Rayat Shikshan Sanstha's
YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA
(AUONOMOUS)

Lead College of Karmaveer Bhaurao Patil University, Satara

Syllabus For

Master of Science

Part - II

Zoology

Syllabus to be implemented w.e.f June2024
As per NEP-2020

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 alongwith 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.

Credit Framework of M. Sc.-II
Structure of Course: M. Sc.-II

Semester-III

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
		Discipline Specific Courses (Mandatory)			
6.5	III	MZT 531	Genetics	4	4
		MZT 532	Enzymology	4	4
		MZT 533	Computational Molecular Biology	4	4
		Discipline Specific Elective (ChooseAny one among two)			
		MZT 534 E-I MZT 534 E-II	E-I) Molecular Biology of Gene E-II) Cell Signaling and Communication	2	2
		MZP 535	Research Project	12	6
		MZP 536	LAB- I (based on MZT-531, 532 and 533)	4	2
Total					**22**

Semester IV

Level	Semester	Course Code	Course Title	No. of Lectures Per Week	Credits
		Discipline Specific Courses (Mandatory)			
6.5	IV	MZT 541	Animal Cells in Biotechnology	4	4
		MZT 542	Toxicology	4	4
		MZT 543	Cell in Differentiation, Development and Specialization	4	4
		Discipline Specific Elective (Choose Any one among two)			
		MZT 544 E-I MZT 544 E-II	E-I) Cell Pathology E-II) Immunology	4	4
		MZP 545	On Job Training (OJT)	8	4
		MZP 546	LAB- I (based on MZT-541, 542 and 543)	4	2
Total					**22**

SEMESTER III
MZT 531: Genetics

Course Objectives: Student should be able to:

1. understand the karyotype of human and to identify the chromosomal abnormalities in human
2. predict the evolutionary variation in population.
3. illustrate the effect of mutation in organism
4. relate the genetic disease, pedigree and counseling about congenital birth defects.

Credit- 4	**MZT 53: Genetics**	**No. of hours per unit/ credits**
Unit I	**Chromosomal variations**	**15**
	1. Human Karyotypic analysis- normal and abnormal chromosomes,banding, nomenclature 2. Genetic basis of sex determination in human beings 3. Y linked genes, X linked genes, Dosage compensation, and testicular feminizationSyndrome. 4. Numerical abnormalities of human chromosomes and related syndrome Nondisjunction, Aneuploidy, Patau syndrome, Edward syndrome, Down syndrome, Turner syndrome and Klinefelter syndrome 5. Structural abnormalities of human chromosomes and related syndromes 6. RobertsonianTranslocation	
Unit II	**Population and Evolutionary Genetics**	**15**
	1. Populations, gene pool, gene frequency**;** Hardy- Weinberg principle 2. Concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation 3. Convergent evolution sexual selection; coevolution 4. Altruism, Reciprocal Altruism 5. Molecular evolution: Concepts of neutral evolution, Molecular divergence and clocks	
Unit III	**Mutations**	**15**
	1. Introduction to the mutation, mutation and environment, 2. Types of mutation : Spontaneousversus inducedmutation, Somatic and germinalmutation, Back mutation and suppressor mutation 3. Phenotypic effects of mutation. 4. Molecular basis of mutation 5. Radiation induced mutation 6. Chemical induced mutation 7. Mutation and DNA repair mechanism 8. Pleiotropy 9. Mutation frequency	

	10. Practical application of mutations 11. Mutagenicity and carcinogenicity. 12. Mutations and human welfare	
Unit IV	**Basis of genetic counselling and developmental genetics**	**15**
	1. Ethical and psychological approach of genetic counselling 2. Avoidance of risk factor with genetic diseases, prenatal genetic counselling 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	

Course Outcomes: After completion of syllabus, student will be able to:

1. identify different syndromes in human being.
2. describe genetic variation in population.
3. determine the possible effects of different types of mutation with the help of genetics example
4. predict pedigree tree and possible genetic counseling.

