar, Himalaya Publishing House.
3. Cytology and Genetics, P. K. Gupta, S. Chand & Company, Delhi.
4. Elements of Biotechnology, P. K. Gupta, S. Chand & Company, Delhi.
5. Principles of Genetics (2nd Ed), Peter Snustad, M. J. Simmons, John Wiley & Sons
6. Basic Genetics, R. F. Weaver and P. W. Hedrick, WCB Publishers.
7. Concepts Of Genetics, W. S. Klug and M. R. Cummings, Pearson Education Pvt. Ltd.
8. Essential Genetics, D. L. Hartl and E. W. Jones, Jones & Barlett Publishers.
9. Genetics, P. S. Verma and V. R. Agarwal, S. Chand & Company, Delhi.

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Biotechniques:

1. Elements of Biotechnology, P. K. Gupta, Rastogi Publication, Meerut.
2. Culture of Animal Cells-A Manual of Basic Technique, R. Ian Freshney, 5th Ed., A John Wiley & Sons Inc. Pub.
3. Biotechniques, Dr.Capt.N. Arumugam, Saras Publication

ZOM353P: Zoology Major Practical-353

Semester: V	Course Title:- Zoology Major Practical-253	Credit: 4
Course No.: 353P	Major-13 (P)	Hours: 8/week

Course Outcomes: On successful completion of the course, the learner will be able to:

COs	Cognitive Abilities	Course Outcomes
CO 1	Remembering	Recall classification, habit & habitat of non-chordates (Sepia, Asterias, larvae, Brachiopoda); recall types of carbohydrates, proteins, DNA, RNA; recall cytological tools (TEM, SEM, PAGE, karyotyping) and biotechniques (PCR, blotting, tissue culture).
CO 2	Understanding	Explain morphology & anatomy of Sepia & Asterias, explain shell, foot, torsion; explain plasma membrane (Fluid Mosaic Model & junctions); explain biological significance of biomolecules; describe DNA replication, transcription, translation, and molecular techniques.
CO 3	Applying	Demonstrate practical skills: detection & estimation of carbohydrates/proteins, centrifugation, chromatography, mitotic squash, karyotype preparation; construct atomic models of biomolecules; apply standard curves in colorimetry.
CO 4	Analyzing	Differentiate structural features (shells, feet, larvae, junctions, protein bonds, DNA types); compare functional anatomy across non-chordates; interpret karyotype abnormalities; analyze results from biochemical tests.
CO 5	Evaluating	Assess evolutionary & functional adaptations (torsion-detorsion, reproductive strategies,); evaluate roles of bonds in protein stability; evaluate significance of PCR, DNA fingerprinting in biology & society; critically assess membrane functions in communication & transport.
CO 6	Creating	Construct atomic models of carbohydrates, proteins, peptides; design basic experiments on cell differentiation; create integrative diagrams/models of DNA replication and protein synthesis.

CO-PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	1	1	1	1	1	1	1	1
CO 2	3	2	1	2	2	1	1	2	1
CO 3	3	3	1	3	2	2	2	2	2
CO 4	3	3	1	2	2	2	1	3	2
CO 5	3	3	3	2	3	2	2	3	3
CO 6	3	3	2	3	2	3	2	2	3

Unit No.	Unit Contents	No. of Hours of Teaching
1	<p align="center">PART - A (Based on paper ZOM 351T)</p> <p>ANIMAL DIVERSITY (Nonchordates): Study of Cuttlefish (<i>Sepia officinalis</i>):</p> <ul style="list-style-type: none"> • External characters • Digestive system • Circulatory system • Excretory system • Nervous system • Reproductive system <p>Arthropoda:</p> <ul style="list-style-type: none"> • Crustacean larvae (Nauplius, Zoea, Megalopa, Phyllosoma). <p>Mollusca:</p> <ul style="list-style-type: none"> • Shell in mollusca (Chiton, Dentalium, Mytilus, Cypraea) • Foot in mollusca (Aplysia, Solen, Pearl oyster, Octopus) 	15
2	<p>ANIMAL DIVERSITY (Nonchordates): Study of Seastar (<i>Asterias rubens</i>):</p> <ul style="list-style-type: none"> • External characters • Body wall • Digestive system • Water vascular system • Reproductive system. <p>Echinodermata:</p> <ul style="list-style-type: none"> • Larval forms (Bipinnaria, Brachiolaria, Ophiopluteus, Echinopluteus, Doliolaria & Auricularia, Doliolaria of Crinoidea) <p>Minor phyla:</p> <ul style="list-style-type: none"> • Brachiopoda (eg. Lingula). 	15
3	<p>CYTOLOGY:</p> <ul style="list-style-type: none"> • Separation of mixture (Urine/blood sample) by centrifuge • Separation and Identification of mixture of amino acids by Paper Chromatography • Separation and Identification of mixture of amino acids by TLC (demonstration) • Preparation of Karyotype- Normal man, Normal woman, Down syndrome, Klinefelter syndrome, Turner syndrome 	15

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	<ul style="list-style-type: none"> • Temporary mounting of polytene chromosome (Drosophila/Chironomous larva) • Preparation of mitosis by squash method from onion root tip 	
4	<p>CYTOLOGY: Study by charts/photographs:</p> <ul style="list-style-type: none"> • TEM • SEM • Fluorescent microscope • PAGE • Fluid Mosaic model of Plasma membrane <p>Specialized structures of plasma membrane:</p> <ul style="list-style-type: none"> • Specialization due to outpushings /evaginations • Specialization due to inpushings /invaginations • Specializations due to contact: Desmosomes, Hemi-desmosomes, Septate desmosomes, Tight junctions, Gap junctions, Terminal bars and Interdigitation <p>Hammerling's experiment on Acetabularia Bantook's experiment on zygote of Mayetiola destructor Spemann's experiment on eggs of newt</p>	15
1	<p align="center">PART - B (Based on paper ZOM352 T)</p> <p>Detection of carbohydrates & proteins:</p> <ul style="list-style-type: none"> • Monosaccharides - Glucose and Fructose • Disaccharides - Lactose, Maltose and Sucrose • Proteins - Albumin and Casein <p>Colorimetric estimation of:</p> <ul style="list-style-type: none"> • Proteins (Preparation of Std. Curve by Biuret method) • Glucose (Nelson-Somogyi method) 	15
2	<p>Atomic models of carbohydrates: Preparation of atomic models (Acyclic as-well-as cyclic structures) of</p> <ul style="list-style-type: none"> • Ribose, Arabinose, Ribulose, Glucose, Mannose, Galactose, Psicose, Fructose and Tagatose. • Maltose, Lactose, Cellobiose and Sucrose <p>Atomic models of proteins: Preparation of atomic models of:</p>	15

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	<ul style="list-style-type: none">• All amino acids except heterocyclic amino acids.• Dipeptides (Gly-Val, Ala-Ser & Glu-Lys.)	
3	<p>Study by charts/photographs:</p> <ul style="list-style-type: none">• DNA replication type• DNA synthesis in vitro• Types of DNA• Types of RNA• Protein synthesis (Central dogma, Transcription, Translation).	15
4	<p>Study by charts/photographs:</p> <ul style="list-style-type: none">• Southern blotting• Thermocycler• DNA fingerprinting• Laminar air flow• Trowel's type II culture chamber• Tissue culture technique• Organ culture technique• Whole embryo culture technique	15