



**Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara (Autonomous)**

**Under Choice Based Credit System (CBCS)
(June 2019-2020)**

SYLLABUS

For

M. Sc. Zoology

(Semester Pattern)

M. Sc. II Sem. III to IV

Academic flexibility with credit system to be implemented

From

June, 2019 onwards

1. TITLE:Zoology

2. YEAR OF IMPLEMENTATION: 2019 – 2020

3. PREAMBLE:

M. Sc. Zoology course under autonomy has been prepared keeping in view the unique requirements of M. Sc. Zoology students. The prominence of the contents is to provide students the latest information along with due weightage to the concepts of traditional zoology so that they are able to understand and appreciate the current interdisciplinary approaches in the study of animal sciences and its role in societal and environmental development. The course content also advanced practical exercises so the students gets a hands on experience of the newest techniques that are currently in use. Project curriculum covering over the two years of the course which is designed in a way that, to give the students first hand research experience as it consists of writing of synopsis, literature review along with actual laboratory work and handling laboratory instruments. The course will also encourage students to hunt higher studies and research in life sciences, for becoming an entrepreneur and enable students to get employed in research institutes.

4. GENERAL OBJECTIVES OF THE COURSE:

- To impart the knowledge of animal science is the basic objective of the course.
- To develop scientific attitude among the students and to make the students open minded, enthusiastic, critical and curious so that they enter research field with a positive approach.
- To develop skill in practical work, experiments and handling laboratory instruments.
- To understand scientific terms, concepts, facts, phenomenon and their relationships.
- To make the students aware of natural resource, diversity, environment up to cell biology.
- To enable the students to acquire knowledge of animal cells and different molecules as well as genetics for the wellbeing of human.
- Enrichment of basic knowledge of techniques in zoology, bioinformatics and genetics.

5. DURATION:02 year

6. PATTERN:CBCS Semester

7. MEDIUM OF INSTRUCTION:English

Course Structure

M. Sc. II

Semester III

Sr. No.	Paper code and Name	Theory (TH)	
		Lecture	Credits
1	MZT 301 Genetics	4	4
2	MZT 302 Enzymology	4	4
3	MZT 303 Computational Molecular Biology	4	4
4	MZT 304 Molecular Biology Of Gene	4	4
5	MZP 305	4	4
6	MZP 306 + Project	4	4
Total Semester III		24	24

- Total Credit For M. Sc. II Semester III – 24 Credits
- Total Marks for M. Sc. II Sem. III - 600

Semester IV

Sr. No.	Paper code and Name	Theory (TH)	
		Lecture	Credits
1	MZT 401 Animal cells in Biotechnology	4	4
2	MZT 402 Toxicology and Immunology	4	4
3	MZT 403 Cell In Differentiation, Development & specialization	4	4
4	MZT 404 Cell Pathology	4	4
5	MZP 405	4	4
6	MZP 406+ Project	4	4
Total Semester IV		24	24

- Total Credit for M. Sc. II Semester VI – 24 Credits
- Total Marks for M. Sc. II Sem. VI – 600
- Total Marks for M. Sc. part II - 1200

Evaluation Structure for M. Sc. Zoology

Evaluation pattern for M.Sc.I : Semester – I from academic year 2020-21

Paper Code	Theory		Practical		Total
	ESE	ISE	ESE	ISE	
Theory Paper-I	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20 (Book Review) Total =40	---	---	100
Theory Paper-II	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20 (CIII online course) Total =40	---	---	100
Paper-III	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20 (Survey / Seminar) Total =40	---	---	100
Theory Paper-IV	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20(Group discussion / Innovative idea presentation) Total =40	---	---	100
Practical Paper-I	---	---	60	Journal=10 Student Performance=10 Activity = 20(case study / Survey report) Total=40	100
Practical Paper-II	---	---	60	Journal=10 Student Performance=10 Activity = 20(Model Presentation / Project –Part I) Total=40	100
Total	240	160	120	80	600



M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-III

MZT 301 Genetics

Credit: (Theory – 04 Practical - 04) Theory Lectures: 60

Learning objectives:

- This will provide understanding of the inheritance and expression of various genes.
- An understanding of the clinical relevance of genetic concepts.
- To understand the chromosome structure, chromatin organization and variation
- To analyze strategies of gene transfers
- To learn the concepts of Linkage concept of sex determination and sex linked inheritance
- This syllabus will provide the student with knowledge and understanding of the role and application of genetics with learning difficulties and the implications to other family members

Unit- I Chromosomal variations

1. Human Karyotypic analysis- normal and abnormal chromosomes, banding, nomenclature
2. Genetics basis of sex determination in human beings Y linked genes, X linked genes, Dosage compensation, and testicular feminization Syndrome.
3. Numerical abnormalities of human chromosomes and related syndrome Nondisjunction, Aneuploidy, Patau syndrome, Edward syndrome, Down syndrome, Turner syndrome and Klinefelter syndrome
4. Structural abnormalities of human chromosomes and related syndromes Robertsonian Translocation
5. Linkage groups, genetic maps, crossing over, genetic recombination.
6. Chromosome painting

Unit- II- Population and Evolutionary Genetics

1. Genetic variation in natural population, phenotypic variation
2. Hardy- Weinberg principle, Genetic drift, Genetic pool
3. Models of Speciation Measurement of Genetic variations
4. Use of Molecular techniques to study genetic evolution.
5. Human Behavioral genetics