Reference Books:

1. P. W. Hedrick, Genetics of population, Jones and Bartlett Publishers, Fourth edition, 2010.
2. D. L. Hartl and A. G. Clark, Principles of Population Genetics, OUP USA, Fourth edition, 2006.
3. B. D. Singh, Fundamentals of genetics, Med tech Science press, Sixth edition, 2022.
4. D. P. Clark and N. J. Pazdernik, Molecular Biology, Academic Cell, Second edition, 2012.
5. W. Klug, M. Cummings, C. Spencer, M. Palladino, D. Killian, Concepts of Genetics ,Pearson, Twelfth edition, 2019

MZT 532: Enzymology

Course Objectives: Student should be able to:

1. understand the classification and structure of enzymes.
2. discuss the different extraction and purification methods for enzymes.
3. illustrate the different equations in enzyme kinetics.
4. justify the enzyme activities by non-genetic mechanism.

Credit- 4	**MZT 532: Enzymology**	**No. of hours per unit/ credits**
Unit I	**Classification and Nomenclature**	**15**
	1. Classification and Nomenclature of Enzymes, Isoenzymes, Multienzyme Complexes. 2. Cofactors. 3. Inorganic. 4. Organic: Pyridoxyl Phosphate, Biotin, Lipoic acid, Thiamine diphosphate, Flavin nucleotides, Nicotinamide	
Unit II	**Extraction and Purification of Enzymes.**	**15**
	1.The extraction of solubleenzymes. 2. Extraction of membrane boundenzymes. 3. The nature of the extraction medium. 4. Preliminary purification& procedures. 5.Criteria of purity. 6.Determination of molecular weight of enzymes.	
Unit III	**Enzyme Kinetics**.	**15**
	1. Relationship between initial velocity and substrate concentration. 2. Michaelis Menten 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. 10Enzyme Actions of- Chymotrypsin.**,** Fructose bisphosphate aldolase	
Unit IV	**The control of Enzyme Activities by Non Genetic Mechanism.**	**15**
	1.Enzymes in Organized System. (Enzyme regulation) 1.1.RNA nucleotidyl transferase. 1.2.The Pyruvate dehydrogenase.	

	2. Enzyme Technology. 2.1. Use of isolated enzymes in industrial processes. 2. 2 Immobilized enzyme. 3. Mechanism of enzyme catalysis - Principles	

Course Outcomes: After completion of syllabus, student will be able to:

1. describe the types and structure of enzymes.
2. demonstrate different extraction and purification methods for enzymes.
3. compare the enzyme activities by non genetic mechanism.
4. analyze equations in enzyme kinetics.

Reference Books–

1. Misc, Methods in Enzymology, Volume 42, DB Elsevier, 2005
2.I.J. Niggins, D.J. Best and J. Jones, Biotechnology – Principles and applications, Black well, scientific oxford, 1985.
3.J. Bulock. and B. Kristiansen, Basic biotechnology, Acanthophyllum Books, 1987.
4.T. Palmer and P. L. Bonner, Enzyme biochemistry, biotechnology and clinical chemistry, Horwood Publishing Ltd, Second edition, 2007.
5. Kimmel, Methods in Enzymology, Volume 411, DB Academic press, 2006

MZT 533: Computational Molecular Biology

Course Objective: Student should be able to:

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

Credit-4	MZT 533: Computational Molecular Biology	No. of hours per unit/ credits
Unit I	**Advanced molecular techniques**	**15**
	1.DNA sequencing – Sangers Di-deoxy method, Illumine, Nanopore, PacBio (Pacific biosciences) 2.Gene editing- CRISPR 3. Gene silencing 4. Real time PCR, 2D gel-Electrophoresis	
Unit II	**Sequence comparison methods & search algorithms**	**15**
	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**	**15**
	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.**	**15**
	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. Secondary structure prediction	

Course Outcomes: After completion of syllabus, student will be able to:

1. identify the genes from DNA sequence.
2. compare the different types of structural proteins in bioinformatics
3. apply different DNA sequencing method for searching the systematic position of an organism.
4. perform existing software effectively to extract information from large databases and to use this information in depiction the lines of evolutionary descent of different species,

organisms, or genes from a common ancestor

Reference Books:

1. S. G. Sandhu, Bioinformatics and its application, Pragun Publications, 2012.
2. T. K. Attwood and D. J. Parry Smith, Introduction to Bioinformatics (Cell and molecular biology in action series), Prentice Hall, 1999.
3. A. M. Lesk, Introduction to Bioinformatics, Oxford University press, 2002
4. T. K. Attwood, Introduction to Bioinformatics, Pearson education, 2007.
5. J. Xiong, Essential Bioinformatics, Cambridge University Press, 2007.

