Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)
Reaccredited by NAAC with 'A+' Grade

NEW SYLLABUS FOR

M. Sc. II

Zoology

(Semester Pattern)

M. Sc. Sem. III & IV

To be implemented from June, 2022 onwards

Course Structure

M. Sc. II

Semester III

Sr. No.	Paper code	Paper Name
1	MZT 301	Genetics
2	MZT 302	Enzymology
3	MZT 303	Computational Molecular Biology
4	MZT 304	Molecular Biology Of Gene
5	MZP 305	Practical Courses III- Lab I
6	MZP 306	Practical Courses III- Lab II

Semester IV

Sr. No.	Paper code	Paper Name
1	MZT 401	Animal cells in Biotechnology
2	MZT 402	Toxicology and Immunology
3	MZT 403	Cell In Differentiation, Development & specialization
4	MZT 404	Cell Pathology
5	MZP 405	Practical Courses IV- Lab I
6	MZP 406	Practical Courses IV- Lab II

Evaluation Structure for M. Sc. Zoology

Paper of Each Sem.	ESE	Internal Exam			Practical			Submission		Total
		ISE 1st	ISE 2nd	Activity		Exam	Journal	Project Part I / II/ III /IV	Day to Day performance	
Paper I	60	10	10	20	Practical I/ III/ V/ VII	60	10	20	10	100
Paper II	60	10	10	20						
Paper III	60	10	10	20	Practical II/ IV/ VI / VIII	60	10	20	10	100
Paper VI	60	10	10	20						
Total	240	40	40	80		120	20	40	20	600

Semester III

Course: MZT 301 Genetics

Course objectives: Student will be able to

1. Understand the karyotype of human and to identify the chromosomal abnormalities in human
2. Study the evolutionary variation in population.
3. Study of effect of mutation in organism
4. Study the genetic diseases, pedigree and counsel about congenital birth defects.

Credits (4)	MZT 301 Genetics	No. of hours per unit/ credits(60)
Credits I **Unit I**	**Chromosomal variations** 1. Human Karyotypic analysis- normal and abnormal chromosomes, banding, nomenclature 2. Chromosome painting 3. Genetics basis of sex determination in human beings 4. Y linked genes, X linked genes, Dosage compensation, and testicular feminization Syndrome. 5. Numerical abnormalities of human chromosomes and related syndrome Nondisjunction, Aneuploidy, Patau syndrome, Edward syndrome, Down syndrome, Turner syndrome and Klinefelter syndrome 6. Structural abnormalities of human chromosomes and related syndromes Robertsonian Translocation	15
Credits I **Unit II**	**Population and Evolutionary Genetics** 1. Genetic variation in natural population, phenotypic variation 2. Hardy- Weinberg principle, Genetic drift, Genetic pool 3. Evolutionary genetics 4. Synthetic theory of Evolution. 5. Evidence for adaptive evolution 6. Molecular evolution	15

Credits I **Unit III**	**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. Radiation induced mutation 8. Chemical induced mutation 9. Mutation and DNA repair mechanism 10. Mutation frequency 11. Practical application of genetic mutations 12. Mutagenicity and carcinogenicity. 13. Mutations and human welfare	15
Credits I **Unit IV**	**Basis of genetic counselling 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	15

Course outcomes: Student should be able to -

1. Identify different syndromes in human being.
2. Understand genetic variation in population.
3. Justify the possible effects of different types of mutation with the help of genetics example
4. Predict pedigree tree and initiate possible genetic counselling.