Unit- III- Mutations

1. Introduction to the mutation, mutation and environment, Spontaneous versus induced mutation.
2. Phenotypic effects of mutations.
3. Somatic and germinal mutation.
4. Pleiotropy,
5. Back mutation and suppressor mutation

6. Molecular basis of genetic mutation
7. Chemical induced mutation
8. Mutation and DNA repair mechanism
9. Mutation frequency
10. Practical application of genetic mutations
11. Mutagenicity and carcinogenicity.
12. Mutations and human welfare

Unit- IV- Basis of genetic counseling and developmental genetics

1. Ethical and psychological approach of genetic counseling
2. Avoidance of risk factor with genetic diseases, prenatal genetic counseling and diagnosis.
3. Family pedigree, Genetic inheritance and investigations
4. Developmental genetics –Developmental anomalies in case of human –Inborn errors of metabolism
5. Socio-economic importance of developmental genetics.

Learning outcomes –

1. Students will be able to define genetic terms and explain their clinical relevance
2. They will be able to Describe the inheritance and expression of human blood groups
3. The significance of a knowledge of genetics in medical field related to anomalies of inborn errors
4. They will know the importance of inheritance of genetic characters in any individual and will be able to interpret the factors responsible for that
5. They will understand the role of genetic counselor in life.
6. They will explore the changes in genes caused due to different types of mutations taking place in body due to environmental and evolutionary changes.

Reference Books:

1. Genetics of population by Philip Hedrick (Unit I & IV)
2. Principles of Population Genetics By Hartl and Clark (Unit II)
3. Gene Clones by Ernst Winnacker (Unit I)
4. Fundamentals of genetics by B. D. Singh. (Unit I)
5. Principles of genetics 8th edition by Gardner, Simmons and Snustad. (Unit III)
6. Molecular Biology by David Clark (Unit I & IV)
7. Concepts of Genetics By Klug and Cummings (Unit I, II, III & IV)
8. Principles of Genetics By Tamarin (Unit I, II & III)
9. Genetics By Strickberger (Unit I & IV)
10. Facts of Genetics By Robert Edger (Unit I & IV)
11. Introduction to biochemical genetics By Mather and Jinks (Unit I & II)
12. Molecular Genetics By Gunther Stint (Unit I, II, III & IV)

M.Sc.-Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-III
MZT 302 – Enzymology
Credit: (Theory – 04 Practical - 04) Theory Lectures: 60

Learning objectives -

- To provide knowledge of different enzymatic reactions occurring in the body which is beneficial.
- To classify the enzymes and investigate the structure and role of enzymes in body.
- To know the importance of various enzymes in fundamental life processes and its kinetics.
- To deal with current applications and future potential of **enzymes** process.

Unit- I: Classification and Nomenclature of Enzymes, Isoenzymes, Multienzyme Complexes.

1 Cofactors.

2 Inorganic.

3 Organic: Pyridoxyl Phosphate, Biotin, Lipoic acid, Thiamin diphosphate, Flavin nucleotides, Nicotinamide.

Unit- II: Extraction and Purification of Enzymes.

1. The extraction of soluble enzymes.

2. Extraction of membrane bound enzymes.

3. The nature of the extraction medium.

4. Preliminary purification procedures

5 Further purification procedures.

6 Criteria of purity.

7 Determination of molecular weight of enzymes.

Unit- III: Enzyme Kinetics.

1. Relationship between initial velocity and substrate concentration.

2. Michaelis Mentene equation.

3. Briggs Haldane Hypothesis.

4. The Line Weaver Burk Plot.

5. The Halden relationship for reversible reaction

6. Effect of Modifiers on enzyme Kinetics.

7. Effect of temperature.

8. Thermal denaturation.

9. Effect of pH.

10. Enzyme Actions of-

11. Chymotrypsin.

12. Fructose biphosphate aldolase

Unit- IV: The control of Enzyme Activities by Non Genetic Mechanism.

1. Enzymes in Organized System.
2. RNA nucleotidyltransferase.
3. The Pyruvatedehydrogenase.
4. EnzymeTechnology.
5. Use of isolated enzymes in industrialprocesses.
6. Immobilizedenzyme.

Learning outcomes –

1. Student will be able to classify the enzymes according tonomenclature
2. They will be to explain the function of various enzymes and their factors related to it
3. They will learn the and understand the enzyme kinetics and effect of different factors on enzyme action,
4. They will know the different processes of extraction and purification off enzymes.
5. They will explore the recent advances in the enzyme technology in the industrial process.

Reference book–

1. Methods in Enzymology all volumes.(Unit I, II, III &IV)
2. Scopes, R.K. Protein Purification, Principles and Practice. (UnitII)
3. Ferdinand, W. (1976) fundamentals of enzyme kinetics, Butterworths, London. Enzyme by Palmer.(Unit III)
4. Fundamentals of Enzymology: Price N.C. and L. Stevens e.. Oxford, New York. Dixon, M., Webb, E.C; et al. (3rd Ed.) Longman, London.(UnitI)
5. Niggins, I.J. Best D.J. and Jones, J. Biotechnology – Principles and applications, Black well, scientific oxford (1985).(UnitIV)
6. Bullock, J. and Kristiansen, B- (1987) Basic biotechnology.(UnitIV)
7. Palmer and Bonner- Enzyme biochemistry, biotechnology and clinical chemistry 2nd edition.(Unit I, II, III &IV)

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-III
Cell biology – Elective Paper- I
MZT 303 Computational Molecular Biology

Learning objectives –

- To impart knowledge to students to develop keen interest in molecular biology and genetics, information technologies and computerscience.
- This syllabus will provide students the information of sequences of DNA which will help in the research
- This will help them to understand diagnosis of diseases with the help of new emerging technique in the bioinformatics.
- knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
- to improve the problem-solving skills, including the ability to develop new algorithms and analysis methods

Unit –I: Advanced molecular techniques

- 1 DNA physical, chemical, biological properties
- 2 DNA sequencing, whole genome analysis techniques, next gen sequencing method, PCR, Nucleic acid hybridization technology, DNA libraries
- 3 RNA sequencing and Protein sequencing
- 4 Gene Structure Prediction of open reading frame, 6 frame translation
- 5 Genomic markers- RAPD, RFLP, SNP, EST.