MZT 534: Molecular biology of the gene

Course Objective: Student should be able to:

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

Credit- 2	**MZT 534: Molecular biology of the gene**	**No. of hours per unit/ credits**
Unit I	**Gene and its expression**	**15**
	1. Gene and its expression: 1.1.Concept of gene 1.2. Transcriptional control of gene expression in prokaryote (Lac, trp operon). 2**. Control of gene expression** 2.1. The role of transcription factor in regulating gene expression. 2.2. Structure of transcription factor 2.3. DNA sites involved in regulating transcription 2.4. An example of transcriptional activation: Glucocorticoid receptors 2.5. Transcriptional Activation: role of enhancer, promoters & coactivators	
Unit II	**Cell signalling and signal transduction:**	**15**
-	**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	

Course Outcomes: After completion of syllabus, student will be able to:

1. remember DNA structure, replication and replication error repair
2. explain different pathways for gene expression.
3. differentiate post transcriptional gene control and nuclear transport cascade
4. describe cell signaling and signal transduction and communication between cell

Reference Books:

1. J. D. Watson, Molecular Biology of the gene, Pearson Education, Seventh edition, 2017.
2. N. Arumugam, Molecular Biology, Saras Publication,2014
3. J. D. Watson, Molecular Biology of the gene, Pearson Education, Seventh edition, 2014
4. V. B. Rastogi, Principles of Molecular Biology, MedTech Science Press, Second Revised edition, 2016.
5. B. Lewin, Gene, Jones and Bartlett Publisher, 9th edition, 2007.

MZT 534: Cell Signaling and Communication

Course Objective: Student should be able to:

1. recall cell, cell signaling and cell communication
2. understand gene expression by different pathways
3. remember general principles of cell communication
4. restate the mechanisms of cell to cell signaling, including intracellular second-messenger pathways.

Credit- 2	**MZT 534: Cell Signalling and Communication**	**No. of hours per unit/ credits**
Unit I	**Cell signalling**	**15**
	1. Autocrine, paracrine, endocrine and exocrine 2. Hormones and their receptors 3. Cell surface receptor - Types of ligands and receptors 3.1. Membrane receptors 3.2. Cytoplasmic receptors 3.3. Nuclear receptors 4. Molecular mechanism of ligand- receptor interaction. 5. Signalling through G-protein coupled receptors 6. Signal transduction pathways	
Unit II	**Cellular communication**	**15**
	1. Regulation of hematopoiesis 2. General principles of cell communication, cell adhesion and roles of different adhesion molecules, 3. Gap junctions 4. Extracellular matrix	

	5. Integrins 6. Neurotransmission and its regulation 7. Hormone receptor interaction	

Course Outcomes: After completion of syllabus, student will be able to:

1. memorize DNA structure, replication and replication error repair
2. understand gene expression by different pathways
3. explain signal transduction pathway
4. discuss the mechanisms of cell to cell signaling, including intracellular second-messenger pathways.

Reference Books:

1. J. D. Watson, Molecular Biology of the gene, Pearson Education, Seventh edition, 2017.
2. N. Arumugam, Molecular Biology, Saras Publication,2014
3. J. D. Watson, Molecular Biology of the gene, Pearson Education, Seventh edition, 2014
4. V. B. Rastogi, Principles of Molecular Biology, MedTech Science Press, Second Revised edition, 2016.
5. B. Lewin, Gene, Jones and Bartlett Publisher, 9th edition, 2007.

MZP 535: Research Project

Credit- 6	MZP 535: Research Project	No. of hours per unit/ credits
	Students will undertake research in specific area of his Major/Core with an advisory supported by a teacher/Faculty member. Students are required to take 6 credit Research Project for semester III under the guidance of faculty members.	

