

**JECRC UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF ZOOLOGY
Session 2015-16**

M.Sc. ZOOLOGY

SEMESTER –I		
Code	Title of Course	Credits
MZO 001A	Taxonomy And Evolution	4
MZO 002A	Structure And Function Of Invertebrates	4
MZO 003A	Biochemistry	4
MZO 004A	Biostatistics And Computer Application	4
MZO 005A	Biochemistry, Biostatistics, Taxonomy & Invertebrates Lab	12
	Total Credits	28
SEMESTER –II		
MZO 006A	Biology Of Chordates	4
MZO 007A	Tools And Techniques	4
MZO 008A	General Physiology	4
MZO 009A	Molecular Biology And Biotechnology	4
MZO 010A	Physiology, Molecular Biology & Chordates Lab	12
	Total Credits	28
SEMESTER –III		
MZO 011A	Genetics	4
MZO 012A	Microbiology & Applied Zoology	4
	SPECIAL PAPER A *	
MZO 013A	Cell & Molecular Biology	4
MZO 014A	Immunology	4
	OR	
	Special Paper B *	
MZO 015A	Environment & Natural Resources	4
MZO 016A	Eco-toxicology & Biodiversity conservation	4
MZO 017A	Genetics, Microbiology and Cell Biology, or Environmental Biology Lab	12
	Total credits	28
SEMESTER –IV		
MZO 018A	Animal Biotechnology	4
MZO 019A	Developmental Biology	4
MZO 020A	Animal Biotechnology & Developmental Biology Lab	4

MZO 021A	Project report	14
MZO 022A	SEMINAR	2
	Total credits	28
	Total Credits of all 4 Semesters	112
*A student is required to take any one special paper ie either A or B in Semester III		

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Course Objectives:

In this course, the student gains an in-depth study of various invertebrate and vertebrate specimens. The purpose of this course is:

- To acquaint students with the identification, systematics, life history, anatomy, and adaptive strategies of the invertebrate and vertebrates and to expose them to field techniques used in their study.
- To inculcate in the students an understanding, appreciation and respect for the other animals which share our planet.
- To make students aware of the various disciplines encompassed by the field of zoology and to encourage them to pursue those areas that interests them through further reading and coursework.
- To understand the systemic and functional morphology of various groups of chordates.
- To know the principles of genetics, pedigree analysis and population genetics.
- To generate up-to-date knowledge on environmental conservation and management through a comprehensive understanding of the components of ecosystem, biological cycles, habitat ecology, resource ecology, pollution and its management.
- To comprehend the chemical constituents of living matter, chemistry of food stuffs and their transformation in animal systems, the energy changes associated with these transformation and hormonal regulation.

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MZO 002A	Structure And Function Of Invertebrates	4
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	Total Credits	28

MZO 001A: TAXONOMY AND EVOLUTION

Credit(s): 4

Unit I

Definition and basic concepts of biosystematics and taxonomy- Importance and applications of biosystematics in biology. Definition and understanding of various taxonomic categories. Species concepts and species categories –subspecies and infra species. Modern trends in taxonomy- Chemotaxonomy. Cytotaxonomy. Molecular taxonomy. Neotaxonomy. Theories of biological classification. hierarchy of categories

Unit II

Taxonomic procedures; collection, preservation, curation and process of identification. Different kinds of systematic Publications. Taxonomic characters of different kinds. Quantitative and Qualitative analysis of variation. Process of typification, different zoological types and their significance.

Unit III

Taxonomic Keys: their kinds, merits and demerits. Use of taxonomic keys. International Code of Zoological Nomenclature (ICZN). Interpretation and application of important rules, Zoological nomenclature and formation of scientific names of different taxa.

Unit IV

Concepts of evolution and theories of organic evolution with an emphasis on Darwinism Neo- Darwinism : Gene pool, Gene frequency, Hardy-Weinberg law of genetic equilibrium. Detailed account of destabilizing forces- Natural selection, Mutation, Genetic drift, Migration.

Unit V

Variation, Mimicry, Adaptation

Genetics of speciation- Isolation; and role in evolution.

Suggested Readings

- Principle of Animal Taxonomy; G.G Simpson. Oxford IBH Publishing Company.
- Elements of Taxonomy. E. Mayer.
- Theory and Practice of Animal Taxonomy. V.C. Kapoor. Oxford & IBH Publishing Co. Pvt. LTD.
- Advancement in Invertebrate Taxonomy and Biodiversity. Rajeev Gupta. Agrobios International.
- Evolution of the vertebrates, Colbert. E.H. John Wiley and Sons Inc., New York.
- Genes and Evolution. Jha A.P. John Publication, New Delhi
- Evolutionary Genetics. Smith, J.M. Oxford University Press, New York.
- Evolution and population genetics, Rashmi Sisodia, Paragon, International Publishers.

MZO 002A: STRUCTURE AND FUNCTION OF INVERTEBRATES

Credit(s):4

Unit I

Organization of Body: Uni and multi cellular organisms,

Body cavity: Acoelome, Pseudocoelome, Coelome (schizo and enterocoelous)

Fate of Blastopore (Protostome, Deuterostome) and Blastomeres (Determinate and Indeterminate blastomeres)

Type of cleavage (Spiral and Radial)

Unit II

Type of symmetry: Body planes, Asymmetry, Radial, biradial, bilateral symmetry

Segmentation: Pseudo, superficial and metameric

Locomotion: Flagellar, ciliary movement in Protozoa and Hydrostatic movement in coelenterate, annelid and echinodermata,

Unit III

Nutrition and Digestion in invertebrates and lower Metazoa. Filter Feeding in Polycheta, Mollusca and Echinodermata.

Respiration: respiratory organs in invertebrates (Gills, book lungs and trachea). Mechanism of respiration, respiratory pigments.

Unit IV

Excretion: Excretory organs in invertebrates (Coelomoducts, Nephridia and Malpighian tubules, organ of bojanus, green gland), Mechanism of excretion

Nervous System : Primitive type (Coelenterata and Echinodermata) and Advanced type (Annelida, Arthropoda (Crustacea and insecta) and Mollusca (Cephalopoda))

Unit V

Reproduction: Asexual (*Paramecium*, *Obelia*) and sexual reproduction (annelida, arthropoda and mollusca)

Larval forms of invertebrates, Evolutionary significance of larval forms.