Unit –II: Sequence comparison methods & search algorithms:

1. Searching sequence databases by sequence similarity. (Nucleic acid and proteins).
2. Pairwise alignment techniques – local and global sequence alignment Needleman-Wunsch algorithm, Smith-Waterman algorithm.
3. Multiple sequence alignment, consensus sequences.

Unit –III: Phylogenetic and Sequence annotation

1. Phylogenetic, Cladistics and Ontology
2. Building Phylogenetic trees
3. Evolution of macromolecular sequences
4. Principles of genome annotation
5. Annotation tools and sequences

Unit –IV: Structural bioinformatics.

1. Conceptual models of protein structure
2. The evolution of protein structure and function
3. Obtaining and viewing and analyzing structural data
4. Structural alignment
5. Classification of protein to known CATH and SCOP
6. Structure prediction by comparative modeling
7. Secondary structure prediction

8. Advanced structure prediction and prediction strategies

Learning outcomes –

- They will gain the insight of advanced molecular techniques of DNA sequencing.
- They will be able to describe various sequence comparison methods and related algorithms.
- Students will be able to use online tools and software for various molecular sequence analysis and investigate the phylogenetic relationship also.
- They can explain the various and analyses the structure and function of protein structure with the help of proteomics through software related to it.
- They will gain the knowledge of structural and functional relationships, and molecular evolution.

Reference Books:

1. Introduction to Bioinformatics (2002) – AM Lesk Pub. By oxfordUniversity Press.(Unit I, II, III &IV)
2. Bioinformatics – A practical guide to the analysis of genes & proteins (2001) = Edby A.D. Baxevanis& B.F, Francis Ouelletele pub. By A JahnWiley&sons publication, New York.(Unit I, II, III &IV)
3. Introduction to Bioinformatics (2002) – AM Lesk Pub. By oxfordUniversity Press.(Unit I, II, III &IV)
4. Bioinformatics – A practical guide to the analysis of genes & proteins (2001) = Ed by Baxevanis& B.F, Francis Ouelletele pub. By A JahnWiley&sons publication, New York. (Unit I, II, III &IV)
6. Introduction to Bioinformatics (2003) T.K. Atwood & D.J. Parry smith.(Unit I, II,III &IV)
7. Instants notes :Bioinformatics (2003) West head D.R. Parish J.H.&Twyman R.M. Pearson Education (Cell & Molecular biology in action series).

M. Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-III
Cell Biology – Elective Paper – II
MZT 304-Molecular Biology of Gene

Learning objective:

- This syllabus will improve knowledge of basic concept in genetics alongwith advanced techniques in molecularbiology.
- This will impart basic understanding of fundamental molecular processes
- Student will gain knowledge of genes and their expression at nuclear level.
- Students will gain -depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecularmechanisms.

Unit I: Fundamentals of Molecular Biology

1. Chromosome as a carrier ofgenes
2. DNA replication (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons) andrecombination (Homologous and site specificrecombination)
3. Replication error and repair.

Unit II: Genes, Genomics and Chromosome.

2. Transposable DNA elements a)DNA Transposones
b) LTRRetrotransposons
c) Non LTR Retrotransposons (SINES andLINES)
3. OrganellesDNA
a) Mitochondrial DNA
b) ChloroplastDNA
4. Genomics- Genome wide Analysis of Gene Structure and Expression (With model organism as example, organization structure and mapping ofgenome)
5. Morphology and Functional Elements of Eukaryotic Chromosomes)
Chromosome number, size and shape atmetaphase

Unit III:

1. Gene and itsexpression:
a) Concept of gene
b) Transcriptional control of gene expression in prokaryote (Lac, trp operon).
2. Transcriptional control of gene expression in eukaryotes:
a) RNA polymerases and genecontrol.
b) Regulatory sequences in protein coding gene.
c) Activators & Repressors of Transcription.
d) Regulation of transcription factor activity.
e)Regulation of elongation and termination oftranscription.
f) DNA binding motifs in gene regulatoryproteins.

2. Post transcriptional gene control and nuclear transport:

- a) Processing of prem-RNA.
- b) Regulation of prem-RNA processing.
- c) Macromolecular transport across the nuclear envelope.
- d) Cytoplasmic mechanisms of post transcriptional control.
- e) RNAs in gene regulation (RNA interference, siRNA, miRNA mechanism)

Unit IV: Signaling pathway that control gene activity.

1. TGF β receptors and the direct activation of smads.
2. Cytokine receptors and the JAK-STAT pathway.
3. Receptor tyrosine kinase and activation of Ras.
4. MAP kinase pathways

Learning outcome –

1. Student will gain an understanding of chemical and molecular processes that occur in and between cells
2. Student understanding will become such that you will be able to describe and explain processes and their meaning for the characteristics of living organisms
3. They will be able to explain signaling pathways undergone by different cells
4. They will learn about the role of gene regulation in the proper working of the organ system of the body.