MZP 536: Based on MZT 531, 532 & 533

Course Objective: Student should be able to:

1. remember different syndromes by the karyotype
2. understand type of possible mutation by the genetics examples.
3. state total content of different biochemical moieties by employed standard method.
4. identify various Biological databases that provide information about nucleic acids and protein**.**

Credit-2	**MZP 536: Based on MZT 531, 532 & 533**	**No. of hours per unit/ credits**
	1. To Study the human normal karyotype and Manual preparation of human karyotype from metaphasic chromosomes. 2. To Study the X chromosome heterochromatinization by Barr body staining. 3. To Study the karyotype and case identification with reference to Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome(from photographs). 4. To Study the Drosophila culture, Sexual dimorphism in Drosophila and heritable characters in Drosophila 5. Examples based on Hardy-Weinberg Equilibrium 6. Examples based on Mutation. 7. Examples based on Pedigree analysis. 8. Estimation of proteins by Lowry's method. 9. Estimation of Amylase/any other suitable enzyme. 10. Effect of pH, temperature on Amylase activity/any other suitable enzyme. 11. Effect of time & substrate concentration on Amylase activity/any other suitable enzyme. 12. Example based on DNA and RNA sequencing. 13. Example based on Protein sequencing & SS bond prediction, trans membrane &signal peptide sequence prediction. 14. Examples based on Genetic code frame translation at frames. Codon preference base translation frames. Open reading framesearch. 15. To Study the Database search- NCBI, DDBJ, EMBL, BRENDA, KEGG, Uni Prot. 16. To Study the Primary sequence analysis of proteins- Prot PARAM, Secondary structure prediction, Tertiary structure analysis 17. To Study the pairwise sequence alignment- FASTA, BLAST, Multiple sequence alignment-Clustal Omega	**60**

	18. To Study the Phylogenetic analysis- by MEGA. 19. Isolation and estimation of DNA &RNA. 20. Isolation and Estimation of Histones.	

Course Outcomes: After completion of syllabus, student will be able to:

1. describe different syndromes and their symptoms
2. explain 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.

Reference Books:

1. J. D. Watson, Molecular Biology of the gene, Pearson Education, Seventh edition, 2017.
2. D. L. Hartl and A. G. Clark, Principles of Population Genetics, OUP USA, Fourth edition, 2006.
3. A. M. Lesk, Introduction to Bioinformatics, Oxford University press, 2002
4. T. K. Attwood, Introduction to Bioinformatics, Pearson education, 2007.
5. J. Xiong, Essential Bioinformatics, Cambridge University Press, 2007.

SEMESTER IV

MZT 541: Animal cells in Biotechnology

Course Objectives: Student should be able to:

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

Credit- 4	**MZT 541: Animal cells in Biotechnology**	**No. of hours per unit/ credits**
Unit I	**Animal care and maintenance**	**15**
	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 **5. Laboratory design and introduction of cells:** 5.1. Design of Tissue Culture Laboratory 5.2. Equipment: Laminar Flow Hoods, CO2 incubator, Microscopes, centrifuge,Refrigerators and Freezers, pipetting aids, MiscellaneousEquipment. 5.3.Glass wares/plastic wares and filters for tissue culture.	
Unit II	**Growth media**	**15**
	1. Cryopreservation, types of culture and Growth media 2. Cryopreservation for Storage and shipment 3. Primary cell culture, Established cell line, transformed cell line 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	
Unit III	**Biology and Characterization of cultured cells**	**15**
	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 7. Evaluation of Chemical carcinogenicity, Cell malignancy Testing Uses of Embryonic stem cells and Pluripotent stem cells	
Unit IV	**Cell surgery and Cell Fusion Methods**	**15**

	1. Surgical manipulation of in vitro fertilization 2. Cell fusion by Sendai virus and Polyethylene glycol 3. Hybridoma cell preparations and their properties 4. Tissue Engineering 5. Capillary culture Units 6. Techniques for culturing differentiated cells: Use of Reconstituted basement membrane rafts and use of feeder layers.	

Course Outcomes: After completion of syllabus, student will be able to:

1. describe cell culture laboratories, instruments and animal ethics
2. explain various types of growth media used in cell culture laboratory
3. demonstrate various cell culture laboratory techniques
4. state differentiate between cell fusion methods

Reference Books:

1. R.I. Freshne, Culture of Animal Cells: A manual of Basic Technique, John Wiley & Sons Inc. Pub. USA., 1994.
2. M. Butler, Mammalian Cell Biotechnology: A practical Approach, IRL Press Oxford, 1991.
3. R. J. Kuchler, Biochemical Method Cell culture & vivology. Dowden, Huchinson & Ross, Inc. Strausberg, USA. 1977.
4. S.I. Morgan, Animal Cell culture, Bio. Scientific Publishers Ltd Oxford. 1993.
5. M. Butler, Cell Biotechnology: A practical Approach, IRL Press Oxford. 1991.