References:

1. Philip Hedrick ,Genetics of population, Jones & Bartlett; 4th edition (2010) (Unit I & IV)
2. Daniel L. Hartl and Clark, Principles of Population Genetics,OUP USA; 4th edition (31 December 2006) (Unit II)
3. Fundamentals of genetics by B. D. Singh. MedTech Science Press (2022) (Unit I)
4. Gardner, Simmons and Snustad. Principles of Genetics – Wiley; 8th edition, (2006) (Unit III)
5. David P. Clark, Nanette J. Pazdernik, Michelle R. ,Molecular Biology ,Academic Cell; 3rd edition (2018) (Unit I &IV)
6. William S. Klug , Michael R. Cummings , Charlotte A. Spencer , Michael A. Palladino, Darrell Killian ,Concepts of Genetics Plus Mastering genetics, Pearson College Div; 12th edition (What's New in Genetics) (2018) (Unit I, II, III & IV)
7. Robert Tamarin ,Principles of Genetics (2017) (Unit I, II &III)
8. Monroe W.Strickberger ,Genetics , 3ed, (2015) (Unit I & IV)
9. Robert Edger, Facts of Genetics By (Unit I &IV)
10. Introduction to biochemical genetics By Mather and Jinks (Unit I & II)
11. Peter J. Russell , iGenetics: A Molecular Approach Unknown Binding – Pearson Education India (2016) (Unit I, II, III & IV)

Course: MZT 302 Enzymology

Course objectives: Student will be able -

- To understand the types and structure of enzymes.
- To confer the different extraction and purification methods for enzymes.
- To study the different equations in enzyme kinetics.
- To understand the enzyme activities by non genetic mechanism.

Credits 4	**MZT 302 Enzymology**	**No. of hours per unit/ credits(60)**
Credits I **Unit I**	**Classification and Nomenclature of Enzymes, Isoenzymes, Multienzyme Complexes.** Cofactors. 1.Inorganic. 2.Organic: Pyridoxyl Phosphate, Biotin, Lipoic acid, Thiamine diphosphate, Flavin nucleotides, Nicotinamide.	10
Credits I **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.	17
Credits I **Unit III**	**Enzyme Kinetics**. 1. Relationship between initial velocity and substrate concentration. 2. Michaelis Menten equation. 3. Briggs Haldane Hypothesis. 4. The Line Weaver Burk Plot.	18

	5. The Halden relationship for reversible reaction 6. Effect of Modifiers on enzyme Kinetics. 7. Effect of temperate. 8. Thermal denaturation. 9. Effect of pH **10. Enzyme Actions of -** • Chymotrypsin. • Fructose bisphosphate aldolase	
Credits I **Unit IV**	**The control of Enzyme Activities by Non Genetic Mechanism.** **Enzymes in Organized System.** 1. RNA nucleotidyl transferase. 2. The Pyruvate dehydrogenase. **Enzyme Technology.** 1. Use of isolated enzymes in industrial processes. 2. Immobilized enzyme.	15

Course outcomes: Student should be able to -

1. Understand the types and structure of enzymes.
2. Demonstrate different extraction and purification methods for enzymes.
3. Analyze equations in enzyme kinetics.
4. Compare the enzyme activities by non genetic mechanism.

Reference book–

1.Methods in Enzymology all volumes. (Unit I, II, III & IV)
2. Scopes, R.K. Protein Purification, Principles and Practice. (Unit II)
3. Fundamentals of Enzymology: Price N.C.and L. Stevens e.. Oxford, New York. Dixon, M., Webb, E.C; et al. (3rd Ed.) Longman, London.(Unit I)
4. Bulock, J. and Kristiansen, B- (1987) Basic Biotechnology. (Unit IV)
5.Palmer and Bonner- Enzyme biochemistry, biotechnology and clinical chemistry 2nd edition. (Unit I, II, III & IV)

Course: MZT 303 Computational Molecular Biology

Course objectives: Student will be able -

1. To know the DNA sequencing methods.
2. To inculcate problem-solving skills, including the ability to develop new algorithms and analysis methods
3. To construct phylogenetic tree and learn their interpretation.
4. To categorize different types of proteins in structural bioinformatics.