Suggested Readings

- Invertebrate structure and function. Barrington, E.J.W. Thomas Nelson and Sons Ltd. London.
- Invertebrate Zoology Barnes, RD. W.B.Saunders Co., Philadelphia
- A Biology of higher invertebrates, Russel-Hunter, WD. McMillan Co. Ltd., London
- Text book of Zoology. Parker, T.J., Haswell. W.A.Macmillan Co., London.
- Invertebrates Richard C. Brusca , Gary J. Brusca and Nancy J. Haver

MZO 003A: BIOCHEMISTRY

Credit(s): 4

Unit I

Bioenergetics - types of chemical bonds, pH, Acid, Base, Buffer, Concept of free energy. Laws of thermodynamics and biological system, Enthalpy, Entropy.

Enzymes- Classification- (I.U.B. system), Specificity of enzyme action, Mechanism of enzyme action, Enzyme kinetics- Michaelis-Menten equation, Enzyme inhibition , Allosteric enzymes, Iso-enzyme and ribozyme, conenzymes and cofactors , Factors influencing enzyme action.

Unit II

Vitamins-Classification, structure, occurrence and functions of fat soluble vitamins, Classification, structure, occurrence and biological functions of water soluble vitamins

Unit III

Carbohydrates : Classification with examples, Biological roles of monosaccharides, Disaccharides & Polysaccharides

Carbohydrate Metabolism: Glycolysis, Citric acid cycle, Electron transport system and oxidative phosphorylation; Chemiosmotic hypothesis; Gluconeogenesis, Glycogenesis, Glycogenolysis; Pentose-phosphate pathway (HMP pathway),

Unit IV

Proteins- Classification & Structure of protein, Biological roles of proteins.

Protein Metabolism : Transamination, Deamination, Decarboxylation, fate of ammonia (Ornithine cycle).

Amino acids– Classification & Structure of Amino acid

Unit V

Lipids - Structure, Nomenclature. Classification and Biological roles of lipids.

Prostaglandins – Chemical nature and functions.

Lipid Metabolism: β -oxidation of fatty acids, Biosynthesis of fatty acids, Biosynthesis of cholesterol.

In born errors of metabolism

Suggested Readings

- Deb A.C. Fundamentals of Biochemistry, New Book Agency Pvt. Ltd. Calcutta.
- Stryer L. Biochemistry. W.H.Freeman and Co. New York, 2001

- Voet D. Voet J.G. and Pratt C.W. Fundamentals of Biochemistry. John Wiley and sons Inc. New York, 1999
- Harper's biochemistry by Murray, Granner, Mays Rodwell, McGraw Hill Publication, 2000
- Biochemistry, Berry, A.K. Emkey Pub. New Delhi.
- Jain, J.L. Fundamentals of Biochemistry, S.Chand publishers New Delhi.
- Lehninger, A.L. (2008), Principles of Biochemistry, 5th edition, CBS publishers and distributors, Delhi
- Devlin, T.M. (2006), A Text of Biochemistry with clinical correlations, John Wiley & Sons

MZO 004A:BIOSTATISTICS AND COMPUTER APPLICATION Credit(s):4

Unit I

Introduction: Biostatistics: Definition, Terms, Applications & Role of biostatistics in modern research.

Data collection: Types of data: Primary, secondary, qualitative, quantitative

Methods of data collection and classification:- Types of sampling method- Advantages and disadvantages of census and sampling method, Classification of data, Tabulation, Methods of classification, Class intervals- exclusive and inclusive method,

Diagrammatic and graphical presentation of data, Bar diagram – (types), Pie diagram, Histograms, Frequency polygon, Frequency curve (types- skewness, kurtosis, ogive)

Unit II

Statistical Methods: Measures of central tendency and dispersal, Mean, median, mode, quartile; Range, Mean deviation, Quartiles deviation, variance, Standard deviation, Standard error, degree of freedom, Standard error of mean.

Probability distributions: Basic concepts and definition: Laws of probability, Probability distribution: Binomial, Poisson and Normal

Unit III

Correlation and Regression Types of correlation, Methods to measure correlation, types of Regression analysis, differences between regression and correlation analysis.

Statistical inference: Difference between parametric and non-parametric statistics; Testing of hypothesis, Errors, Student's t-test, F-test, Testing goodness of Fit, Chi-square test, Chi-square distribution and characteristics, Applications of Chi-square test. Yate's correction. Analysis of Variance (ANOVA) One-way classification. Two-way classification.

Unit IV

Computer Application: Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, Commonly used commands. Introduction in MS Office software concerning Word processing, spread sheets and presentation software.

Unit V

Networking fundamentals, client, server, LAN, WAN, Flp, TelNET, INTERNET, ICNET, WWW, HTML, e-mail, introduction to MEDLINE, CCOD and PUBMED for accessing biological information.

Suggested Readings

- Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
- Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stongtton, London.
- Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
- Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ika's Publishing House, New Delhi.
- Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition New Delhi.

MZO005A: Biochemistry, biostatistics, taxonomy & invertebrates lab **Credit(s): 12**

