SYLLABUS
for
Choice Based Credit System
(CBCS)

M.Sc. ZOOLOGY
(w.e.f. 2021-23)

PATNA WOMEN'S COLLEGE
Autonomous
PATNA UNIVERSITY
3rd Cycle Accredited at 'A' Grade with CGPA 3.58/4
"College with Potential for Excellence" Status Accorded by UGC

Vision

Rooted in the life, vision, and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a center of academic excellence in higher education, social responsibility, and empowerment of women.

Mission Statement

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

To this end, we strive

- To become a center of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

Programme Outcomes (PO)

Upon completion of the Post Graduate programme, the students will be able to achieve the following outcomes:

PO1: Profound Professional Knowledge: Obtain proficiency to maneuver in diverse context of the advance subject knowledge.

PO2: Critical Thinking and Analysis: Attain the analytical expertise to create, analyse, formulate, and solve challenging problems.

PO3: Environment and sustainability: Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO4: Research and Innovation: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Effective Communication: Demonstrate skills such as effective communication, decision making, problem and adapt ability to create technical writing.

PO6: Problem Solving: Understand, interpret, explain, analyse and assess the tools, techniques, models and methodologies to solve problems.

PO7: Employability: Demonstrate skills for doctoral, post-doctoral education, professional development and employability.

PO8: Advance tools and techniques: Attain ability to work with advanced IT tools and techniques in their domain.

PO9: Social Consciousness: Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues

PO10: Nation Building: Introspect and evolve into dynamic and creative individuals capable of socially productive, constructive actions that positively impact our Nation and the World at large.

Programme Specific Outcome (PSO)

Students enrolled in M.Sc. degree program in Zoology will study and acquire complete knowledge of disciplinary as well as allied biological sciences. After completion of their degree, a Zoology post graduates can find jobs in numerous sectors. They can work as professors of zoology, work as researchers, animal trainers, wildlife experts and contributes their knowledge for Nation building.

PSO1: Understand the nature and basic concepts of cell biology, genetics, taxonomy, physiology, ecology and applied Zoology and analyse the relationships among animals, plants, microbes and environment. Gain the Concept and Dynamics of ecosystem, Principles pertaining to limiting factors, Population Growth, Predation and Regulation, Global Environmental Issues and Pollution Biology.

PSO2: Get the concept of Bio-membrane, Cytoskeleton, the Organization of Chromosomes, Microbial genetics, Cell cycle, Sex determination and dosage compensation and Techniques and Methods in genetics. DNA replication, Transcription, translation and intra cellular protein trafficking. Acquire the knowledge of multiple ovulations, embryo transfer and assisted reproduction technologies, basic concept of development, differentiation, morphogenesis, organogenesis and understanding of stem cell biology.

PSO3: Understand the Principles and uses of analytical instruments, microscopy, separation and immunological techniques and biostatistics. Acquire the knowledge of Bioenergetics, Biochemistry of macro and micro molecules. Gain the concept of Biosystematics, Pattern of genetic variation and natural selection, Molecular evolution, Mechanism of speciation and Population genetics.

PSO4: Understand the innate and acquired immunology, Nature of Antigens, Structure and functions of Antibodies, Antigen- antibody interaction, Complement system, Cytokines, Organization and expression of immunoglobin genes and immune diseases. - Gain the knowledge of hormones, its biosynthesis, hormone receptors and principles of hormone action. Acquire the knowledge about basics of animal, social and reproductive behaviour biological rhythms and control of behaviour.

PSO5: Perform procedures as per laboratory standards in the areas of Taxonomy, Physiology, Ecology, Cell biology, Genetics, Applied Zoology, Clinical science, tools and techniques of Zoology, Toxicology, Entomology, Nematology, Sericulture, Biochemistry, Fish biology, Animal biotechnology, Immunology, Chemical biology, Genetic engineering and Research Methodology.

PSO6: Gains knowledge about research methodologies, effective communication and skills of problem-solving methods.

PSO7: Acquire awareness towards gender, environment, sustainability, human values, and professional ethics and understand the difference between acting, responding, reacting to various social issues.

Syllabus for M.Sc in Zoology

SEMESTER I-IV

Semester	Core Course (CC)	Elective Course (EC)	Discipline Specific Elective Course (DSE)	Generic Elective Course (GE)	Skill/Ability Enhancement Course(SEC)	Ability Enhancement Compulsory Course(AECC)
1	**MZOO-CC101:** Functional Biology of Invertebrates					**MAECC-101**
	MZOO-CC102: Molecular Cell Biology					
	MZOO-CC103: Genetics					
	MZOO-CC104: Practical(Core)					
2	**MZOO-CC205:** Environmental Science					
	MZOO-CC206: Bioinstrumentation & Biostatistics					
	MZOO-CC207: Biochemistry					
	MZOO-CC208 Biosystematics and Evolution					
	MZOO-CC209: Practical(Core)				**MZOO SEC-**201	
3	**MZOO-CC310:** Vertebrate Immunology					**MAECC 302:** Human Values and Professional Ethics and Gender Sensitization
	MZOO-CC311: Gamete and Developmental Biology					

	MZOO-CC312: Vertebrate Endocrinology					
	MZOO-CC313: Animal Behaviour					
	MZOO-CC314 Practical(Core)					
			MZOO-DSE 401: Chemical Biology			
			MZOO-DSE402: Chemical Biology Practical + Dissertation			
			MZOO-DSE 401: Cell and Molecular Biology			
			MZOO-DSE 402: Cell and Molecular Biology Practical + Dissertation			

Semester-I

MZOOCC- 101: Functional Biology of Invertebrates and Chordates

Full Marks - 70

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To comprehend the concept and organization of coelom and its significance

CO2- To learn and appreciate the invertebrate larvae, their types and significance; feeding pattern, mode of nutrition, mechanism and the organs associated in digestion; concept of respiration, respiratory pigments, and the mechanism of respiration in invertebrates.