Credits (4)	**MZT 303 Computational Molecular Biology**	**No. of hours per unit/ credits**
Credits I **Unit I**	**Advanced molecular techniques** 1. DNA sequencing – Sangers Di-deoxy method, Illumina, Nanopore, PacBio (Pacific biosciences) 2.Gene editing- CRISPR 3. Gene silencing 4. Real time PCR, 2D gel-Electrophoresis	15
Credits I **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.	15
Credits I **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	15
Credits I **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	15

	4. Structural alignment 5. Classification of protein to known CATH and SCOP	

Course outcomes: Student should be able to

1. Identify the genes from DNA sequence.
2. Apply different DNA sequencing method for searching the systematic position of an organism.
3. Perform existing software effectively to extract information from large databases and interpret the phylogenetic tree.
4. Compare the different types of structural proteins in bioinformatics

References:

1. A.M Lesk Pub, Introduction to Bioinformatics–. By oxford University Press. (2002) (Unit I, II, III & IV)
2. A.D. Baxevanis & B.F, Francis Ouelletele pub. Bioinformatics – A practical guide to the analysis of genes & proteins, John Wiley& Sons publication, New York. (2001) (Unit I, II, III & IV)
3. T.K. Atwood & D.J. Parry Smith , Introduction to Bioinformatics (2003).(Unit I, II, III & IV)
6. D.R. Parish J.H. &Twyman R.M, Instants notes : Bioinformatics West head ,Pearson Education (Cell & Molecular biology in action series). (2003)
7. Ute Schepers, RNA Interference in Practice: Principles, Basics, and Methods for Gene Silencing in C. elegans, Drosophila, and Mammals. Copyright (2005) WILEY-VCH Verlag GmbH & Co. KGaA,Weinheim ISBN: 3-527-31020-7(Unit I)
8. Muhammad Sohail, Gene Silencing by RNA Interference: Technology and Application, CRC Press; 1st edition (2004) (Unit I)
9. Magnus Lundgren , Emmanuelle Charpentier (Editor), Peter C. Fineran (Editor), CRISPR: Methods and Protocols, Springer Nature; 2015th edition (2015) (Unit I)
10. Stephen H. Tsang and George M. Church , Precision Medicine, CRISPR, and Genome Engineering: Moving from Association to Biology and Therapeutics ,Springer; 1st edn. (2017) (Unit I)
11. Jonathan Pevsner , Bioinformatics and Functional Genomics ,3rd Edition, Wiley-Blackwell; (2015) (Unit I)
12. Rui Jiang; Xuegong Zhang and Michael Q. Zhang, Basics of Bioinformatics: Lecture Notes of the Graduate Summer School on Bioinformatics of China, Springer Nature (2020) (Unit I,II,III,IV)

Course: MZT 304 Molecular Biology of the Gene

Course objectives: Students will be able -

1. To recite DNA structure, replication and replication error repair
2. To understand gene expression by different pathways
3. To illustrate post transcriptional gene control and nuclear transport cascade
4. To study the mechanisms of cell to cell signaling, including intracellular second-messenger pathways.

Credits (4)	**MZT 304 Molecular Biology of the gene**	**No. of hours per unit/ credits**
Credits I **Unit I**	**Fundamentals of Molecular Biology** 1. Complexity of genome. 2. DNA denaturation 3. DNA renaturation 4.Replication error and repair.	15
Credits I **Unit II**	**1.Gene and its expression:** a) Concept of gene b) Transcriptional control of gene expression in prokaryote (Lac, trp operon). 2**. Control of gene expression** a. The role of transcription factor in regulating gene expression. b. Structure of transcription factor c. DNA sites involved in regulating transcription d. An example of transcriptional activation: Glucocorticoid receptors e. Transcriptional Activation: role of enhancer, promoters & coactivators f. transcriptional Repression.	15
Credits I **Unit III**	**Post transcriptional gene control and nuclear transport** 1. RNA processing control 2. Translational control 3. The role of microRNAs in Translational control 4. Posttranslational Control: Determining Protein Stability	15

Credits I **Unit IV**	**Cell signaling and signal transduction : communication between cell** 1. Signal Transduction by G Protein-Coupled Receptors 2.Second Messengers 3. Protein-Tyrosine Phosphorylation as a Mechanism for Signal Transduction 4.The RAS-MAP kinase pathway	15

Course outcomes: Student should be able to:

1. Sketch DNA structure, replication and replication error repair
2. Understand the different pathways for gene expression.
3. Differentiate post transcriptional gene control and nuclear transport cascade
4. Categorize signaling molecules and evaluate their role in signal transduction pathways.