1. To study and assess taxonomic diversity in a habitat. (grassland, arid land, wet land etc.)
2. To study and identify at least 6-10 orders of insects (upto order level only) by the use of taxonomic keys.
3. To study zooplanktons in different water samples collected from ponds etc..
4. To study methods of Collection, Preservation and curation of specimens.
5. To prepare dichotomous (simple bracket) keys; minimum ten sets from the identified specimens.
6. To identify, classify & study distinguishing features of representatives from :
Phylum Protozoa- Polystomella, Opalina, Paramecium(Fission & conjugation), Vorticella, Euglena, Plasmodium.
7. To identify, classify & study distinguishing features of representatives from :
Phylum Porifera-Sycon L.S & T.S, Spicules, Spongin fibres, Leucosolenia, Euplectella
8. To identify, classify & study distinguishing features of representatives from :
Phylum Cnidaria- Obelia,(polyp & Medusa), Millepora, Physalia, Pennatula, Metridium, Madrepora, Alcyonium, Gorgonia, Aurelia.
9. To identify, classify & study distinguishing features of representatives from :
Phylum Helminthes- Ascaris, Taenia, Planaria
10. To identify, classify & study distinguishing features of representatives from :
Phylum Annelida- Pontobdella, Aphrodite, Leech, Polygordius, Chaetopterus, Neries, Heteroneries, Arenicola.
11. To identify, classify & study distinguishing features of representatives from :
Phylum Arthropoda- Cyclops, Peripatus, Balanus, Lepas, Limulus, Eupagurus, Julus, Scolopendra, Praying mantis.
12. To identify, classify & study distinguishing features of representatives from :
Phylum Mollusca- Pinctada, Cypraea, Octopus, Nautilus.
13. To identify, classify & study distinguishing features of representatives from :
Phylum Echinodermata- Echinus, Holothuria, Antedon, Asterias, ophiothrix
14. To identify and study the larval Stages: Planula, Redia, Miracidium, Sporocyst, Cercaria, Metacercaria Trochophore,
15. To identify and study the larval Stages: Nauplius, Zoea, Mysis, Velligar, Bipinnaria, Echinopluteus, Auricularia, Tornaria
16. To prepare permanent slides of - : Hydra, Obelia,
17. To prepare permanent slides of - : paramecium, different zooplanktons.
18. To Determine pH of different solutions.
19. To identify unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitable tests.
20. To perform the qualitative estimation of proteins in various tissues/food materials.
21. To perform the qualitative estimation of carbohydrate in various tissues/food materials.

22. To perform the qualitative estimation of lipid in various tissues/food materials.
23. To perform the quantitative estimation of glycogen in given sample.
24. To perform the quantitative estimation of glucose in given sample.
25. To perform the quantitative estimation of ascorbic acid in given sample.
26. To estimate the quantitative estimation of sialic acid in given sample.
27. To perform the quantitative estimation of total proteins in given sample.
28. To perform the quantitative estimation of Total lipid and phospholipids in given sample.
29. To perform the quantitative estimation of cholesterol in given sample.
30. To perform the quantitative estimation of Acid phosphatase in given sample.
31. To perform the quantitative estimation of alkaline phosphatase in given sample.
32. To study and prepare frequency tables, bar diagrams , histograms, frequency curves, ogives and pie diagrams.
33. To calculation standard deviation and coefficient of variation.
34. To estimate significance between samples using Student's t-test, F-test and Chi-square test..
35. To plotting regression lines and calculate correlation and regression analysis.
36. To study analysis of variance (One-way & Two –way classification).

SEMESTER-II

MZO 006A	Biology Of Chordates	4
MZO 007A	Tools And Techniques	4
MZO 008A	General Physiology	4
MZO 009A	Molecular Biology And Biotechnology	4
MZO 010A	Physiology, Molecular Biology & Chordates Lab	12
	Total Credits	28

MZO 006A: BIOLOGY OF CHORDATES

Credit(s): 4

Unit I

Origin and outline classification of the chordates.

Salient features and Interrelationships of Hemichordata, Urochordata and Cephalochordata.

Life – histories of- Pyrosoma, Salpa. Doliolum and Oikopleura

Unit II

General characters of Agnatha: Ostracoderms and Cyclostomes.

A general account of the Dipnoi, Difference between chondrichthyes & Osteichthyes.

Parental care in Amphibia, Neoteny in Amphibia

Unit III

Living reptiles: a brief account of Rhynchocephalia.

Birds. Origin of flight: Flight adaptations. Flightless Birds.

Origins of mammals: Primitive mammals (Prototheria and Metatheria).

Unit IV

General account on adaptive radiations in chordates (fishes, amphibians, mammals)
Development and physiology of extra-embryonic membranes in amniotes.
Evolution of viviparity, Placentation.

Unit V

Metamorphosis in Amphibia, Endocrine control of metamorphosis.
Regeneration: Morphological and histological process in amphibian limb regeneration.

Suggested Readings

- Comparative anatomy of vertebrates. Kent. C.G.
- The Biology of Hemichordata and Protochordata. Barrington, E.J.W. Olter and Boyd. Edinhourgh.
- Vertebrate Paleontology. Romer. A.S.University of Chicago Press, Chicago.
- Chordata structure and function. Waterman. A.J.Macmillan Co. New York.
- Vertebrate evolution. Joysey.K.A. and T.S.Kemp. Oliver and Boyd. Edinborough.
- The Phylogeny of vertebrate. Lovtrup.S.JohnWiley and Sons. London

MZO 007A: TOOLS AND TECHNIQUES

Credit(s): 4

Unit I

Principle and application of:-Light & electron microscopy
Principle, types and applications of Centrifugation

Unit II

Principle, types and applications of:-Electrophoresis
Principle, types and applications of:- Chromatography,

Unit III

Spectrophotometry :X-ray diffraction, Lamberts – Beer's Law and Colorimetry, Flow cytometry
Principle and application of : radiation techniques in biology, Radioisotopes and half life of isotopes, Geiger Muller counter, Scintillation Counter, Autoradiography,

Unit IV

Principles and technique of :-Nucleic acid hybridization and cot curves, Blotting techniques (southern, northern and western), Polymerase chain reaction
Assay : Definition and types - Chemical assays, Biological assays-in vivo and in vitro assays.
Principles of cytological and cytochemical techniques : Fixation & staining

Unit V

Cell Culture techniques: Design of tissue culture laboratory, Culture media preparation and cell harvesting methods, cell cloning

Suggested Readings

- Animals Cell Culture - A practical approach, John R.W.Masters, IRL Press.
- Introduction to Instrumental analysis. Robert Braun. McGraw Hill International Edition

- Principles and Techniques of Biochemistry and Molecular Biology ,(6th edition), K Wilson and J Walker (editor), Cambridge University Press,
- Cell and Molecular Biology, P Sheeler and D E Bianchi, John Wiley & Sons, Inc,
- Essentials of Biophysics, P Narayanan, New Age Int. Pub. New Delhi.
- Bioinstrumentation, J G Webster, John Wiley & Sons Inc.
- Methods in Modern Biophysics, B Notting, Springer Verlag Berlin Heidelberg New York,
- Spectroscopy for the Biological Sciences, G G Hames, John Wiley & Sons Inc.