Reference books:

1. An introduction to genetic engineering By Desmond S.T. Nicholl (Unit I, II, III & IV) Genes by Benjamin Lewin.(Unit I, II, III & IV)
2. Molecular Biology of the gene by Watson (Unit I, II, III & IV)

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-III
MZP 305
Practical based on MZT 301 & MZT 302

❖ **Learning Objective:**

Student will able to

1. understand of the inheritance and expression of various genes.
2. An understanding of the clinical relevance of genetic concepts.
3. To classify the enzymes and investigate the structure and role of enzymes in body.
4. To know the importance of various enzymes in fundamental life processes and its kinetics.

- 1 Human lymphocyte culture.
2. Preparation of metaphasic chromosomes from human lymphocyteculture.
3. Study of human chromosomes explaining aspects of chromosomestructure.
4. Study of human normalkaryotype.
5. Manual preparation of human karyotype from metaphasicchromosomes.
6. Assessing quality and quantity ofmetaphases.
7. Harvesting of mitotic chromosomes from rat bonemarrow.
9. Study of X chromosome heterochromatinization by Barr body staining.
10. G banding of rat chromosomes/Humanchromosomes.
11. Preparation of chromosomeideogram.
12. Karyotype identification with reference to Patau syndrome, Edward Syndrome,Down syndrome, Klinefelter syndrome and Turner syndrome(from photographs).
13. Identification of cases of Patau syndrome, Edward Syndrome, Down syndrome Klinefelter syndrome and Turner syndrome from photographs bymorphological/ Symptomatic features
14. Principle of Fluorescence In Situ Hybridization, Interpretation of results FISH for Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome(from photographs).
15. Drosophilaculture
16. Sexual dimorphism inDrosophila
17. Study of heritable characters inDrosophila
18. Examples based on Hardy-WeinbergEquilibrium
19. Symbols used in Pedigreeanalysis
20. Studies of Human pedigrees concerned with autosomal recessive disorders, autosomal dominant disorders, X linked dominant disorders and X linkedrecessive disorders.
21. Clinical test for Phenylketonuria by Guthrie test /Ferric chloridetest
24. Estimation of proteins.
25. Estimation of Amylase/any other suitable enzyme.

26. Effect of pH on Amylase activity/any other suitable enzyme.
27. Effect of temperature on Amylase activity/any other suitable enzyme.
28. Michaelis–Menten constant determination for Amylase/ any other suitable enzyme.
29. Effect of modifiers on enzyme activity/Thermo ability of enzyme.
30. Isolation of Amylase or any other enzyme.
31. Anyother practical set by the Department.
33. Catalase estimation using H₂O₂ as substrate
34. SDS-PAGE Electrophoresis

AT LEAST 12 EXPERIMENTS TO BE COVERED IN THE SEMISTER FROM GENET

Learning outcomes –

1. Student will be able to classify the enzymes according to nomenclature
2. They will be to explain the function of various enzymes and their factors related to it
3. They will learn the and understand the enzyme kinetics and effect of different factors on enzyme action,
4. They will know the different processes of extraction and purification of enzymes.

Suggested Readings:

1. Genetics of population by Philip Hedrick
2. Principles of Population Genetics By Hartl and Clark
3. Gene Clones by Ernst Winnacker
4. Fundamentals of genetics by B. D. Singh.
5. Principles of genetics 8th edition by Gardner, Simmons and Snustad.
6. Molecular Biology by David Clark.
7. Concepts of Genetics By Klug and Cummings.
8. Principles of Genetics By Tamarin.
9. Genetics By Strickberger
10. Facts of Genetics By Robert Edger
11. Introduction to biochemical genetics By Mather and Jinks.
12. Molecular Genetics By Gunther Stint.
13. Methods in Enzymology all volumes.
14. Scopes, R.K. Protein Purification, Principles and Practice.
15. Ferdinand, W. (1976) fundamentals of enzyme kinetics, Butterworths, London.
Enzyme by Palmer.
16. Palmer and Bonner- Enzyme biochemistry, biotechnology and clinical chemistry
2nd edition

M. Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-III
MZP 306
Cell Biology Practical-I
Practical based on MZT 303 & 304

Learning Objective:

1. Example based on DNAsequencing.
2. Example based on RNAsequencing.
3. Example based on Protein sequencing & SS bond prediction, trans membrane & signal peptide sequence prediction.
4. Examples based on Geneticcode6 frame translation atframes.
Codon preference base translation frames.
Open reading framesearch.
5. Database search- NCBI, DDBJ, EMBL, BRENDA, KEGG, Uni Prot.
6. Primary sequence analysis of proteins- ProtPARAM
7. Secondary structureprediction
8. Tertiary structureanalysis
9. Pairwise sequence alignment- FASTA,BLAST,
10. Multiple sequence alignment-ClustalOmega
11. Phylogenetic analysis- byMEGA.
11. Metaphasic chromosome preparation from bone marrowcells.
12. C-band of metaphasicchromosomes.
13. Isolation and estimation of DNA &RNA.
15. Demonstration of RNA (by RNase digestion &TBpH 3.5) &estimation.
18. Estimation ofHistones.
9. Demonstration of Histones.
20. Estimation of phosphate from isolated nucleicacids.
21. Visualization of isolated DNA on Agarose gelElectrophoresis.
22. Estimation of DNA using Gel –DOC.
23. Polymerase Chain Reaction.
24. Any other experiments / practicals set by theDepartment.