References:

1. Desmond S.T. Nicholl , An introduction to genetic engineering ,Cambridge University Press; 3rd edition (2008) (Unit I, II, III & IV)
2. Benjamin Lewin ,Genes ,by.,Jones and Bartlett Publishers, Inc; 9th edition (2007) (Unit I, II, III & IV)
3. Jocelyn E. Krebs (Author), Elliott S. Goldstein (Author), Stephen T. Kilpatrick (Author)
4. Lewin's Genes (2017)
5. James D.Watson, Molecular Biology of the gene, 5th ,7th Edition,Pearson Education (1 January 2004) (Unit I, II, III & IV)
6. Karp's Cell and molecular biology concept and Experiment 8th edition by Janet Iwasa and Wallace Marchal (Unit III & IV)
7. Molecular Biology of the cell 6th edition Bruce Albert (Unit III & IV)

Practical MZP 305 (Based on MZT 301&302)

Course objective:

1. To demonstrate different syndromes by the karyotype.
2. To analyze type of possible mutations by the genetics examples.
3. To evaluate total content of different biochemical moieties by employed standard method.

Credits 4	**Practical MZP 305 (Based on MZT 301&302)**	**No. of hours per unit/ credits 60**
	1. Human lymphocyte culture. 2. Preparation of metaphasic chromosomes from human lymphocyte culture. 3. Study of human chromosomes explaining aspects of chromosome structure. 4. Study of human normal karyotype. 5. Manual preparation of human karyotype from metaphasic chromosomes. 6. Assessing quality and quantity of metaphases. 7. Harvesting of mitotic chromosomes from rat bone marrow. 8. Study of X chromosome heterochromatinization by Barr body staining. 9. G banding of rat chromosomes/Human chromosomes. 10. Preparation of chromosome ideogram. 11. Karyotype identification with reference to Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome (from photographs). 12. Identification of cases of Patau syndrome, Edward Syndrome, Down syndrome Klinefelter syndrome and Turner syndrome from photographs by morphological/ Symptomatic features 13. Principle of Fluorescence In Situ Hybridization, Interpretation of results FISH for Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome (from photographs). 14. Drosophila culture	

	15. Sexual dimorphism in Drosophila 16. Study of heritable characters in Drosophila 17. Examples based on Hardy-Weinberg Equilibrium 18. Examples on Mutation 19. Symbols used in Pedigree analysis 20. Studies of Human pedigrees concerned with autosomal recessive disorders, autosomal dominant disorders, X linked dominant disorders and X linked recessive disorders. 21. Examples on pleiotropy 22. Clinical test for Phenylketonuria by Guthrie test /Ferric chloride test 23. Estimation of proteins 24. Estimation of Amylase/any other suitable enzyme. 25. Effect of pH on Amylase activity/any other suitable enzyme. 26. Effect of temperature on Amylase activity/any other suitable enzyme. 27. Michaelis– Menten constant determination for Amylase/ any other suitable enzyme. 28. Effect of modifiers on enzyme activity/ Thermo ability of enzyme. 29. Isolation of Amylase or any other enzyme. 30. Anyother practical set by the Department. 31. Catalase estimation using H_2O_2 as substrate 32. SDS-PAGE Electrophoresis 33. AT LEAST 12 EXPERIMENTS TO BE COVERED IN THE SEMISTER FROM GENETICS	

Course outcomes: Student should be able to

1. Understand different syndromes and their symptoms
2. Elucidate different pathways for gene expression.
3. Interpret the change in DNA mRNA and possible type of mutation
4. Determine total content of different biochemical moieties from animal tissue and enzyme activity.