MZO 008A: GENERAL PHYSIOLOGY

Credit(s): 4

Unit I

Digestion and Metabolism : Nature of food-stuff, Various types of digestive enzymes and their action in alimentary canal, Absorption and assimilation of food, control of digestion.

Circulatory system: Composition and function of blood, blood groups, Haemopoiesis, blood clotting, homeostasis, anatomy of heart structure, Myogenic heart, cardiac cycle, ECG – its principle and significance,.

Unit II

Mechanism of breathing, Physiology of respiration, Oxygen and Carbon dioxide transport in blood, The role of hemoglobin, control of breathing. Gas Exchange and Acid-base Balance: Respiratory organs (lungs).

Excretory system: Osmoregulation in aquatic and terrestrial environments, physiology of Excretion -Functional architecture of nephron, formation and regulation of nitrogenous end products, formation of urine and its hormonal control, Role of kidney in osmoregulation, counter- current multiplier system.

Unit III

Muscle Function and Movement: Types and properties of muscles, Anatomy of muscle, Regulation of contraction, Excitation-contraction coupling, Molecular theory of muscle contraction, cori cycle.

Nervous system: Functional architecture of neurons, Origin and propagation of nerve impulse through neuron (myelinated, non-myelinated), Action potential, Synapses and neurotransmitters, Reflex arc and reflex action.

Unit IV

Sensory Transduction : Auditory receptors, Chemoreceptors; taste and smell, Mechanoreceptors, Vision and Photoreception, Thermoreception.

Stress Biology : Basic concepts of environmental stress and strain, Adaptation, Acclimation and acclimatization, Concept of Homeostasis, Physiological response to oxygen deficient stress.

Unit V

Endocrinology: Hormones as messengers. Classification of hormones, endocrine glands (Pituitary, pancreas, adrenal, thyroid, testes, ovary). Neuroendocrine system and neurosecretion, General principles, structure and hormone action.

Suggested Readings

- Animal Physiology Mechanisms and Adaptation. Eckert, R.W.H. Freeman and Company, New York

- General and Comparative Animal Physiology, Hoar, W.S. Prentice Hall of India.
- Animal Physiology: adaptation and Environment, Schiemdt Neilsen. Cambridge
- Environmental and Metabolic Animal Physiology, Prosser, C.L. Wiley-Liss Inc., New York.
- General and Comparative Endocrinology, E.J.W. Barrington. Oxford. Clarendon Press.
- Comparative Vertebrate Endocrinology. P.J. Bentley. Cambridge University Press.
- Text Book of Endocrinology, R.H. Williams. W.B. Saunders.
- Endocrine Physiology. C.R. Martin. Oxford Univ. Press.
- Comparative Endocrinology, A. Gorbman et al. John Wiley & Sons.

MZO 009A: MOLECULAR BIOLOGY & BIOTECHNOLOGY Credit(s): 4

Unit I

Nucleic acids –DNA & RNA, DNA replication: modes of replication, Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, Enzymes and Accessory proteins involved in DNA replication, Models of DNA replication, Inhibitors of DNA replication, DNA repair mechanisms

Unit II

Transcription in prokaryotes and eukaryotes: Structural organisation and life span of mRNA; rRNA & tRNA, Mechanism of transcription in prokaryotes and eukaryotes. Post transcriptional modification of RNA- Capping, Polyadenylation, Splicing, RNA editing.

Unit III

Genetic code : Characteristics of genetic code, Start codons and stop codons, Degeneracy of the code: Wobble hypothesis

Translation in prokaryotes and eukaryotes: Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis, Translational inhibitors, Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications.

Unit IV

Bacterial genetics: Molecular mapping of genome, genetic and physical mapping. Gene transfer mechanisms-Transformation- molecular mechanism, mapping and other uses of transformation, Transduction- generalized transduction, co-transduction and specialized transduction. Bacterial conjugation, Chromosome transfer in other bacteria. Plasmids and Transposons: types and properties.

Unit V

Molecular markers in genome analysis (RFLP, RAPD and AFLP).

Transgenesis & Transgenic animals: Production, Applications, Animal Cloning.

Stem cell: types and applications.

Suggested Readings

- Benjamin Lewin : Genes, Vol. VIII, Pearson Prentice Hall, Singapore
- Elliott, W. H and Elliott, D. C. : Advanced molecular Biology, Viva Books, New Delhi
- Freifelder, D. : Molecular Biology, Narosa Publishing House, New Delhi
- Gupta, P. K. : Cell and molecular Biology, Rastogi Publications, New Delhi
- Kumar, H. D.: Molecular Biology, Vikas publications, New Delhi

- Russel, P. J. : Cell and Molecular Biology, Cengage learning
- Veer Bal Rastogi : Fundamentals of Molecular Biology, Ane Books India
- Molecular Biology of the Gene. I.D Watson, N.H. Hopkins, J.W. Roberts, J.A. Steiz and AM Weiner The Benjamin/Cummings Pub. Co., Inc., California.
- De Robertis E.D.P. and De Robertis Jr, E.M.F., Cell and Molecular Biology. K. M. Varghese Cop. Bombay.