CO3- To understand and describe the modes of excretion, organs involved in excretion and the mechanism of osmoregulation in invertebrates.

CO4- To Understand and describe the neurotransmitters, conduction of nerve impulse, muscle contraction and mechanism of thermoregulation in invertebrates.

Units	Existing Syllabus
1.	1.1 Organization of coelom and its significance 1.2 Patterns of feeding and digestion in invertebrates 1.3 Invertebrate larvae: Types and significance
2.	2.1 Respiratory pigments in different phylogenetic groups 2.2 Organs of Respiration in Invertebrates: Gills, Lungs and Trachea 2.3 Mechanism of Respiration in Invertebrates
3.	3.1 Organs of respiration in vertebrates: Gills, ARO and Lungs 3.2 Principles of gaseous exchange and Fick's modified equation 3.3 Transport of gases in blood and body fluid 3.4 Regulation of respiration (Neural and chemical control) 3.5 Respiratory adaptations at higher altitude and in diving mammals

4.	4.1 Patterns of nitrogenous excretion in different phylogenetic groups 4.2 Organs of excretion: Coelomoducts, nephridia, Malpighian tubules and kidney 4.3 Mechanism of osmoregulation and excretion in aquatic (freshwater and marine) and terrestrial animals 4.4 Mechanism of acid-base balance
5.	5.1 Thermoregulation in vertebrates 5.2 Mechanism of energetic of muscle contraction (Skeletal) 5.3 Physiology of electrical and synaptical transmitters in neurons 5.4 Neurotransmitters and their functions

Suggested Readings:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
3. Brusca R C (2016). Invertebrates. Published by Sinauer Associates, an imprint of Oxford University Press.
4. Ganguli et al (2018). Biology of Animals. NCBA Publications.
5. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
6. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
7. Pough H. *Vertebrate life*, VIII Edition, Pearson International.

Semester - I

MZOOCC- 102: Molecular Cell Biology Full Marks - 70

Time:3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To describe the concept of bio-membrane system i.e., their composition, structural arrangement, their types and mechanism of transport.

CO2- To describe the structure and function of microtubules and microfilament in cytoskeleton, role of kinesin and dynein, axonal transport and cell movement etc.

CO3- To understand the concept of DNA replication in Prokaryotes and Eukaryotes, DNA damage and repair mechanism; Transcription in Prokaryotes and Eukaryotes; Regulatory elements and DNA binding domains of transcription apparatus; Processing of primary transcript and RNA editing in eukaryotes.

CO4- To describe the mechanism of Gene Regulation in Prokaryotes and Eukaryotes.

Units	Existing Syllabus
1.	**(A) Bio membrane** 1.1 Molecular composition, arrangement and functional consequences 1.2 Models of bio-membrane 1.3 Transport across bio-membrane: diffusion, active transport and membrane pumps (P-type pump, V-type pump and ABC transporter) 1.4 Co-transport by symporters and antiporters **(B) Cytoskeleton** 1.5 Microtubules and microfilaments: structure and dynamics 1.6 Role of Kinesin and Dynein in intracellular transport 1.7 Axonal transport and cell movement (with respect to non-muscle motility)
2.	**DNA replication** 2.1 Outline of prokaryotic replication 2.2 Replication features of single stranded phages 2.3 Mechanism and machinery of replication in eukaryotes 2.4 DNA damage and repair mechanism

3.	**Transcription** 3.1 Outline mechanism of prokaryotic transcription 3.2 Organization of eukaryotic transcription machinery 3.3 General and specific transcription factors 3.4 Regulatory elements & DNA binding domains of transcription apparatus 3.5 Processing of primary transcript & RNA editing in eukaryotes
4.	**Translation** 4.1 Genetic code: Codon assignment and features 4.2 Outline of Prokaryotic translation 4.3 Eukaryotes translation: machinery (Ribosome & tRNA) 4.4 Eukaryotes translation: mechanism (lnitiation, elongation and termination)
5.	Intra cellular protein trafficking: 5.1 Targeting proteins to ER: Signal hypothesis 5.2 Co- and post- translational modifications of proteins 5.3Trafficking mechanisms: (a) Vesicular transport (b) Protein sorting (c) Endocytosis and exocytosis

Suggested Readings:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter:*Molecular Biology of the Cell*, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.

Semester - I

MZOOCC- 103: Genetics Full Marks - 70

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To differentiate between organization of prokaryotic and eukaryotic chromosomes; explain heterochromatin and functional significance of polytene and Lampbrush chromosomes.