MZT 542: Toxicology

Course Objectives: Student should be able to:

1. define toxicology, discipline and types of toxicology.
2. predict the effects of pesticide, heavy metal poisoning.
3. demonstrate the different toxicity testing methods.
4. correlate the effects of different toxicant on chromosomes & DNA

Credit- 4	**MZT 542: Toxicology**	**No. of hours per unit/ credits**
Unit I	**Fundamentals of toxicology & Toxicity tests**	**15**
	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 graphical and statistical methods (Probit analysis).	
Unit II	**Insecticide & Heavy Metal Toxicity**	**15**
	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- 4.Bio-transformation of toxicant-Mechanism Phase I and Phase II reaction. 5. Food Toxicants- Food additives	
Unit III		**15**
	1.Outline of toxicological testing Methods: Behavioural, Analytical, Functional, other toxicity tests. 2.Dose response relationship: Selection of Doses, Duration of exposure, Types of exposure, types of Dose response relationship. 3.Mode of action of toxicants : Receptors concept, Mechanism of action of commonly used toxicants: (Metals, Pesticides, Environmental carcinogens, teratogens and radiations)	
Unit IV	**Genetic Toxicology**	**15**
	1.Origin of genetic toxicology: historical prospective of genetic toxicology, fundamentals of genetic toxicity **2.**Mechanism chromosomal alterations and gene mutation 3.Mutagens-chemical, physical, biological & environmental 4.Genetic toxicology and congenital malformations 5.Consequences of genotoxic effects in humans.	

Course Outcomes: After completion of syllabus, student will be able to:

1. state toxicology, discipline, and types of toxicology
2. explain effects of pesticide, heavy metal poisoning.
3. demonstrate the different toxicity testing methods.
4. identify the effects of different toxicant on chromosomes & DNA

References Books:

1. P. Kamleshwar, J.P. Shuklar and S.P. Trivedi, Fundamental of Toxicology. New Central book agency PVT. LTD. Kolkata, 2005
2. J. H. Thomas and O.B. William, Handbook of Toxicology, 1987
3. C. Kent, Basics of Toxicology, Willey, First edition, 1998.
4. J.K. Devid and A.K. Kit, Toxicological testing hand book , 2nd Ed. 2006
5. K. Pandey, J. P. Shukla and S. P. Trivedi, Fundamentals of Toxicology. New Central Book Agency, 2011

MZT 543: Cell in Differentiation, Development and Specialization

Course objective: Student should be able to:

1. recall different cell types
2. memorize the differentiation of various tissues.
3. discuss about development of various tissues.
4. analyze different types of precursors for development of tissues.

Credit- 4	**MZT 543: Cell in Differentiation, Development and Specialization**	**No. of hours per unit/ credits**
Unit I	**Differentiated cells and maintenance of tissues**	**15**
	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**	**15**
	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		**15**
	1.Muscle as a cell and contraction unit: 1.1.Genesis, modulation and regeneration of skeletal muscle. 1.2.Fibroblasts and their transformations- The connective tissue cell family. 1.3.Bone remodelling. **2.Mammalian neurons:** 2.1.Neurons: Building Blocks of the nervous system 2.2.Voltage-gated Ion Channels and the propagation of action potential in nerve cells, Communication at synapses	
Unit IV		**15**
	1.Pancreatic Cells 1.1.Acinar Cells 1.2.Islets of Langerhans 1.3.Ductal Cells 2.Pituitary Cell Type 3.Neurosecretary Cells	

	4.Corneal Endothelial cells 5.Hepatoparenchymal cells	

Course Outcomes: After completion of syllabus, student will be able to:

1. remember different cell types.
2. discuss the differentiation of various tissues.
3. describe the development of various tissues.
4. distinguish different types of precursors for development of tissues.