MZO 010A: Physiology, Molecular Biology & Chordates Lab Credit(s): 12

1. To identify, classify & study distinguishing features of representatives from :
Lower Chordates: Salpa, Doliolum, Botrylus, Herdmania, and Amphioxus.
2. To identify, classify & study distinguishing features of representatives from :
Cyclostomata: Petromyzon, Myxine, Pisces: Pristis, Trygon, Chimaera, Polydon,
3. To identify, classify & study distinguishing features of representatives from :
Pisces: Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Notopterus,
4. To identify, classify & study distinguishing features of representatives from :
Pisces : Exocoetidae, Eel, Pleuronectes, Diodon, Tetradon, Ostracion,
5. To identify, classify & study distinguishing features of representatives from :
Syngnathus, Hippocampus, Anguilla, Labeo.
Amphibia: Ichthyophis, Necturus, Proteus, Ambystoma, Axolotl,
6. To identify, classify & study distinguishing features of representatives from :
Amphibia: Siren, Alytes, Pipa, Bufo, Hyla, Rhacophorus.
7. To identify, classify & study distinguishing features of representatives from :
Reptilia: Testudo, Chelonea, Sphenodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus,
8. To identify, classify & study distinguishing features of representatives from :
Reptilia: Chamaleon, Cobra, Hydrophis, Viper, Pit Viper, Krait, Eryx, Gavialis, alligator, crocodile.
9. To identify, classify & study distinguishing features of representatives from :
Aves: Talor Bird, Indian koel, Jungle fowl, Pavo cristis, Columba, parrot, Wood packer, ostrich, Archéoptéryx.
10. To identify, classify & study distinguishing features of representatives from :
Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat.
11. To identify and study the permanent slides of:
Lower Chordates: *Herdmania* spicules, ascidian tadpole larva, *Amphioxus* :T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete larva (whole mount).
12. To identify and study the permanent slides of:
Pisces: Placoid scale, Cycloid scale, Ctenoid scale.
13. To identify and study the permanent slides of:
Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary.
14. To identify and study the permanent slides of:
Reptilia: V S skin of lizard.
Aves: V S skin of bird, contour feather, down feather.
15. To identify and study the permanent slides of:
Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney,
16. To identify and study the permanent slides of:
Mammals: testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord.
17. To study a comparative account of Skull of Frog, Varanus, Fowl and Rabbit.
18. To study a comparative account of pectoral girdle of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).

19. To study a comparative account of pelvic girdle of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
20. To study a comparative account of forelimb of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
21. To study a comparative account of hindlimb of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
22. To study pH meter and measurement of pH
23. To separate mixtures of amino acids and sugars by Paper chromatography and identification of unknown amino acids and sugars.
24. To separate mixtures of amino acids and sugars by Thin layer chromatography.
25. To determine haemoglobin in given blood samples.
26. To enumerate the RBC in given blood samples.
27. To enumerate the WBC in given blood samples.
28. To enumerate the MCV, MCH, MCHC of the given sample of blood.
29. To determine the blood clotting time, erythrocyte sedimentation rate, haemolysis and crenation.
30. To study the permanent slides of mitotic cell division.
31. To study the permanent slides of meiotic cell division.
32. To study and prepare slides of mitotic stages from onion root tip.
33. To study and prepare slides of meiotic stages from grasshopper testes.
34. To study and prepare slide of giant chromosome in salivary glands of Chironomous larva.
35. To prepare slide and study of Barr body for identification of Gender in Human.

SEMESTER-III

MZO 011A	Genetics	4
MZO 012A	Microbiology & Applied Zoology	4
	SPECIAL PAPER A *	
MZO 013A	Cell & Molecular Biology	4
MZO 014A	Immunology	4
	OR	
	Special Paper B *	
MZO 015A	Environment & Natural Resources	4
MZO 016A	Eco-toxicology & Biodiversity conservation	4
MZO 017A	Genetics, Microbiology and Cell Biology, or Environmental Biology Lab	12
	Total credits	28
*A student is required to take any one special paper ie either A or B		

MZO 011A: GENETICS

Credit(s): 4

Unit I

Biochemical Genetics : Inborn errors of metabolism -Definition and mode of inheritance,
Disorders of carbohydrate metabolism, Diseases of amino acid metabolism, Disorders of lipid

metabolism, Disorders of nucleic acid metabolism, Mineral metabolism disorders.

Unit II

Mutation: molecular mechanism of mutation, forward & reverse mutation, transition, transversion, chemical induced mutations, applications of mutations.

Study of human birth defects (Teratology)- Syndromology, Dysmorphology, Neural tube defect, Anencephaly, Meningocele, Spina bifida, Herlequin ichthyosis.

Unit III

Reproductive Genetics : Spermatogenesis, oogenesis, Computer assisted Semen Analysis (CASA), Assisted Reproductive Techniques (ART) IUI, IVF, ICSI, ZIFT, GIFT.

Pre-implantation Genetic Diagnosis (PGD).

Unit IV

Molecular Diagnosis : DNA fingerprinting, Linkage analysis - RFLP, blotting techniques (southern, northern and western), Gene sequencing, Probes- Preparation and classification, *in situ* hybridization, FISH, application of FISH.

Unit V

Prenatal Diagnosis: Non-invasive techniques- Ultrasonography, foetal MRI, Invasive techniques- Amniocentesis, chorionic villus sampling (CVS), Chromosome analysis, metabolic disorders, DNA Analysis, Current knowledge of prenatally diagnosed genetic disorders, haemoglobinopathies,

Treatment of genetic disorders. Genetic counseling, Eugenics, Euthenics, Euphenics

Suggested Readings

- Gardner: Principles of Genetics
- Pierce Benjamin: Genetics- A Conceptual Approach
- Scriver *et al.*: The metabolic and molecular basis of inherited diseases. 8th edition, McGraw-Hill.
- Strachan, T. and Read, A.P.: Human molecular Genetics. John Wiley, New York
- Strickberger: Genetics
- Tomarin Robert, H: Principles of Genetics

MZO 012A: MICROBIOLOGY AND APPLIED ZOOLOGY Credit(s): 4

Unit I

Introduction of microbiology

Microbial Taxonomy and Phylogeny: Major characteristics (classic and molecular), Bergey's Manual (mention major groups)

Unit II

Bacterial cell structure and function: Plasma membrane and internal system – Cytoplasmic inclusions, ribosomes, nucleoid, Bacterial cell wall Peptidoglycan - structure-Gram positive and gram negative cell wall- Mechanism of gram staining, Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility.

Viruses : General structural properties and Types.

Unit III

Microbial diseases : Human diseases caused by bacteria, virus, fungi
Control of microorganisms : Disinfectants; (A) - physical- Heat, filtration and radiation
(B)-Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
Antibiotics- Penicillin's, Cephalosporins, Chloramphenicol, Tetracyclines.
Microbial drug resistance.