CO2- To understand microbial genetics and reproduction in bacteria; construct linkage map in bacteria.

CO3- To understand and explain the concept of cell cycle, sex determination and dosage compensation.

CO4- To understand different techniques used in DNA sequencing, DNA amplification and DNA finger printing and analyze the genome expression.

Units	Existing Syllabus
1.	**Organization of Chromosomes** 1.1 Organization of prokaryotic chromosomes 1.2 organization of eukaryotic chromosome: Nucleosome as functional particle, 30 nm chromatin fibre, higher order structure of chromatin 1.3 Organization of centromere and kinetochore, organization of telomere and its maintenance 1.4 Heterochromatin: Types, organization, formation and significance 1.5 Structural organization and functional significance of polytene and Lampbrush chromosomes.
2.	**Microbial genetics** 2. 1 Transformation, conjugation, transduction and sexduction in bacteria 2.2 Construction of linkage map in bacteria 2.3 Molecular mechanism of recombination
3.	**Cell cycle** 3.1 Stages and check points in cell cycle 3.2 Genetics of cell cycle regulation: Role of cyclins and CDKs 3.3 Molecular basis of cellular check points

4.	**Sex determination and dosage compensation** 4.1 Genetic and Molecular basis of sex determination in *Coenorhabditis elegans*, Drosophila & human 4.2 Genetic basis of dosage compensation in *Coenorhabditis elegans*, Drosophila & mammals
5.	**Techniques & Methods in genetics** 5.1 DNA sequencing: Base destruction method, chain termination method and automated sequencing, Pyro- sequencing and whole genomic short-gun sequencing. 5.2 DNA amplification: Polymerase chain reaction, its application and limitations. 5.3 DNA finger printing: VNTR profiling, STR profiling (Autosomal & Y Chromosome), mitochondrial DNA profiling and SNP profiling 5.4 Genome expression analysis: Southern, Northern & Western blotting, Reverse Transcription PCR, DNA micro array.

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach.*III Edition. Benjamin Cummings
5. Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York and London.
6. Pierce BA (2012). Genetics- A Conceptual Approach. W H Freeman & Company

Semester - I

MZOOCC- 104 Practical Full Marks – 70

Course Outcome

On completion of the course students will be able:

CO 1- To prepare and demonstrate polytene chromosomes from Chironomus/ *Drosophila* larvae.

CO 2- To calculate mitotic index by preparing slides from onion root tip and study stages of meiosis by preparing slides from grasshopper testes.

CO 3- To enumerate RBC and WBC (TC and DC) by preparing blood smear and prepare slides of invertebrate larvae to show detailed structure.

CO 4- To solve problems related to concept of Mendelian principle of inheritance, sex-linked inheritance and pedigree of human.

Existing Syllabus
1st sitting 1. Squash preparation using any of the following: 10 (a) Chironomus/ *Drosophila* larvae for polytene chromosomes (b) Onion root tip for mitosis and mitotic index (c) Grasshopper testes for meiosis and related features 2. Experimental demonstration (any one of the following A and B): 10 (a) Enumeration of RBC (b) Enumeration of WBC (TC and DC) (c) Preparation of a histological slide of the given paraffin section/whole mount of an invertebrate larva 05 3. Identification and comment upon spots (cytological slides= 02) 05 (i) slides showing stages of mitosis; (ii) slides showing stages of meiosis
2nd sitting 4. Identification and comments upon spots (invertebrate slide-03, vertebrate slide-02) 10 Gills/trachea Nephridia Larval forms of *Fasciola hepatica* Crustacean larvae T.S of lung of mammal T.S. of kidney of mammal

5. Genetics (any of the following)	10
(a) Solving problems on Mendelian principles and sex-linked inheritance (b) Preparation of linkage map based on data from *Drosophila crosses* and tetrad analysis in *Neurospora* (c) Pedigree analysis in human	
6. Class records, charts/ models & field collection	10
7. Viva-voce	10

Semester - II

MZOOCC- 205: Environmental Science Full Marks - 70

Time:3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To understand the concept and dynamics of ecosystem, abiotic and biotic factors and different energy flow models. Describe biogeochemical and hydrological cycles.

CO2- To discuss the principles pertaining to limiting factors such as Liebig's law of minimum and Shelford's law of tolerance.

CO3- To understand demography, population growth and its regulation mechanism and gain the concept of niche, resource partitioning and character displacement.

CO4- To understand the global environmental issues and importance of wild life conservation. Define pollutants, its source and classification, biomagnification and eutrophication and bio-indicators as index of pollution.