Practical MZP 306 (Based on MZT 303 & 304)

Course objective: Student will be able -

1. To identify various biological databases that provide information about nucleic acids and protein.
2. To summarize various computational methods and tools used for protein secondary structure prediction and genome analysis
3. To demonstrate various computational tools and techniques employed in biological sequence analysis

Credits 4	**Practical MZP 306 (Based on MZT 303 & 304)**	**No. of hours per unit/ credits 60**
	1. Example based on DNA sequencing. 2. Example based on RNA sequencing. 3. Example based on Protein sequencing & SS bond prediction, trans membrane & signal peptide sequence prediction. 4. Examples based on Genetic code 6 frame translation at frames. Codon preference base translation frames. Open reading frame search. 5. Database search- NCBI, DDBJ, EMBL, BRENDA, KEGG, Uni Prot. 6. Primary sequence analysis of proteins- Prot PARAM 7. Secondary structure prediction 8. Tertiary structure analysis 9. Pairwise sequence alignment- FASTA, BLAST, 10. Multiple sequence alignment- Clustal Omega 11. Phylogenetic analysis- by MEGA. 11. Metaphasic chromosome preparation from bone marrow cells. 12. C-band of metaphasic chromosomes. 13. Isolation and estimation of DNA & RNA. 15. Demonstration of RNA (by RNase digestion &TBpH 3.5) & estimation.	

	18. Estimation of Histones. 19. Demonstration of Histones. 20. Estimation of phosphate from isolated nucleic acids. 21. Visualization of isolated DNA on Agarose gel Electrophoresis. 22. Estimation of DNA using Gel – DOC. 23. Polymerase Chain Reaction. 24. Experiments set by the Department	

Course outcomes: Student should be able to:

1. Understand nucleic acids and protein with the help of Biological databases.
2. Apply various computational methods and tools used for protein secondary structure prediction and genome analysis
3. Interpret DNA sequence by using various computational tools and techniques which are employed in biological sequence analysis

Semester IV

MZT 401 - Animal cells in Biotechnology

Course objective: Student will be able -

1. To quote the animal ethics while using laboratories and experimentation.
2. To summarize types of growth media used in cell culture laboratory
3. To illustrate various cell culture laboratory techniques
4. To analyze different cell fusion methods

Credits 4	**MZT 401 - Animal cells in Biotechnology**	**No. of hours per unit/ credits=60**
Credits I **Unit I**	1. Animal care and management of laboratory animals. 2. Animal house: Design and maintenance, infrastructure. 3. Animal ethics and associated laws and issues. 4. New trends in animal experimental biology **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	15
Credits I **Unit II**	**Growth media** **Cryopreservation, types of culture and Growth media** 1. Cryopreservation for Storage and shipment **2.** Primary cell culture, Established cell line, transformed cell line **3.** Physical requirements and Nutritional Requirements of Cells Natural media **4.** Basal salt solution (BSS)-Various types Minimum Essential Medium (MEM) Antibiotics in media **5.** Serum dependent defined media **6.** Serum independent defined media – Cell specific media	15

Credits I **Unit III**	**Biology and Characterization of cultured cells** 1. Karyotyping 2. Contamination Testing of Culture 3. Viability measurement and cytotoxicity, **MTT assay** 4. Measurement of growth parameters 5. 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	15
Credits I **Unit IV**	**Cell surgery and Cell Fusion Methods** **Surgical manipulation of *in vitro* fertilization** 1. Cell fusion by Sendai virus and Polyethylene glycol 2. Hybridoma cell preparations and their properties **Tissue Engineering** 1. Capillary culture Units 2. Techniques for culturing differentiated cells: Use Of Reconstituted basement membrane rafts and use of feeder layers.	15

Course outcomes: Student should be able to

1. Understand the cell culture laboratories, instruments and animal ethics
2. Explore various types of growth media used in cell culture laboratory
3. Differentiate various cell culture laboratory techniques
4. Criticize different cell fusion methods

Reference books:

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. 581979/recent volume. Academic Press. Kuchler, R. J. BiochemicalMethods in Cell culture & virology 1977. Dowden, Huchinson & Ross, Inc. Strausberg, USA (Unit I, II, III & IV)
4. Morgan, S.I. Animal Cell culture 1993Bio. Scientific Publishers Ltd Oxford.
5. Butler, M. Mammalian Cell Biotechnology.: A practical Approach 1991 IRL Press Oxford.(Unit I, II, III & IV) JenniP. 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

MZT 402 - Toxicology & Immunology

Course objective: Student will be able -

1. To study toxicology, disciplines, and types of toxicology.
2. To understand the effects of pesticide, heavy metal poisoning.
3. To criticize various types of antigen and antibodies.
4. To know different types of hypersensitivity reaction.