Unit IV

Economic importance of Protozoa and Helminthes, Arthropods, Mollusca.
Important insect pest and their management.
A brief account of sericulture, apiculture, vermiculture, lac culture and pearl culture.

Unit V

Edible Freshwater and Marine Fishes of India. Pisciculture and products of fishing industry, Prawn fisheries. Poultry, Dairy farming.

Suggested Readings

- Hans G. Schlegel : General Microbiology-Cambridge low price editions
- Mansi- Fermentation, Microbiology and Biotechnology-Taylor and Francis
- Pelczar, M.J, Reid, R.D. & Chan, E.C.S-Microbiology-TMH edition
- Prescott, Harley and Klein- Microbiology, IVth ed. McGraw-Hill
- Tortora, Funke and Case - Microbiology : An Introduction Eight edition- pearson education.
- Veerbala Rastogi-Fundamentals of Molecular biology-Ane books
- Economic Zoology by G.S Shukla & V.B. Upadhyay, 1991-92 Rastogi Publications, Meerut,
- A hand book on Economic Zoology by Jawid Ahsan and Subhas Prasad Sinha, S. Chand & company Ltd. Ramnagar.

SPECIAL PAPER-(A)- CELL AND MOLECULAR BIOLOGY

MZO 013A: CELL AND MOLECULAR BIOLOGY

Credit(s): 4

Unit-1

Cellular organization

Membrane structure and transport of small molecules, electrical properties of membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, structure and function of cytoskeleton and its role in motility, cell junction, cell adhesion and extracellular matrix.

Unit II

Transport across cell membrane: Mechanism of diffusion, Facilitated diffusion. Osmosis and passive transport. Active transport - P-class ion pumps, F-class and V-class ion pumps and ABC superfamily. Ca⁺ATPase pump and Na/K⁺ATPase pump. Cotransport by symporters and antiporters. Receptor mediated endocytosis.

Cell signaling

Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial two-component signaling systems, bacterial chemotaxis and quorum

sensing.

Unit III

Structural and Molecular organization of eukaryotic chromosomes : structure of nucleosome particles and chromatin organization, heterochromatin, Euchromatin . specialized chromosomes: structural organization and functional significance of polytene chromosomes, lampbrush chromosome.

Nucleic acids :DNA , RNA

Unit IV

DNA replication (prokaryotes and eukaryotes), repair and recombination:

Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms.

Transcription:

Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing and editing

Unit V

Gene expression and its regulation

The operon, regulatory circuits, promoters and enhancers activating transcription

Protein synthesis process

ribosome, initiation complex and their regulation, chain elongation, termination, genetic code, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post translational modification, protein sorting, chaperons.

Suggested Readings :

Robertis, De and Robertis Cell and molecular biology Lea and Febiger.

Watson Hopkins Roberts Steitz Weiner, Molecular Biology of the Gene the Benjamin, Cummings Publishing Company inc.

Bruce Alberts Bray Lewis Raff Roberts Watson Molecular Biology of the Cell, Garland Publishing inc.

Alberts, B. et al. (2008). *Molecular Biology of the Cell*. 5th Ed. Garland Publishing House.

Cooper, G. M. (2004). *The Cell*. 3rd ed. ASM Press.

Freifelder, D. (1987). *Molecular Biology*. Narosa Publishing House, New Delhi.

Karp, G. (2008). *Cell and Molecular Biology: Concepts and experiments*. 5th ed., John Wiley.

Lewin B. et al. (2007). *Cells*. Jones and Bartlett Publishers.

Watson, J. D., Baker, T. A. & Bell, S. P. (2007). *Molecular Biology of the Gene*. 6th ed. Benjamin Cummings.

Malacinski, G. M. (2003). *Essentials of Molecular Biology*. 4th ed. Jones & Bartlett.

Pollard T.D. and Earnshaw W.C. (2007). *Cell Biology*. Elsevier.

MZO 014A: IMMUNOLOGY Credit(s): 4

Unit I

Immunology: Introduction- Innate and adaptive immunity, Cells and organs of the immune system (Primary lymphoid organs, Secondary lymphoid organs , B-lymphocytes, T-lymphocytes and Antigen presenting cells), Humoral and cell-mediated immune responses (CMI),

Unit II

Antigenicity, immunogenicity and Haptens, Factors influencing immunogenicity, Recognition of antigen by B-and T-lymphocytes, Antigens, Antibodies: Structure and functions of Antibody Molecules, Molecular structure of Ig, Immunoglobulin classes (IgG, IgM, IgE and IgD and their biological activities. Generation of Antibody diversity.

Unit III

Antigen-Antibody Interactions: Strength of Antigen Antibody Interactions, Cross reactivity, precipitation reactions ,agglutination reactions,

Unit IV

Immunotechniques -Detection of molecules using ELISA, RIA, Western Blot, Immunoprecipitation. Monoclonal antibodies-Hybridoma Technology and Applications, Production of monoclonal antibodies, Clinical uses of monoclonal antibodies, Catalytic monoclonal antibodies (abzymes).

Unit V

Immune effector Mechanisms: Cytokines & Antagonists, Complement System-components & functions, Complement activation and regulations(classical ,alternate and lectin pathways), Inflammation & hypersensitivity. Major Histocompatibility Complex (MHC): General organisation and inheritance of MHC, MHC genes & molecules, Antigen processing and presentation– Endogenous and Exogenous pathways.

Suggested Readings :

Kuby, Immunology, W.H. Freeman and Company.
Roitt Male Snustad Immunology.

SPECIAL PAPER(B) - ENVIRONMENTAL BIOLOGY

MZO 015A: ENVIRONMENT & NATURAL RESOURCES Credit(s): 4

Unit I

Environment and climate, Earth (core, mantle, tectonic plates); Atmosphere- structure and composition;
Clouds and their formation and Cloud categories:
Element and factors of climate: External factors: solar radiation, Internal factors.
Biosphere and Biogeochemical cycles.
Environmental monitoring and impact assessment.

Unit II

Cause, effects and remedial measure of Air pollution, Water pollution.
Noise. radioactive and thermal pollution.
soil pollution.
Solid waste management.