Reference Books:

1. G. Karp, Cell & Molecular Biology, published by John Wiley & sons, 2005
2. Lodish, Berk, Matsudaira, Kaiser, Krieger, Molecular cell biology published by W. H. Freeman & company, New York, 2004.
3. S. F. Gilbert and M.J. F. Barresi, Developmental Biology, Sinauer Associates Inc, Eleventh edition, 2016
4. S. F. Gilbert, Developmental Biology, Sinauer Associates Inc.,U.S.; 8th Revised edition, 2006
5. G.E. Hall and M. E. Hall,Textbook of Medical Physiology, Elsevier; 14th edition, 2020

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MZT 544: Cell Pathology

Course Objective: Student should be able to

1. describe different stressful conditions of the cell .
2. Explain the effects of different type of cancer.
3. interpret various theories of aging.
4. differentiate effect of inhibitors on DNA & RNA synthesis.

Credit- 4	**MZT 544: Cell Pathology**	**No. of hours per unit/ credits**
Unit I	**Cell in stress and death**	**15**
	1. Different types of stressful conditions on cell and cell response 2. Adaptive Disorders:Karyolysis, pyknosis, hypertrophy, hyperplasia, Fatty change, Atrophy, Metaplasia, Dysplasia. 3. Cell death and its regulation: Apoptosis-molecular mechanism and regulation 4. Cell organelles during cell degeneration/necrosis	
Unit II	**Cancer Biology**	**15**
	1. Tumor cells and onset of caner, metastasis, Genetic rearrangements in progenitor cells, virus-induced cancer, interaction of cancer cells with normal cells, 2. The genetic basis of cancer- oncogenes, tumor suppressor genes,	

	carcinogens and caretaker genes 3. Oncogenic mutations in growth promoting proteins 4.Cancer and the cell cycle 5. Cancer targeted treatment -therapeutic interventions of uncontrolled cell growth.	
Unit III	**Ageing**	**15**
	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	
Unit IV		**15**
	A. 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	

Course Outcomes: After completion of syllabus, student will be able to:

1. understand different stressful conditions of the cell.
2. explain the effects of different type of cancer.
3. interpret various theories of aging.
4. examine effect of inhibitors on DNA & RNA synthesis

Reference Books:

1. G. Karp, Cell & Molecular Biology, John Wiley & Sons, 2005.
2. Lodish, Berk, Matsudaira, Kaiser, Krieger, Molecular cell biology published by W. H. Freeman & company, New York, 2004.
3. R. M. Hochster, M. Kates, J. H. Quastel, Metabolic Inhibitors, Academic Press, Inc., Vol-IV, 2012
4. G.M. Cooper, R.E. Hausman, The Cell: A molecular approach, Sinauer Associates Inc., U. S. Fourth edition, 2007.
5. G.M. Cooper, R.E. Hausman, The Cell: A molecular approach, Sinauer Associates Inc., U. S. Sixth edition, 2007.

MZT 544: Immunology

Course Objectives: Student should be able to:

1. define various types of immunity
2. classify different types of cytokines.
3. interpret effect of hypersensivity
4. relate different types of vaccines to respective type and disease.

Credit- 4	**MZT 544: Immunology**	**No. of hours per unit/ credits**
Unit–I	**An introduction to Immunology**	**15**
	1.Innate immunity & Adaptive immunity: Cells and molecules involved in innate and adaptive immunity 2.Antigen antibody reactions 3.Monoclonal Antibody production 4.Epitopes: B and T cell epitopes 5.Antibody: Structure and function of antibody molecules, Antibody classes. 6.MHC molecules	
Unit-II	**Cells of the immune system& Cytokines**	**15**
	1.Lymphocytes 2.Antigen presenting Cells 3.Lymphoid tissue & organs: Primary, Secondary & Tertiary. 4.Cytokines: Nomenclature & properties 5.Interferons & Interleukins	
Unit III		**15**
	1.Inflammation: Inflammatory cells, Acute Inflammation , Chronic Inflammation. 2.Cell mediated immunity: T cell activation, Effector T cell Differentiation, 3.Humoral Immunity: 4.Hypersensitivity: Hypersensitive reactions, IgE mediated (Type I) hypersensitivity, Antibody mediated cytotoxic (Type II) hypersensitivity, and Immune complex mediated (Type III) hypersensitivity, Delayed type (Type IV)	
Unit IV		**15**
	1.Vaccine development (recombinant, combined, polyvalent vaccine) 2.Immunological techniques- Agglutination, Serological reactions, Fluroscent antibody technique, RIA, Radioallergosorbant Test & gene probe. 3.Immunity to Cancer	

Course Outcomes: After completion of syllabus, student will be able to:

1. understand various types of immunity
2. explain about different types of cytokines.
3. discuss about effect of hypersensivity
4. distinguish different types of vaccines to respective type and disease.