Units	Existing Syllabus
1.	**Concept and Dynamics of ecosystem** 1.1 Energy flow (a) Lindemann's rule of trophic dynamics (b) Energy flow models 1.2 Biogeochemical cycles: Nitrogen, carbon, sulphur and phosphorous cycle
2.	**Principles pertaining to limiting factors** 2.1 Liebig's Law of minimum, Shelford's Law of tolerance 2.2 Concept &Law of limiting factors 2.3 Factors compensation and ecotypes
3.	**Population Growth, Predation and Regulation** 3.1 Demography: Life tables, Generation time, Net reproductive rate, Reproductive value 3.2 Population growth: Exponential growth, Verhulst-Pearl logisitic growth model, 3.3 Population regulation extrinsic and intrinsic mechanisms

	3.4 Concept of niche, niche width and overlap, fundamental and realized niche, Resource partitioning character displacement
4.	**Global Environmental Issues** 4.l Climate Change 4.2 Carbon Footprint 4.3 Water Security - conservation of surface and ground water 4.4 Wildlife conservation (a) Causes of extinction (b) Biosphere reserves (c) Wildlife protection Acts
5.	**Pollution Biology** 5. l Pollutants, their sources and classification 5.2 Biomagnification and Eutrophication 5.3 Thermal and Radioactive pollution 5.4Emerging pollutants: POPs, Pharmaceuticals 5.5 Bio-indicators as index of pollution and their significance

Suggested Readings:

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith Ecology and field biology Harper and Row publisher

Semester – II

MZOOCC- 206: Bio-instrumentation & Biostatistics Full Marks - 70

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To understand the principles and uses of analytical instruments, microscopy and different separation and immunological techniques.

CO2- To understand the basic concepts in biostatistics.

CO3- To learn to calculate mean, standard deviation, standard error, correlation and regression.

CO4- To understand the rules of probability and test of significance.

Units	Existing Syllabus
1.	1.1 Principles and uses of analytical instruments - pH meter, colorimeter, Spectrophotometer, Ultra-centrifuge. 1.2 Microscopy - Principles of light, Transmission Electron, Scanning Electron, Fluorescence, Phase-contrast and Confocal Microscopes. Photomicrography.
2.	**(A) Separation techniques** 2.1 Electrophoresis: SDS PAGE, Agarose gel Electrophoresis 2.2 Chromatography: Column, GLC, HPLC 2.3 Organelle separation by centrifugation 2.4 Cell separation by flow cytometry and density gradient centrifugation **(B) Immunological techniques** 2.5 Radio- immunoassay (RIA) 2.6 Enzyme-linked Immunosorbent assay (ELISA)
3.	3.1 Basic concepts in Biostatistics (sampling design, data collection and scaling techniques)

	3.2 Mean: Arithmetic, Geometric & Harmonic Mean 3.3 Standard Deviation 3.4 Standard Error 3.5 Analysis of Variance (ANOVA)
4.	4.1 Correlation (Karl Pearson and Rank's correlation) 4.2. Regression
5.	5.1 Rules of probability 5.2 Binomial probability distribution 5.3 Poisson probability distribution 5.4 Normal probability distributions 5.5Test of Significance (a)Chi-square test (b)Student's t-test

Suggested Readings:

1. John G Webster (2003). Bioinstrumentation. Wiley Publication
2. Reilly MJ (2018). Bioinstrumentation (PB 2018). CBS publication.
3. Donald L. Wise (1990). Bioinstrumentation: Research, Development and Applications. Butterworth-Heinemann Ltd (publisher)
4. Whitlock and Schluter (2008). The Analysis of Biological Data. Roberts and Company Publishers
5. Zar JH (2010). Biostatistical Analysis. Pearson publication.

Semester - II

MZOOCC- 207: Biochemistry Full Marks - 70

Time:3 hrs
Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To understand the laws of thermodynamics, enthalpy, entropy, concept of free energy, redox potential, energy rich compounds, mitochondrial electron transport chain and oxidative phosphorylation.

CO2- To explain different types of carbohydrates, glycolysis, HMP shunt, gluconeogenesis and glycogenolysis.

CO3- To understand the biochemistry of proteins and lipids, peptide conformation, synthesis and importance of fatty acids. Discuss enzymes, its mechanism of action, enzyme kinetics, free radicals and antioxidants.

CO4- To Explain the general principles of histochemistry of carbohydrate, protein, lipid, nucleic acids and enzymes. Understand the general principles of fixation and staining.

Units	Existing Syllabus
1.	**Bioenergetics** 1.1 Laws of thermodynamics, internal energy, enthalpy, entropy 1.2 concept of free energy, redox potential, energy rich compounds 1.3 Mitochondrial electron transport chain and oxidative phosphorylation
2.	**Biochemistry of Carbohydrates** 2.1 Monosaccharides and Disaccharides, Types and properties 2.2 Polysaccharides: Homopolysaccharide and Heteropolysaccharide 2.3 Glycolysis, HMP shunt, Glyconeogenesis and Glycogenolysis
3.	**Biochemistry of proteins and lipids** 3.1 Primary, secondary, tertiary, quaternary and domain structures 3.2 Stabilizing forces in protein structure 3.3 Peptide conformation (Ramachandran plot, helices, turns and sheets) 3.4 Biosynthesis of Urea 3.5 Free fatty acids: Synthesis and importance 3.6 β-Oxidation of long chain fatty acids

4.	**Enzyme Biochemistry** 4.1 Enzyme: Classification and nomenclature 4.2 Mechanism of enzyme action 4.3 Kinetics of enzyme catalyzed reaction 4.4 Non-genetic Regulation of enzyme activity: (a) Feedback inhibition (b) Allosteric inhibition 4.5 Free radicals, Antioxidants and detoxification
5.	**Principles of Histology and Histochemistry** 5.1 General principles of fixation and types of fixatives 5 .2 General principles of staining and types of dyes 5.3 General principles of histochemistry: (a) Carbohydrate (b) Protein (c) Lipid (d) Nucleic acids (e) Enzymes