SuggestedReadings:

1. Introduction to Bioinformatics (2002) – AM Lesk Pub. By oxford University Press.
2. Bioinformatics – A practical guide to the analysis of genes & proteins (2001) = Ed by A.D. Baxevanis & B.F, Francis Ouelletele pub. By A Jahn Wiley & sons publication, New York.
3. Introduction to Bioinformatics (2003) T.K. Atwood & D.J. Parry smith.
4. Instants notes – Bioinformatics (2003) West head D.R. Parish J.H. & Twyman R.M.
5. Genes by Benjamin Lewin.
6. Molecular Biology of the gene by Watson
7. An introduction to genetic engineering By Desmond S.T. Nicholl

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc. II Sem. IV
MZT 401 Animal Cells in Biotechnology

Learning Objective:

1. Student are introduced with the different animal cells used for tissue culture
2. To Understand the use and limitations of in vitro cell analysis
3. To Understand the basic requirements for a tissue culture laboratory
4. To Understand the basic techniques of tissue culture, sterile technique, contamination analysis, bio-waste, cell storage

Unit I:

1. Laboratory design and introduction of cells:

1. Design of Tissue Culture Laboratory
 - Equipment: Laminar Flow Hoods, CO₂ incubator, Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous Equipment.
2. Glass wares/plastic wares and filters for tissue culture.
3. Basic Aseptic Techniques
4. Cryopreservation for Storage and shipment
5. Primary cell culture, Established cell line, transformed cell line

Unit II:

2. Growth media

1. Physical requirements and Nutritional Requirements of Cells
Natural media
Basal salt solution (BSS)-Various types
Minimum Essential Medium (MEM)
Antibiotics in media
Serum dependent defined media
Serum independent defined media – Cell specific media

3 Basic Techniques of mammalian cell culture

1. Primary Cell culture – Isolation and separation of cells, viable cell count, maintenance of cell culture, maintenance of stock culture, Antibiotic free stock cultures
2. Types of cell cultures – Monolayer, Suspension, Clonal culture, Mass culture-micro carrier culture (monolayer), Stem cell cultures (ESC)

Unit III:

5. Biology and Characterization of cultured cells

- Karyotyping
Contamination Testing of Culture
Viability measurement and cytotoxicity, **MTT assay**
Measurement of growth parameters
Cell cycle analysis and Synchronization of cultures

6. Uses of Animal Cells in Culture

- Evaluation of Chemical carcinogenicity, Cell malignancy Testing
Uses of Embryonic stem cells and Pluripotent stem cells

Unit IV:

7. Cell surgery and Cell Fusion Methods

Surgical manipulation of *in vitro* fertilization

Cell fusion by Sendai virus and Polyethylene glycol

Hybridoma cell preparations and their properties

Tissue Engineering

Capillary culture Units

Techniques for culturing differentiated cells: Use of Reconstituted basement membrane rafts and use of feeder layers.

Learning outcomes -

- Student will be able to explain the differences between primary and cell line cultures
- Student will get Brief understanding of cell growth requirements
- Brief understanding of analytical techniques
- They will be able to know the cell fusion techniques and different methods of maintaining the contamination free culture.

Reference:

1. Freshney, R.I. Culture of Animal Cells : A manual of Basic Technique, 1994, John Wiley & Sons Inc. Pub. USA. (Unit I)
2. Butler, M. Mammalian Cell Biotechnology: A practical Approach 1991 IRL Press Oxford. (Unit I, II, III & IV)
3. Cell Culture: Methods in Enzymology, vol. 58/1979/recent volume. Academic Press. Kuchler, R. J. Biochemical Methods in Cell Culture & Virology 1977. Dowden, Hutchinson & Ross, Inc. Strausberg, USA (Unit I, II, III & IV)
4. Morgan, S.I. Animal Cell culture 1993 Bio. Scientific Publishers Ltd Oxford.
5. Butler, M. Mammalian Cell Biotechnology.: A practical Approach 1991 IRL Press Oxford. (Unit I, II, III & IV) Jenni P. Mather & David Barnes Eds: Animal Cell Culture Methods .Methods in Cell Biology Vol. 57 Academic press. (Unit I, II, III & IV)
6. Ranga M.M.- Animal biotechnology 2nd edition. (Unit I, II, III & IV) Dubey R.C.- Advanced biotechnology (Unit I, II, III & IV)

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc. II Sem. IV
MZT 402 Toxicology & Immunology

Learning objectives –

- To provide knowledge of how chemicals spread, accumulate and impact on Nature and people
- Introduces you to the principles of toxicology, with particular emphasis on the principles governing toxic responses to chemical exposures, including the disposition of toxicants, and the nature and effect of toxicity.
- Student will gain knowledge about the immunological techniques for the detection of various diseases.
- I will impart knowledge of antigens and structures of antibodies within body

Unit I

Concept and Scope of Toxicology: Definition, History, Recent development, Disciplines of toxicology. Classification of toxicants, toxic effects, principle aspects and importance of toxicology.

Toxicity Tests: Types of toxicity tests, acute, sub acute and chronic toxicity tests and their objectives, experimental design, route of administration, doses and number.

Bioassays i.e. determination LD₅₀ or LC 50 value using fish/mollusk/ insects graphical and statistical methods (**Probit analysis**).