Credits 4	**MZT 402 - Toxicology & Immunology**	**No. of hours per unit/ credits=60**
Credits I Unit I	1. **Concept and Scope of Toxicology:** Definition, History, Recent development, Disciplines of toxicology. Classification of toxicants, toxic effects, principle aspects and importance of toxicology. Outline of toxicological testing method. 2. **Toxicity Tests:** Types of toxicity tests, acute, sub-acute and chronic toxicity tests and their objectives, experimental design, route of administration, doses and number. 3. Bioassays i.e., determination LD50 or LC 50 value using fish/mollusk/ insects graphical and statistical methods (**Probit analysis**). 4. Dose response relationship 5. Mode of action of toxicants 6. Introduction to genetic toxicology	15
Credits I Unit II	1. **Insecticides toxicity-** Synthetic organic insecticides, their classification, prospectus effects, symptoms mechanism of toxic action of Organochlorine, Organophosphate, Carbamate and synthetic Pyrethroids insecticides, 2. **Toxic metals**-Arsenic, Lead, Mercury and Cadmium, their toxic effects on animals and toxic kinetics. 3. **Bio-accumulation and bio magnification toxicants-** Organochlorine insecticides and heavy metal mercury. 4. **Bio-transformation of toxicant-** Organochlorine and Organophosphate insecticides i.e. Metabolism of insecticides-DDT, BHC, Parathion and Malathion- Mechanism Phase I and	15

	Phase II reaction. 5. **Food Toxicants-** Food additives, Contaminants, adulterants, food poisoning due to bacterial fungal and algal toxins.	
Credits I **Unit III**	1. Antigens: Antigenicity and immunogenicity 2. Factors influencing immunogenicity, 3. Epitopes, 4. Antibody: Basic structure of antibodies, Immunoglobulin fine structure, Antibody classes and biological activities. 5. MHC molecules: Genomic map of MHC genes, Regulation of MHC expression, MHC and immune responsiveness, 6. T cell, B cell antigenic properties, 7. Cytokines and therapeutic use of cytokines.	15
Credits I **Unit IV**	1. Innate immunity: Anatomy, physiologic, phagocytic and inflammatory, 2. Adaptive immunity: Antigenic specificity, diversity, immunologic memory, self and non-self-recognition, 3. 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, 4. Vaccine development (recombinant, combined, polyvalent vaccine), 5. Cancer immunology, 6. Immunological techniques- RIA, Monoclonal antibodies, and immunohistochemistry.	15

Course outcomes: Student should be able to-

1. Understand toxicology, disciplins, and types of toxicology
2. Evaluate effects of pesticide and heavy metal poisoning.
3. Classify various types of antigen and antibodies.
4. Differentiate between different types of hypersensitivity reaction in immunology

References Book

1. Clark W.R.. Experimental functions of Modern Immunology.
2. Immunobiology - Charles A. Janeway and oyhers – 2001.(Unit III & IV)
3. Pandey Kamleshwar. Shukla J.P. and TrivediS.P.(2005):Fundamental of Toxicology. New Central book agency PVT. LTD. Kolkata.(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. 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)

MZT 403 Cell in Differentiation, Development and Specialization

Course objective: Students will be able -

1. To Know differentiation and renewal of various cell types
2. To simplify the mechanism of animal development.
3. To clarify different organ system in human and their development.
4. To categorize different types of cells according to their origin in embryonic development of human body.