Suggested Readings:

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

Semester - II

MZOOCC- 208: Biosystematics and Evolution Full Marks - 70

Time:3 hrs

Questions to be set in three parts representing all the five units. Part 1, will consist of l0 objective questions of 2 marks each. Part B will consist of five short questions (Four to be answered) of 5 marks each. Part C will consist of five questions (three to be answered) of l0 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To understand the basic concept of biosystematics and taxonomy, its importance and application in biology, hierarchy of categories, species concept, International code of Zoological nomenclature (ICZN) and trends in taxonomy.

CO2- To understand the pattern of genetic variation and natural selection (Darwinian and neo- Darwinian) and mode of its operation, mechanism of molecular evolution, neutral theory of molecular evolution and origin of new genes and evolution of multi gene family.

CO3- To explain the mechanism of speciation, reproductive isolation and its role in evolution and different models of speciation.

CO4- To understand the concept of gene pool, allele frequency and genotype frequency, Hardy-Weinberg principle of genetic equilibrium and its destabilizing forces such as Natural selection, Mutation, Migration, Meiotic drive and Genetic Drift.

Units	Existing Syllabus
1.	**Biosystematic** 1.1 Definition & basic concept of Biosystematics and taxonomy, its importance and application in biology. 1.2 Hierarchy of categories, outline of classification of animals, important criteria used for classification up to Classes in each phylum 1.3 Species concept : Biological and phylogenetic, sub-species and other Infraspecific categories, evolutionary relationship among taxa 1.4 International code of Zoological nomenclature (ICZN): operative principles, and important rules, Zoological nomenclature and scientific names of various taxa 1.5 Trends in taxonomy : chemo - taxonomy, cyto – taxonomy and molecular taxonomy
2.	**Pattern of genetic variation and natural selection** 2.1 Genetic polymorphisms, variation in chromosome structure, protein structure and nucleotide sequences

	2.2 Concept of Natural Selection (Darwinian and neo- Darwinian), mode of its operation: stabilizing, directional and disruptive modes of Natural Selection
3.	**Molecular evolution** 3.1 Variation in the evolution of protein and DNA sequences 3.2 Molecular phylogenies 3.3 Rates of molecular evolution and molecular clock 3.4 Neutral theory of molecular evolution 3.5 Origin of new genes and evolution of multi gene family
4.	**Mechanism of speciation** 4.1 Patterns and mechanisms of reproductive isolation and its role in evolution 4.2 Models of speciation : sympatric and allopatric
5.	**Population genetics** 5.1 Concept of Gene pool, allele frequency and genotype frequency 5.2 Hardy-Weinberg principle of genetic equilibrium and its mathematical derivation 5.3 Detailed account of destabilizing forces of genetic equilibrium: Natural selection, Mutation, Migration, Meiotic drive and Genetic Drift

Suggested Readings:

1. Ridley, M. (2004). Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
4. Indira P. Sarethy, Sharadwata Pan (2016). Biosystematics and Taxonomy. Publisher: Intelliz Press

Semester - II

MZOOCC- 209: Practical Full Marks - 70

Course Outcome

On completion of the course students will be able:

CO1- To determine the salivary amylase activity. Estimate glucose, urea, uric acid or albumen in a given sample by colorimetry. Separate amino acids by paper chromatography.

CO2- To identify and comment upon the spots of evolutionary significance.

CO3- To use the reagents such as PAS, Alcian Blue, Sudan Black B, Sudan III/IV, Feulgen, Methyl green- Pyronin and Mercury bromophenol for histochemical demonstration.

CO4- To measure pH and estimate dissolved 02, free CO2, carbonate & bicarbonate alkalinity and total hardness. To understand the composition & assess taxonomic diversity or biodiversity in a habitat (of grassland, arid & wetland).

Existing Syllabus

First Sitting

l. Biochemical experiments (any one of the followings) 10

(a) Determination of salivary amylase activity
(b) Colorimetric estimation of glucose, urea, uric acid or albumen in a given sample
(c) Separation of amino acids by paper chromatography
(d) Biochemical detection of glucose, starch, protein or lipid in a given sample

2. Identify and comment upon the spots of evolutionary significance (any one of the following): 10

(a) Archaeopteryx
(b) Darwin's finches
(c) Serial homology in cephalothoracic appendages in prawn
(d) Homology vs Analogy
(e) Adaptive radiation in beaks of birds

3. Histochemistry; Histochemical demonstration involving the following reagents: PAS, Alcian Blue, Sudan Black B, Sudan III/IV, Feulgen, Methyl green- Pyronin, Mercury bromophenol 10

or

Preparation of temporary mount of any two of the specimens of planktons

Second Sitting

4. Environmental studies (any one of the following) (i) Measurement of pH (ii) Estimation of dissolved 02 (iii) Estimation of free CO2 (iv) Estimation of carbonate & bicarbonate alkalinity (v) Composition & assessment of the taxonomic diversity / biodiversity in a habitat (of grassland, arid & wetland) (vi) Estimation of the total hardness	10
5. Biostatistics: Standard deviation, standard error, correlation, regression, t-test	10
6. Class record	10
7. Viva-voce	10

Semester-II

MZOOSEC-201 : Course title: Solid Waste Management

Time:3 hrs Full Marks - 40

Credit 5

Course Outcome

On completion of the course students will be able:

CO1- To describe the components of solid waste management and the laws governing it.