Unit- II

Insecticides and metals toxicity- Synthetic organic insecticides, their classification, prospectus effects, symptoms mechanism of toxic action of Organochlorine, Organophosphate, Carbamate and synthetic Pyrethroids insecticides, toxic metals-Arsenic, Lead, Mercury and Cadmium, their toxic effects on animals and toxic kinetics.

Bio-accumulation and bio magnification toxicants- Organochlorine insecticides and heavy metal mercury.

Bio-transformation of toxicant- Organochlorine and Organophosphate insecticides i.e. Metabolism of insecticides-DDT, BHC, Parathion and Malathion- Mechanism Phase I and Phase II reaction.

Food Toxicants- Food additives, Contaminants, adulterants, food poisoning due to bacterial fungal and algal toxins.

Immunology

Unit –III:

Antigens: Antigenicity and immunogenicity, Factors influencing immunogenicity, Epitopes,

Antibody: Basic structure of antibodies, obstacles to antibody sequencing, Immunoglobulin fine

structure, Antibody classes and biological activities. MHC molecules: Genomic map of MHC genes, Regulation of MHC expression, MHC and immune responsiveness, T cell, B cell antigenic properties, cytokines and therapeutic use of cytokines.

Unit –IV:

Innate immunity: Anatomy, physiologic, phagocytic and inflammatory, Adaptive immunity: e played Antigenic specificity, diversity, immunologic memory, self and non-self-recognition, hypersensitive reactions, IgE mediated (Type I) hypersensitivity, Antibody mediated cytotoxic (Type II) hypersensitivity, and Immune complex mediated (Type III) hypersensitivity, Delayed type (Type IV) hypersensitivity. T cell mediated cytotoxicity, vaccine development (recombinant, combined, polyvalent vaccine), cancer immunology, immunological techniques- ELISA, RIA, Monoclonal antibodies, and immunohistochemistry.

Learning outcomes –

- Student will be able to understand the concept and scope of toxicology
- They will be able to define various toxicological terms
- They will understand different toxicity test and their lethal concentration and doses affecting various bodies
- They will be able to describe types of immunity and role played by immunological cells
- Student will have clear concepts of vaccines and their development, and knowledge of various immunologic techniques for identification of diseases by Ag-Ab reaction.

References Book

1. Clark W.R.. Experimental functions of Modern Immunology. Immunobiology - Charles A. Janeway and others – 2001. (Unit III & IV)
2. Pandey Kamleshwar. Shukla J.P. and Trivedi S.P. (2005): Fundamentals of Toxicology. New Central book agency PVT. LTD. Kolkata. (Unit I & II)
3. Thomas J.H. and William O.B. (1987): Handbook of Toxicology. (Unit I & II)
4. Roiff, I Brosfott, J and Male D – Immunology. (Unit III & IV)
5. Sharma, J.M. : Avian Cellular Immunology. Karger and Basel: The year of Immunology 1988. (Unit III & IV)
6. Zapata A.G. and Cooper, E.L. The immune system. (Unit III & IV)
7. Smialowicz R.J. and Holsapple Michael. Experimental Immunology toxicology. (Unit III & IV)
8. Laurie Hoffman – Goetz : Exercise and immune function (Unit III & IV)
9. Chris Kent (2001) : Basics of Toxicology (Unit I & II)
10. Devid J.K. and Kit A.K. (2006): Toxicological testing handbook 2nd Ed. (Unit I & II)
11. Gupta P.K. and Salunkhe D.K. (1985): Modern toxicology (Vol. I, II & III) Pandey, Shukla and Trivedi (2004): Fundamentals of Toxicology. (Unit I & II)
12. Kuby Immunology, WH Freeman, USA. (Unit III & IV)
13. W Paul Fundamentals of Immunology. (Unit III & IV)
14. I.M. Roitt, Essential Immunology, ELBS edition. (Unit III & IV)

M. Sc. Zoology
Academic Flexibility, Credit System

M.Sc.-II Sem.-IV
Cell Biology Elective Paper- III

MZT 403: Cell in Differentiation, Development & specialization

Learning objectives –

- To give deep knowledge of cell development and its differentiation at embryonic level.
- To impart basic understanding of molecular processes in the conversion of a specialized cell
- To clear the concepts of different developmental processes from the beginning of multicellular organisms'
- They will gain knowledge of structure and function of different cell types.

Unit I: Differentiated cells and maintenance of tissues:

1. Differentiated State
2. Tissues with Permanent cells (Eye lens, photoreceptor cells of retina)
3. Renewal of Cells by Mitosis (Liver cell, endothelial cells)
4. Renewal of Cells by Stem cells (Skin epithelium, intestinal epithelium)
5. Renewal of cells by pluripotent stem cells (Blood cell formation)

Unit II Development of multicellular organism

1. Universal mechanism of animal development.
2. Drosophila and the molecular genetics to pattern formation: Genesis of the body plan.
3. Homeotic selector genes and the pattern in of the anterior posterior axis.
4. Organogenesis and patterning of appendages.
5. Cell movement and the shaping of the vertebrate body.

Unit III:

1. Muscle as a cell and contraction unit:

- a. Genesis, modulation and regeneration of skeletal muscle.
- b. Fibroblasts and their transformations- The connective tissue cell family.
- c. Bone remodeling.