Credits 4	**MZT 403 Cell in Differentiation, Development and Specialization**	**No. of hours per unit/ credits=60**
Credits I Unit I	**Differentiated cells and maintenance of tissues:** Differentiated State 1. Tissues with Permanent cells (Eye lens, photoreceptor cells of retina) 2. Renewal of Cells by Mitosis (Liver cell, endothelial cells) 3. Renewal of Cells by Stem cells (Skin epithelium, intestinal epithelium) 4. Renewal of cells by pluripotent stem cells (Blood cell formation)	15
Credits I 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.	15
Credits I 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 remodelling. **2. Mammalian neurons:** a) Neurons: Building Blocks of the nervous system	15

	b) Voltage-gated Ion Channels and the propagation of action potential in nerve cells c) Communication at synapses	
Credits I **Unit IV**	**1. Pancreatic Cells** a. Acinar Cells b. Islets of Langerhans c. Ductal Cells **2. Pituitary Cell Type** 1. Neurosecretary Cells 2. Corneal Endothelial cells 3. Hepatoparenchymal cells	15

Course outcomes: Student should be able to

1. Understand cell differentiation and renewal process.
2. Construct model of development of body plans in organisms.
3. Build different organ system in human and their development.
4. Distinguish between different types of cells according to their origin in embryonic development of human body.

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 Garl and 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)

MZT 404 Cell Pathology

Course objectives: Students will be able -

1. To explore different types of stressed conditions in cell.
2. To elucidate original example of mechanism of different types of cancer development
3. To criticize effect of aging on cellular and molecular level and different theories of aging.
4. To categorize different types of inhibitors and virus in animal.

Credits	MZT 404 Cell Pathology	No. of hours per unit/ credits
Credits I **Unit I**	**Cell in stress and death** 1. Different types of stressful conditions on cell and cell response Common Terms in Pathology: Karyolysis, pyknosis, hypertrophy, hyperplasia, Fatty change, 2. Cell death and its regulation: Apoptosis-molecular mechanism and regulation 3. Cell organelles during cell degeneration/necrosis	15
Credits I **Unit II**	**Cancer Biology** 1. Tumor cells and onset of caner 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 caretaker genes 6. Cancer targeted treatment	15
Credits I **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 lipofuschin granules 6. Ageing and cell cycle 7. Strategies against ageing 8. Antiaging treatment by medicinal plants	15

Credits I **Unit IV**	**Effects of inhibitors** 1. DNA synthesis (Mitomycin) 2. RNA synthesis (Actinomycin and Rifampicin). 3. Protein synthesis (Cyclohexamide, Tetracycline, Chloramphenicol, streptomycin). 4. Mitochondrial metabolism (CN, CO, Actinomycin –A, Azide etc.) **B. Animal viruses:** 1. RNA viruses – Polio (+ strand RNA),VSV (-RNA), influenza (segmented RNA),HIV 2. DNA virus (SV40-ds DNA with circular genome), adenovirus (linear ds DNA genome), parvo virus (ssDNA virus), Ebola virus	15

Course outcomes: Student should be able to-

1. Recite different types of stressed conditions in cell.
2. Understand the mechanism of different types of cancer development
3. Demonstrate example of aging and different theories of aging.
4. Differentiate between different types of inhibitors and virus in animal and their structure.

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.(Unit IV)
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.(Unit IV)

Practical MZP 405 (Based on MZT 401 & 402)

Course objectives: Students will be able -

1. To explain laboratory design and different types of instruments in laboratory
2. To demonstrate biotechnological techniques.
3. To analyze toxicity of different toxic substances on laboratory animals.
4. To compare different immunological techniques.