Unit III

Global warming : Cause of global warming, Impact of global warming – acid rains and ozone depletion, green house effect, Control measures of global warming
Natural Disasters and their management (floods, earthquake, Cyclones, landslides etc.)

Unit IV

Natural Resources:-Renewable and nonrenewable natural resources.
Forest , Land, Water, Mineral, Food resources
Energy resources

Unit V

Biomes: Desert, Grassland, Tundra, Tropical and temperate forests, Deciduous and evergreen rain forests; Ecozones of India
Species interactions: Herbivory, Carnivory, parasites, Prey– Predator, Commensalisms, mutualism and Symbiosis

Suggested reading

- Arora : Fundamentals of environmental biology
- Bottain : Environmental studies
- Clark : Elements of ecology
- Kormondy : Concepts of ecology
- Odum : Ecology
- Simmons : Ecology of estuaries and costal water
- Pawlosuske : Physico-chemical methods for water
- South Woods : Ecological methods
- Trivedi and Goel : Chemical and biological methods for water pollution studies

MZO 016A: ECO-TOXICOLOGY AND BIODIVERSITY CONSERVATION

Credit(s): 4

Unit I

Environmental indicators and their role in environmental balance.
Toxicology- Basic concepts, toxicological methods.
Toxicity testing principles, hazards, risks and their control methods.
Food toxicants and their control methods.
EIA

Unit II

Pesticides, types, nature and their effects on environment.
Important heavy metals and their role in environment.
Agrochemical use and misuse, IPM.
Occupational Health Hazards and their Control.

Unit III

Biodiversity :- concept ,principle and significance of biodiversity
Causes for the loss of biodiversity, threats to biodiversity

Biodiversity hot spots .

Unit IV

Wildlife of India according to ecological zones

Values of wildlife : positive and negative

Wildlife protection Act and its major amendments

Endangered and threatened species

Wildlife corridors and wildlife translocation .

Biodiversity crisis – habitat degradation poaching of wild life.

Unit V

Conservation of Biodiversity: - In situ and exsitu conservation

National Parks and Sanctuaries

Project Tiger

Project Gir Lion and Crocodile breeding project

Wildlife in Rajasthan with references to Reptiles, Birds and mammals

Study of state bird – and state animal

Biospheres reserves

SUGGESTED READINGS :

- Wild life management - Hossetti
- V.B. Saharia wildlife in India
- S.K. Tiwari wildlife in central India
- R.K. Tondon Biodiversity Taxonomy & Ecology
- P.C. Kotwal Biodiversity and conservation

MZO 017A: Genetics, Microbiology And Cell Biology, Or Environmental Biology Lab

Credit(s): 12

1. To study various chromosomal abnormalities.
2. To isolate bacteria from skin surface.
3. To detect antibiotic susceptibility of given microorganism against various antibiotics.
4. To isolate any pathogenic bacteria (*Staphylococcus* or *Salmonella*) from food products.
5. To isolate spoilage microorganisms from spoiled vegetables/fruits.
6. To isolate spoilage microorganisms from bread.
7. To study the effect of pH on bacterial growth.
8. To study the effect of metal on bacterial growth.
9. To Study and perform bacterial staining technique –a. Negative staining b. Hanging drop technique.
10. To Study and perform Gram staining technique .
11. To Study and perform Endospore staining.
12. To study and prepare slides of protozoan species of economic importance.
13. To study selected species of Platyhelminthes of economic importance.
14. To study the characters of Mites, Ticks, Spiders, Insects.
15. To study the Life cycle of silk worm,
16. To study the Life cycle of honey bee.

17. To study the Life cycle of mosquitos.
18. To Visit to fish industry/Poultry farm/ Dairy/ Leather industry etc.
19. To prepare protozoan culture.

Practical Excercises of Molecular biology & Immunology

1. To perform the Differential leucocytes count.
2. To separate serum from blood.
3. To Study the Double immuno diffusion test using specific antibody and antigen.
4. To identify blood groups in man.
5. To separate proteins and DNA by agarose electrophoresis.
6. To separate proteins and isoenzymes on SDS-PAGE and PAGE.
7. To separate amino acids by paper chromatography.
8. To separate phospholipids by TLC.
9. To prepare salivary gland chromosomes from Drosophila / Chironomous larva and stain with acetocarmine/aceto-orcein/ fuelgen.
10. To estimate DNA by Diphenyl Amine method.
11. To estimate RNA by Orcinol method.
12. To estimate Protein by Lowry' method.
13. To isolation RNA fromYeast.
14. To demonstrate agglutination reaction.
15. To demonstrate ELISA technique.
16. To prepare permanent slides of mitotic & meiotic chromosomes and their different phases

Practical Excercises of Environmental Biology

- 1.To Mark important sanctuaries and national parks of Rajasthan on map, and write details of any three.
- 2.To estimate any environmental toxicants (biochemical/ GC/TLC).
- 3.To determine chloride concentration in the given water sample.
4. To estimate the total hardness of given water sample.
5. To determine the acidity of water.
6. To determine the alkalinity of water.
7. To estimate total dissolved solid in water sample.
8. To determine the dissolved oxygen in given water sample.
9. To determine the BOD of given water sample.
10. To determine the free CO₂ of given water sample.
11. To determine hardness of water.
12. To Estimate salinity, phosphates, sulphates, silicates and nitrates in water samples.
13. To Separate and identify soil arthropods using Berlese funnel.
14. To Determine organic matter in soil sample.
15. To Determinate Carbonates & bicarbonates in soil sample.
16. To Determine moisture content and water holding capacity of soil sample.
17. FIELD STUDY-A study tour of at least five days duration (need not be at a stretch) to observe the ecology and behaviour of animals should be undertaken. The places of visit include inter tidal region,

fresh water bodies, lakes, rivers, hill streams ,wetlands, mangroves, forests grasslands, drinking water treatment plants, and sewage treatment plants.