2. Mammalian neurons:

- a) Neurons: Building Blocks of the nervous system
- b) Voltage-gated Ion Channels and the propagation of action potential in nerve cells
- c) Communication at synapses

Unit IV

1. Pancreatic Cells
 - a. Acinar Cells
 - b. Islets of Langerhans
 - c. Ductal Cells
2. Pituitary Cell Type

3. Neurosecretory Cells
4. Corneal Endothelial cells
5. Hepatoparenchymal cells

Learning outcomes –

- Student will be able to get knowledge of stem cells and their renewal system.
- They will be able to describe the cell development processes in the multicellular organisms
- They can know the function of various cell by studying the mutation pattern in them
- They can explain and define various cell types, their structure, location and function of cell.

Reference Books:

1. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley & sons. (Unit I & II)
2. Molecular cell biology by Lodish, Berk, Matsudaira, Kaiser, Krieger (2004) published by W. H. Freeman & company, New York. (Unit I, II, III & IV)
3. The Cell by Bruce Alberts, published by Garland publishing Inc. New York & London (Unit I, & II)
4. Developmental Biology By Gilbert (Unit II & III)
5. Cell & Molecular Biology by E.D.P. De Robertis. (Unit I, II, III & IV)
6. Human physiology- Guyton and Hall. (Unit III & IV)

M. Sc. Zoology
Academic Flexibility, Credit System
M. Sc. II, Semester – IV
Cell Biology Elective Paper- IV
MZT 404: Cell Pathology

Learning objective –

- To provide deep knowledge of reasons of cellular stress and death process in body.
- To make them understand the programmed cell death and aging process in detail.
- To give them knowledge of cancer cells and factors responsible for it
- To impart the basic understanding of study of Viruses and damage caused by them and pathological changes caused due to them.
- To give them knowledge of effect of various antibodies at cellular level.

Unit I: Cell in stress and death

1. Different types of stressful conditions on cell and cell response
2. Cell death and its regulation: Apoptosis-molecular mechanism and regulation
3. Cell organelles during cell degeneration/necrosis

Unit II: Cancer Biology

1. Tumor cells and onset of cancer
2. The genetic basis of cancer
3. Oncogenic mutations in growth promoting proteins
4. Mutations causing loss of growth inhibiting and cell-cycle control
5. Carcinogens and cancer genes
6. Cancer targeted treatment

Unit III: Ageing

1. Mechanism of ageing (Theories of ageing)
2. Cellular changes during ageing
3. Molecular changes during ageing
4. Immunological changes during ageing
5. Accumulation of toxins and chemical garbage, formation of lipofuscin granules
6. Ageing and cell cycle
7. Strategies against ageing
8. Antiaging treatment by medicinal plants

Unit IV:

A. Effects of inhibitors

1. DNA synthesis (Mitomycin)
2. RNA synthesis (Actinomycin and Rifampicin).

3. Protein synthesis(Cyclohexamide,Tetracyclins,Chloramphenicol, streptomycins).
4. Mitochondrial metabolism (CN, CO, Actinomycin –A, Azideetc.)

B. Animalviruses:

1. RNA viruses – Polio (+ strand RNA),VSV (-RNA), influenza (segmentedRNA),HIV
2. DNA virus (SV40-ds DNA with circulargenome), adenovirus (linear dsDNA genome), parvo virus (ssDNA virus),Ebola virus

Learning outcomes –

- 1) Student will be able to explain the reasons behind cellular stress and death.
- 2) They will be able to differentiate the normal and abnormal properties of cell
- 3) They will be able to explain the pathological changes in cell caused due to viral infections and understand the detailed structure and replication cycle of viruses.
- 4) They can describe the mode of action of various inhibitors on body at cellular level.

Reference Books:

1. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley&sons.(Unit I, II, III &IV)
2. Molecular cell biology by Lodish, Berk,Matsudaira,Kaiser,Krieger(2004)published by W.H. Freeman & company, New York.(Unit I, II, III &IV)
3. Lewin's cell 2nd edition by Lewin.(Unit I &II)
4. Metabolic Inhibitors Vol. I –IV.(UnitIV)
5. Molecular Biology of gene by JamesWatson (Unit I &II)
6. The Cell by Bruce Alberts, published by Garland publishing Inc. New York &London.(Unit I, II, III &IV)
7. Laboratory Investigation –Vol.14, 1965.(Unit I, II, III &IV)
8. Inhibitors of nucleic acid synthesis by Kersen & Kersen.(Unit IV)
9. Inhibitors of Protein Synthesis FBII publication.(UnitIV)

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-IV
MZP 405
Practical based on MZT 401 & MZP 402

❖ **Learning Objective:**

Student will be able to

- ❖ Understand toxicity assay.
- ❖ Understand the detection technique of pesticides.
- ❖ understand the immunological techniques for the detection of various diseases.
- ❖ Understand the use and limitations of in vitro cell analysis
- ❖ Understand the basic requirements for a tissue culture laboratory
- ❖ Understand the basic techniques of tissue culture, sterile technique, contamination analysis, bio-waste, cell storage

1. Preparation of glassware for cell culture.
2. Preparation of cells that do not need enzyme digestion (RBC, Spleen lymph nodes, B.M.)
3. Isolation of cells by enzyme digestion
4. Separation of cells by suitable methods
5. Viable cell count (Trypan Blue)
6. MTT assay
7. Primary cell culture and its maintenance
8. Measurements of growth parameters- DNA
9. Cell cycle analysis – mitotic cells.
10. Karyotype studies- Bone marrow peritoneal macrophages.
11. Evaluation of acute toxicity by using static renewal bioassay test (In fish /Insect).
12. Determination of LC₅₀ of toxicant in fish / stored grain pest by employing probit analysis.
13. Effect of toxicant (sublethal dose) on fish gill and alimentary tract in fish and in insect alimentary canal haemolymph (Mulberry silkworm)
14. Detection of heavy metal from animal tissue by AAS (Lead/cadmium/chromium).
15. Detection of pesticide by TLC method from water

sample(organochlorine/ organophosphate).