Reference Books:

1. W. R. Clark, Experimental Foundations of Modern Immunology, John Wiley and Sons Inc., Fourth edition, 1991.
2. C. Janeway, P. Travers, M. Walport, M. Shlomchik, Immunobiology, Garland Publishing Inc., Fifth edition, 2001.
3. K. M. Murphy, C. Weaver, L.J. Berg, Janeway's Immunobiology, ww Norton & Co., Tenth edition, 2022
4. J. Punt, S. Stranford, P. Jones, J.A. Owen, Kuby Immunology, WH Freeman, Eighth edition, 2018.
5. P. Sharma and P. Kumar, Basics of Immunology, (IP) Innovative Publication Pvt. Ltd, 2021.

MZP 545: On Job Training (OJT)

Credit- 4	**MZP 545: On Job Training (OJT)**	**No. of hours per unit/ credits**
	OJT will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. so that students may actively engaged with the employability opportunities. Students will undergo 4 credit work based learning/OJT/internship.	

MZP 546: Based on MZT 541, 542 & 543

Course Objectives: Student should be able to:

1. Understand working of various instruments and glassware in biotechnology laboratory.
2. Identify effects of pesticides on histological structure of different tissues.
3. demonstrate the effect of toxicant on behavior of experimental animal (Fish)
4. draw the histological structure of different tissues.

Credit- 2	**MZP 546: Based on MZT 541, 542 & 543**	**No. of hours per unit/ credits**
	1. To study the preparation of glassware for cell culture. 2. To study the laboratory design of animal cell culture, washing and sterilization of glassware for animal cell culture. 3. To study the preparation of cells that does not need enzyme digestion (RBC, Spleen lymph nodes, B.M.) 4. To study the isolation of cells by enzyme digestion 5. To study the viable cell count (Trypan Blue) 6. To study the Cell cycle analysis – mitotic cells. 7. To study the Karyotype 8. Determination of LC50 of toxicant in fish / insects by employing probit analysis. 9. To study the effect of toxicant (sub lethal dose) on fish gill and alimentary tract in fish. 10. To study the effect of toxicant on O_2 consumption rate in fish. 11. Detection of heavy metal from animal tissue/ Soil sample by Atomic Absorption Spectroscopy (Lead/cadmium/chromium). 12. Detection of pesticide by TLC method from given water sample (organochlorine/ organophosphate). 13. To study the alteration in behaviour in fish exposed to toxicant. 14. To study drug/ toxicant induced lipid peroxidation in Brain of Rat /mice/fish. 15. To study the mitosis in rat testes. 16. To study the nervous system development in chick embryo. 17. To Study Angiogenesis in chick embryo. 18. Demonstration of neurons in cerebral cortex of rat. 19. Demonstration of pituitary cells, pancreatic islet cells of rat. 20. Demonstration of Muscle cells (Cardiac, Striated & Smooth muscle) of rat.	**60**

Course Outcomes: After completion of syllabus, student will be able to:

1. understand working of various instruments and glassware in biotechnology laboratory.
2. identify effects of pesticides on histological structure of different tissues.
3. demonstrate the effect of toxicant on behavior of experimental animal (Fish)
4. draw the histological structure of different tissues.

Reference Books:

1. W. R. Clark, Experimental Foundations of Modern Immunology, John Wiley and Sons Inc., Fourth edition, 1991.
2. C. Janeway, P. Travers, M. Walport, M. Shlomchik, Immunobiology, Garland Publishing Inc., Fifth edition, 2001.
3. D. Proven, Oxford Handbook and Clinical and Laboratory Investigation, OUP, Oxford, Second edition, 2005.
4. P. Sharma and P. Kumar, Basics of Immunology, (IP) Innovative Publication Pvt. Ltd, 2021.
5. G.M. Cooper, R.E. Hausman, The Cell: A molecular approach, Sinauer Associates Inc., U. S. Fourth edition, 2007.
6. M. Butler, Cell Biotechnology: A practical Approach, IRL Press Oxford. 1991.
7. J.K. Devid and A.K. Kit, Toxicological testing hand book , 2nd Ed. 2006