CO2- To discuss the solid waste collection systems, route optimization techniques and processing of solid wastes.

CO3- To outline the design, operation, and maintenance of different methods of treatment.

CO4- To describe the safety environmental issues. To conclude the recent trends in reuse of solid waste.

Unit	Topics (Existing Syllabus)
I	General introduction including definitions of solid waste including municipal, hospital and industrial solid waste; E-wastes; legal issues and requirements for solid waste management; solid waste management rules, 2016
II	Health and environmental issues related to solid waste management
III	Methods of waste collection, collection techniques, waste container compatibility, waste storage requirements, transportation of solid wastes
IV	Treatment and disposal techniques for solid wastes: composting, vermicomposting, autoclaving, microwaving, incineration, non-incineration thermal techniques, landfilling
V	Source reduction, product recovery and recycling recovery of biological conversion products: composts and biogas Incineration and energy recovery Integrated Waste Management (IWM)

Suggested Readings:

1. S. Bhupatthi Rav, Syeda Azeem Unnisa (2012). Sustainable Solid Waste Management
2. Ni-Bin Chang (2015). Sustainable Solid Waste Management

MZOOSEC-201 Practical:

Time:3 hrs Full Marks - 30

Course Outcome

On completion of the course students will be able:

CO1- To know about disposal of different wastes in waste-bin.

CO2- To learn method of composting and vermicomposting.

CO3- To learn methodology of Autoclaving.

CO4- To learn methodology of Biogas production.

Existing Syllabus
1. Awareness about disposal of different wastes in waste-bin (Concept of disposal of biodegradable, non-biodegradable and bio-hazardous wastes in different coloured bins) 2. Method of composting 3. Method of vermicomposting 4. Autoclaving 5. Biogas production

Assignments:

1. Global and Indian issues related to solid wastes
2. Health issues related to solid waste management
3. Environmental issues related to solid waste management
4. Disposal methods of biodegradable wastes
5. Disposal methods of non-biodegradable wastes
6. Disposal methods of recyclable wastes
7. Biomedical wastes and their disposal methods
8. E-wastes and their disposal
9. Landfilling method of solid waste disposal
10. Vermicomposting method of solid waste disposal

Semester - III

MZOOCC- 310: Vertebrate Immunology Full Marks-70

Time:3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To describe the evolution of immunology, historical perspective.

CO2- To describe the fundamental concept of Innate and adaptive immunity.

CO3- To develop the basic concepts of Antigenicity and immunogenicity.

CO4- To describe the molecular structure and function of major histo-compatibility complex and to describe the types of hypersensitivity and mechanism of tolerance.

Units	Existing Syllabus
1.	**Innate and Acquired Immunology** 1.1 cell types of innate and adaptive immunity, Lymphocyte trafficking 1.2 Phagocytosis and inflammation 1.3 Humoral immunity: β cell activation and differentiation, primary and secondary humoral response 1.4Cell mediated immunity: T - cell development and T-cell activation, CTL and NK cell mediated immunity
2.	**(A) Nature of Antigens** 2.1 Antigenicity and immunogenicity, and the factors influencing it. 2.2 Characteristics of β and T cell epitopes and haptens 2.3 Super antigen and its role in T cell activation 2.4 Antigen processing and presentation 2.5 MHC complex **(B) Structure and functions of Antibodies** (a) Gross and fine structure (b) Classes and sub-classes (c) Antibody mediated effector functions and monoclonal antibodies
3.	**(A) Antigen- antibody interaction and Complement system** 3.1 Antibody affinity and antibody avidity 3.2 Precipitation reactions

	3.3 Agglutination reactions 3.4 Complement System - activation pathway, biological function and complement deficiencies 3.5 ELISA **(B) Cytokines** : Classification and function, Cytokines receptors.
4.	**Organization and expression of lg genes** 4.1 Organization of lg genes 4.2 Generation of antibody diversity 4.3 BCR and Generation of T-cell receptor diversity
5.	**Immunology and Diseases** 5.1 Hypersensitivity (Type l, ll, ll, lV). 5.2 Auto-immunity 5.3 lmmune responses to infectious agents - bacterial, viral and parasitic infection (Protozoa and Helminth parasites). 5.4 lmmunodeficiencies

Suggested Readings:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Publication.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology,* VII Edition, Mosby, Elsevier Edition. Saunders Publication.
3. Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology.* V
4. Owen J A, Punt J, Stanford S A (2013). *Kuby Immunology* W H Freeman & Co;
5. Wood P. (2007). Basic Immunology. Pearson publication

Semester - III

MZOOCC- 311: Gamete and Developmental Biology Full Marks-70

Time: 3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To develop the basic concepts of development.

CO2- To explain the fundamental concept of embryogenesis.

CO3- To explain the fundamental concept of Organogenesis.