Credits 4	**Practical MZP 405 (Based on MZT 401 & 402)**	**No. of hours per unit/ credits=60**
	1. Preparation of glassware for cell culture. 2. Study of laboratory design of animal cell culture. 3. Washing and sterilization of glassware for animal cell culture. 4. Preparation of cells that do not need enzyme digestion (RBC, Spleen lymph nodes, B.M.) 5. Isolation of cells by enzyme digestion 6. Separation of cells by suitable methods 7. Viable cell count (Trypan Blue) 8. MTT assay 9. Primary cell culture and its maintenance 10. Measurements of growth parameters- DNA 11. Cell cycle analysis – mitotic cells. 12. Karyotype studies- Bone marrow peritoneal macrophages. 13. Evaluation of acute toxicity by using static renewal bioassay test (In fish / Insect). 14. Effect of toxicant on O2 consumption rate in fish. 15. To study the effects of toxicant on mitosis. 16. Determination of LC50 of toxicant in fish / stored grain pest by employing probit analysis. 17. Effect of toxicant (sublethal dose) on fish gill and alimentary tract in fish and in	

	insect on alimentary canal haemolymph (Mulberry silkworm) 18. Detection of heavy metal from animal tissue by AAS (Lead/cadmium/chromium). 19. Detection of pesticide by TLC method from water sample (organochlorine/ organophosphate). 20. Paw oedema test 21. Granulomata – Quantification by weight and differential cell count. 22. Splenectomy. 23. Study of spleen replica for germinal centres. 24. Separation of immunoglobulin by Electrophoresis. 25. Immuno diffusion technique of agar gel diffusion. 26. RBC rosette technique. 27. Haemagglutination inhibition test. 28. Histology of lymphoid organs spleen, thymus, lymph node& Bone marrow. 29. Any other practical / experiments set by the Department.	

Course outcomes : By the end of this course student should be able to -

1. Prepare a model of laboratory design and different types of instruments in laboratory
2. Perform biotechnological techniques in the laboratory.
3. Illustrate possible effects of toxic substances on laboratory animals.
4. Determine different immunological responses in laboratory animals after exposing to chemicals or surgeries.

Practical MZP 405 (Based on MZT 401 & 402)

Course objectives: Students will be able -

1. To understand the cell cycle and developmental stages in laboratory animals
2. To demonstrate different types of cells.
3. To analyze aging by estimations of biochemical constituents in laboratory animals
4. To compare normal and aged or pathological condition of cell.

Credits (4)	Practical MZP 405 (Based on MZT 401 & 402)	No. of hours per unit/ credits (60)
	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. 5. Study of Angiogenesis in chick embryo. 6. Demonstration of stem cells renewing by mitosis (liver cells Intestinal crypt cells. Bone marrow cells – demonstration of cell division by fulguen technique). 7. Demonstration of neurons in cerebral cortex of rat. 8. Demonstration of pituitary cells. 9. Demonstration of pancreatic islet cells (L, B, Cell types). 10. Demonstrations of muscle striations (PAS method, phase contrast method) smooth muscle cells observations. 11. Demonstration of austochardria in striated & smooth muscle cells (Phase contrast & Janus green B staining). 12. In vitro cell degeneration of liver (histology – nuclear (E+H, Fulgen alterations lysosomal by acid phosphatase alterations in rat). 13. In vivo cell degeneration– of kidney by Induced ischemia (histology, nuclear alterations – E+H, fulgen). 14. Age related lipid peroxidation in various organs of rat / mouse. 15. Demonstration of lipofuschin granules in brain of aged (natural & induced) rat / mouse. 16. Study of histology of stressed liver, kidney, alimentary canal of rat/ mice/fish. 17. Demonstration of lipofuschin granules in brain of aged (natural & induced)	

	rat / mouse./Fish. 18. Drug induced lipid peroxidation in liver & kidney of Rat /mice/fish (CCl4 / any suitable drug). 19. Study of eye lenses in chick embryo. 20. Drug induced lipid peroxidation in liver & kidney (CCl4 / any suitable drug). 21. Any other practical / experiments set by the Department. 22. Project work / Review article	

Course outcomes: By the end of this course: Student should be able to-

1. Understand the cell cycle and recognize the developmental stages in laboratory animals
2. Perform different histological slides and identify the types of cells within it.
3. Apply the facts of aging in laboratory animals by the evaluating biochemical constituents.
4. Distinguish between normal and aged or pathological cell structure.