16. Paw edemates
17. Granulometa – Quantification by weight and differential cell count.
18. Splenectomy.
19. Study of spleen replica for germinal centers.
20. Separation of immunoglobulin by Electrophoresis.
21. Immuno diffusion technique of agar gel diffusion.
22. RBC rosette technique.
23. Haemagglutination inhibition test.
24. Blood group analysis.
25. Histology of lymphoid organs spleen, thymus, lymph node & Bone marrow.
26. Any other practical / experiments set by the Department.
27. Antigen antibody reaction one of each type : precipitation (VDRL setup in tube or gels) WIDAL

Learning outcomes -

After completion of course

- Student will be able to explain the differences between primary and cell line cultures
- Student will get Brief understanding of cell growth requirements
- Brief understanding of analytical techniques
- They will be able to know the cell fusion techniques and different methods of maintaining the contamination free culture.
- They will understand different toxicity test and their lethal concentration and doses affecting various bodies

Suggested Readings:

1. Freshney, R.I. Culture of Animal Cells : A manual of Basic Technique, 1994, John Wiley & Sons Inc. Pub. USA.
2. Butler, M. Mammalian Cell Biotechnology: A practical Approach 1991 IRL Press Oxford.
3. Cell Culture: Methods in Enzymology, vol. 58 1979/recent volume. Academic Press.
- Kuchler, R. J. Biochemical Methods in Cell Culture & Physiology 1977. Dowden,
4. Huchinson & Ross, Inc. Strausberg, USA.
5. Morgan, S.I. Animal Cell culture 1993 Bio. Scientific Publishers Ltd Oxford.
6. Culture Methods in Cell Biology Vol. 57 Academic press.
7. Ranga M.M.- Animal biotechnology 2nd edition.

8. Dubey R.C.- Advanced biotechnology.
9. Clark W.R.. Experimental functions of Modern Immunology. Immunobiology
- Charles A. Janeway and others – 2001.
10. Pandey Kamleshwar. Shukla J.P. and Trivedi S.P. (2005): Fundamentals of Toxicology. New
Central book agency PVT. LTD. Kolkata.
11. Smialowicz R.J. and Holsapple Michael. Experimental Immunology toxicology.
12. Chris Kent (2001): Basics of Toxicology.
13. Devid J.K. and Kit A.K. (2006): Toxicological testing handbook 2nd Ed.
14. Pandey, Shukla and Trevedi (2004): Fundamentals of Toxicology.

M. Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-II Sem.-IV
MZP 406
Cell Biology Practical- II
Practical based on Paper MZT 403 &MZT 404

Learning objectives –

- To give deep knowledge of cell development and its differentiation at embryonic level.
 - To impart basic understanding of molecular processes in the conversion of a specialized cell.
 - To provide deep knowledge of reasons of cellular stress and death process in body.
 - To make them understand the programmed cell death and aging process in detail.
 - To give them knowledge of cancer cells and factors responsible for it
 - To impart the basic understanding of study of Viruses and damage caused by them and pathological changes caused due to them.
1. Mitosis in rat bone marrow.
 2. Meiosis in rat & grass-hopper testis.
 3. Meiotic non-disjunction in human (Identification based on pictures.)
 4. Nervous system development in chick embryo. Study of Angiogenesis in chick embryo.
 5. Demonstration of stem cells renewing by mitosis (liver cells Intestinal crypt cells. Bone marrow cells – demonstration of cell division by fulgure technique).
 6. Demonstration of neurons in cerebral cortex of rat.
 7. Demonstration of pituitary cells.
 8. Demonstration of pancreatic islet cells (L, B, Cell types).
 9. Demonstrations of muscle striations (PAS method, phase contrast method) smooth muscle cell observations.
 10. Demonstration of autochordria in striated & smooth muscle cells (Phase contrast & Janus green B staining).
 10. In vitro cell degeneration of liver (histology – nuclear (E+H, Fulgure alterations lysosomal by acid phosphatase alterations in rat).
 11. In vivo cell degeneration– of kidney by Induced ischemia (histology, nuclear alterations – E+H, fulgure).
 12. Age related lipid peroxidation in various organs of rat / mouse.
 13. Demonstration of lipofuscin granules in brain of aged (natural & induced) rat / mouse.
 14. Drug induced lipid peroxidation in liver & kidney (CCl₄ / any suitable drug).
 15. Any other practical / experiments set by the Department. Project work / Review article

Learning outcomes –

- Student will be able to get knowledge of stem cells and their renewal system.
- They will be able to describe the cell development processes in the multicellular organisms
- They can know the function of various cell by studying the mutation pattern in them
- Student will be able to explain the reasons behind cellular stress and death.
- They will be able to differentiate the normal and abnormal properties of cell
- They will be able to explain the pathological changes in cell caused due to viral infections and understand the detailed structure and replication cycle of viruses.

Suggested Readings:

1. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley & sons.
2. Molecular cell biology by Lodish, Berk, Matsudaira, Kaiser, Krieger (2004) published by W. H. Freeman & company, New York.
3. The Cell by Bruce Alberts, published by Garland publishing Inc. New York & London
4. Developmental Biology By Gilbert