CO4- To describe the developmental model systems- invertebrates and vertebrates.

Units	Existing Syllabus
1.	**Gamete Biology** 1.1 Cellular basis of spermatogenesis and Biochemistry of semen 1.2 Ovarian follicular growth and differentiation 1.3 Oogenesis 1.4 Ovulation and ovum transport 1.5 Molecular events during fertilization
2.	**(A) Multiple ovulation and Embryo transfer technology** 2.1 ln vitro oocyte maturation 2.2 Super ovulation 2.3 ln vitro-fertilization **(B) Assisted Reproduction technologies** 2.4 Collection and preservation of gametes 2.5 lCSl GIFT & lmmuno - contraception
3.	**Basic concept of development** 3.1 Potency, commitment, specification, induction, competence, determination and differentiation 3.2 Morphogenetic gradients, cell fate and cell lineages, genomic equivalence and cytoplasmic determinants
4.	**Differentiation, morphogenesis and organogenesis** 4.1Cell differentiation: Role of cytoplasm and nucleus 4.2 Gene amplification and rearrangement during development 4.3 Axes and pattern formation in *Drosophila*. 4.4 Limb development and regeneration in vertebrates
5.	**Stem cell Biology** 5.1 Definition and characteristics of stem cell 5.2 Type of stem cell (embryonic, adult and cancer stem cell)

	5.3 Nuclear reprogramming of induced pluripotent stem cell, test for pluripotency 5.4 Potential application of stem cells, therapeutic cloning

Suggested Readings:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

Semester - III

MZOOCC- 312: Vertebrate Endocrinology Full Marks - 70

Time : 3 hrs
Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To understand basic principles of homeostatic regulation of biological systems.

CO2- To be familiar with the tools and techniques used in the study of hormones and chemical messengers.

CO3- To know the structures and biosynthetic pathways of major families of chemical messengers.

CO4- To recognize the diversity of hormone receptor systems and transduction pathways. To acquire a systems-based working knowledge of important hormonally regulated physiological processes.

Units	Existing Syllabus
1.	1.1 Aims and scope of endocrinology 1.2 Hormones as messengers 1.3 Chemical nature and gross features of hormones 1.4 Neuro-endocrine system and neurosecretion 1.5 Hypothalamic control of endocrine system
2.	2.1 Hormones involved in reproduction (a) Seasonal breeders (b) Continuous breeders 2.2 Hormonal regulation of reproductive cycle (a) Ovarian cycle (b) Menstrual cycle (c) Oestrus cycle
3.	3.1 Biosynthesis of steroid hormones 3.2 Biosyntheses of amino acid derived hormones (T4, epinephrine) 3.3 Biosynthesis of simple peptide hormones. Pre and Prohormones
4.	**Hormone Receptors** 4.1 p-adrenergic receptor 4.2 Insulin receptor 4.3 Steroid hormone receptor

5.	**General principles of hormone actions (signal transduction)** 5.1 Second messenger concept [G proteins, Nucleotides (cAMp, cGMp), Calcium,Calmodulin, Phospholipids 5.2 Lipid soluble hormones and intracellular receptor 5.3 Lipid insoluble hormone and intracellular signalling

Suggested Readings:

1. General Endocrinology C. Donnell Turner Pub- Saunders Toppan
2. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead. Oxford: BIOS Scientific Publishers; 2001.
3. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
4. Vertebrate Endocrinology by David O. Norris
5. Melmed S, Polonsky K , Larsen P R , Kronenberg H M (2016). Williams Textbook of Endocrinology

Semester - III

MZOOCC- 313: Animal Behaviour Full Marks - 70

Time:3 hrs

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To explain the relationship of behaviour and Cognition.

CO2- To explain Rhythmic behaviours.

CO3- To explain Social behaviours.

CO4- To explain feeding and Reproductive behaviour and describe behaviour assessment.

Units	Existing Syllabus
1.	**Basics of Animal Behavior** 1.1 Ethology- Definition, Branches, Significance 1.2 Approaches and methods in the study of Behavior 1.3 Patterns of Behavior- (a) Innate behavior- Kinases/ Taxes, Simple reflex, Comparison of reflex and complex behaviors,Instinct and, Motivation (b) Learned behavior- Habituation, Imprinting, Conditioned reflex, Trial & error learning, Reasoning and Cognition
2.	**Social Behavior** 2.1 Schooling in fish, Flocking in birds, 2.2 Social organization of Primates 2.3 Altruism: Reciprocal altruism, Inclusive fitness, group selection, and Kin - selection
3.	**Reproductive Behavior** 3.1 Evolution of sex and reproductive strategies 3.2 Mating system 3.3 Courtship & Parental Behaviors: Parental care and parental Investment
4.	**Biological Rhythms** 4.1 Circadian, Circannual, Lunar, Tidal and Epicycles 4.2 Navigation including orientation

5.	**Control of Behavior** 5.1 Neural control of behaviour 5.2 Hormones and Behavior 5.3 Ecological aspects of behavior: Habitat selection, Optimal foraging theory, and Aggressive behavior

Suggested Readings:

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge,University Press, UK.
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
5. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Semester - III

MZOOCC- 314: Practical Full Marks 70

Time : 6 hrs

Course Outcome

On completion of the course students will be able:

CO1- To develop skill of determination of blood group, preparation of blood film and identification of blood cells of immunological importance.