A report of the field study is to be included in the practical record to be submitted at the time of Examination

SEMESTER IV

MZO 018A	Animal Biotechnology	4
MZO 019A	Developmental Biology	4
MZO 020A	Animal Biotechnology & Developmental Biology Lab	4
MZO 021A	Project report	14
MZO 022A	SEMINAR	2
	Total credits	28
	Total Credits of all 4 Semesters	112

MZO 018A-ANIMAL BIOTECHNOLOGY

Credit(s): 4

Unit I

Introduction: Definition, branches, scope and importance of biotechnology;
 Animal cell and tissue culture: Culture media– natural and artificial. Culture methods– primary explantation techniques, various methods of cell and tissue culture, Tissue and organ culture.
 Equipments required for setting the animal cell laboratory;

Unit II

Vectors for gene transfer (plasmids and phages).
 Basic concepts in Genetic Engineering and Ethics of Genetic engineering
 Protoplast fusion in prokaryotes and eukaryotes.
 Recombinant DNA technology and hybridomas and their application,
 Monoclonal antibodies and their applications.

Unit III

Genomic and cDNA library: Construction, Screening– By DNA hybridization, Screening by immunological assay, and screening by protein activity.
 Blotting techniques- Southern blot, Northern blot, Western blot, Dot blot and Slot blot, FISH and GISH, Chromosome walking.
 DNA sequencing–Maxam and Gilbert’s chemical degradation method, Sanger’s dideoxynucleotide synthetic method. Polymerase Chain Reaction: types & Applications.

Unit IV

Transfection methods and transgenic animals: Definition, Methods - Electroporation, DNA micro injection, Calcium phosphate, precipitation, Dextran mediated transfer, shot gun method, virus mediated, lipofection method, engineered embryonic stem cell method, Transgenic animals for human welfare.
 Cloning: Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) – Advantages and disadvantages of cloning.

Unit V

Environmental biotechnology: Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring. pest control, waste water treatment, metal and petroleum recovery. Vaccines.

Suggested Readings

- Bernard R. Glick & Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press Washington D.C.
- Chatterji, A.K. -Introduction to environmental biotechnology-Prentice Hall of India
- Dubey, R.C. -A text book of biotechnology-S. Chand & Co.
- Gupta. P.K. -Elements of biotechnology-Rastogi publications.
- Singh, B.D.-Biotechnology-Kalyani publishers.
- Wilson & Walker : Principles and techniques of Biochemistry and Molecular biology- Cambridge low price editions

MZO 019A: DEVELOPMENTAL BIOLOGY

Credit(s): 4

Unit I

Introduction: Basic concepts of development: Potency, Commitment, Specification - autonomous, conditional, Induction, Competence, Determination and differentiation, Morphogenetic gradients

Environmental regulation of animal development: Environmental regulation of normal development– types of polyphenism

Unit II

Sex determination in *Bonellia*; primary and secondary sex determination, environmental sex determination, Environmental disruptions of normal development (Teratogenesis), Teratogenic agents- Alcohol, retinoic acid, bisphenol, heavy metals, pathogen, Environmental oestrogens.

Unit III

Gametogenesis, fertilization and early development : Production of gametes, Cell surface molecules in sperm-egg recognition in animals, Zygote formation, Cleavage and blastula formation, Gastrulation and formation of germ layers in amphibian.

Unit IV

Embryogenesis and Organogenesis : Axis formation in amphibians - primary embryonic induction, Anterior posterior patterning in Amphibians - Hox code hypothesis, Anterior posterior patterning in *Drosophila* - gap genes, bicoid gradient, segmentation genes, pair rule genes, homeotic selector genes, realistor genes, Dorsoventral patterning and Left right patterning - dorsal protein gradient, Limb development in chick, Insect wings and legs

Unit V

Cellular and Molecular basis of development : Cellular interactions during development, Epithelial - mesenchymal interactions, paracrine factors, RTK pathway, cell death pathways, Cellular interactions concerned in fertilization, Cellular changes during blastulation and gastrulation, Cellular interactions in organogenesis, Molecular basis of cellular differentiation –

cadherins.

Ageing– cellular and extra cellular aging, Causes- Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed aging.

Suggested Readings

- Development Biology S.F.Gilbert, Sinauer Associates Inc., Massachusetts
- An Introduction to embryology, Balinsky, B.I.: W.B. Saunders Comp.
- Developmental Biology. R.M Twyman. Viva Books Private Limited. New Delhi.
- Principles of Development. Wolpert, L. Oxford University Press, Oxford, UK.
- Berril, N. J. Developmental biology.
- Snustad, D. P., J. M. Simmons & J. B. Jenkins. Principles of Genetics.

MZO 020A: Animal Biotechnology & Developmental Biology Lab Credit(s): 4

1. To study Karyotyping of normal human cells.
2. To study Karyotyping of abnormal human cells.
3. To prepare Nutrient Agar media for bacterial culture.
4. To prepare Potato Dextrose Agar media for fungal culture.
5. To prepare Nutrient and SDA Broth for fungal culture.
6. To prepare Culture microflora from soil and air.
7. To prepare Culture microflora from water by spreading and serial dilution method.
8. To prepare and maintenance of E.coli.culture(shake and surface cultures) and quantitative evaluation (number of cells/ml)of a given sample of culture by dilution and plating.
9. To prepare mac conkey agar media .
10. To isolate pure colonies of bacteria.
11. To study bacteriological analysis of water e.g., fecal pollutants.
12. To isolate total RNA from yeast.
13. To study the developmental stages of Frog.
14. To study the developmental stages of Chick.
15. To prepare Sauerkraut.
16. To prepare ginger wine.
17. To prepare grape wine.
18. To study production of citric acid.
19. To estimate citric acid produced.
20. To study the chick embryo culture.
21. To study the Life cycle of Drosophila.
22. To study the sex chromatin.
23. To prepare slide of salivary gland ,polytene chromosome from drosophila larva.
24. To study various meiotic stages in Grass hopper – (testes –squash preparation).

MZO 021A: PROJECT

Credit(s): 14

A student will be assigned a topic for the project at the beginning of semester IV. The student is expected to complete the major literature survey during the semester IV and present a tentative research plane in the end of the first month of the semester IV. The candidate will do the experimental work during semester IV under the supervision of a guide and submit the result in the form of the thesis at the end of semester IV.

MZO 022A: Seminar

Credit(s): 2