CO2- To do hormonal assessment of T3/Testesterone/Oestrogen by ELISA reader.

CO3- To identify and comment on endocrinological slides, embryological slides and endocrine glands in a mammal.

CO4- To prepare a permanent mount of chick embryo and identification to embryonic stages of chick. To learn behavioral aspects in animals such as parental care, caste system of given laboratory specimen and also learn methodology of communication in honey bees.

Existing Syllabus	
1. Any one of the immunological experiments (a) Determination of blood group using ABD antisera (b) Preparation of blood film and identification of blood cells of immunological importance (c) Hormonal assessment of T3/Testesterone/Oestrogen by ELISA reader	10
2. Identify and comment upon the given spots (a) Endocrinological slides-03 (b) Embryological slides (Frog) -02	10
3. Prepare a permanent mount of chick embryo or Identify and comment upon the exposed endocrine glands in a mammal	10
4. Comment upon the behavioural aspects of specimens provided (any two) (a) Parental care (Hippocampus, Cichilids, *Alytes*, Hyla, *Ichthyophis*) (b) Caste system (Honey bee/termites/ants) and its significance (c) Dance as means of communication in honey bees	10

5. Identification and comment upon the given embryonic stages of chick (any two) 10	
6. Class record	10
7. Viva Voce	10

List of Discipline Specific Elective (DSE) Courses :

S.No.	Existing syllabus	Revision requested
1	Chemical Biology	
2	Cell and Molecular Biology	

Semester - IV

MZOODSE- 401: Chemical Biology

Time : 3 hrs FM=70

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To discuss the basic principles of organic, medicinal, structural and biophysical chemistry of molecules, and their interactions in biological systems.

CO2- To demonstrate the basic concepts of drug discovery, drug designing and protein engineering using various techniques related to biochemistry.

CO3- To outline the basics of nanotechnology and its application in drug delivery for understanding diseases like cancer.

CO4- To simplify the functional genomic approaches in chemical biology.

Units	Existing Syllabus
1.	**(A) Basic Chemistry, Bioorganic Chemistry** 1.1 Chemical principles underlying biological systems 1.2 Basics of Organic, Medicinal, structural chemistry 1.3 Diversity and isolation, purification and synthesis of Natural products. 1.4 Spectroscopic and analytical methods for the characterization of small molecules. (TLC, Column chromatography, HPLC and GC). **(B) Biochemistry** 1.5 Chemical properties and synthesis of biomacromolecules. 1.6. Enzymes: catalysis, enzyme inhibitors, kinetics & regulation, catalytic triad.
2.	**Fundamentals of Chemical Biology** 2.1 Introduction to Chemical Biology 2.2 Application in drug discovery (principles, identification, screening-HTS) 2.3. Basic principles in animal experimentation. handling and care, routes of administration of drugs. 2.4 Basic principles of pharmacokinetics, Absorption, distribution, metabolism and Elimination (ADME).

3.	**Drug design and development** 3.1 Introduction to drugs and druggable targets, drug design, protein engineering. 3.2 methods of structural determination of proteins by NMR and crystallography, enzyme inhibitor complexes, 3.4 Structure activity relationship (SAR) e.g. Sulfanilamide-PABA), QSAR parameters.
4.	**Nanomaterials and drug delivery** 4.1 Introduction to nanotechnology, origin, properties and classification of nanomaterials. 4.2 Synthesis of different types of nanoparticles: physical, chemical and biological methods. 4.3 Characterization techniques: optical, UV, X-ray diffraction imaging, DLS, SEM, TEM and Atomic Force Microscope (AFM). 4.4 Application of nanoparticles as antimicrobial and anticancer agents. Use of Nanoparticles in drug delivery.
5.	**(A) Functional genomic approaches in chemical biology:** 5.1 Proteomics: Basic overview and its biological applications 5.2 Protein arrays; Protein identification by mass spectrometry (Maldi-tof-tof and ESI-MS). **(B) Basics in tumor biology and its progression** 5.3 Mechanism of carcinogenesis, Oncogenes, tumor suppressor genes, growth factors and signal transduction, angiogenesis; biomarkers of cancer. 5.4 Cancer cell receptors- PI3-K and AKT and others. 5.5 Anticancer therapeutics - different drugs for cancer therapy examples: small molecule drugs, monoclonal antibodies, small tyrosine kinase inhibitors 5.6 Cancer therapy- chemo resistance and alternative strategies, Ionizing radiation.

Suggested Readings:

1. Introduction to Bioorganic Chemistry and Chemical Biology by David Van Vranken and Gregory A. Weiss. Publisher: Garland Science
2. Chemical Biology: Learning Through Case Studies by Herbert Waldmann , Petra Janning. Wiley publication
3. Essentials of Chemical Biology: Structure and Dynamics of Biological Macromolecules by Andrew D Miller. Publisher: Wiley
4. Concepts and Case Studies in Chemical Biology by Herbert Waldmann, Petra Janning. Publisher: Wiley

Semester - IV

MZOODSE- 402: Chemical Biology **(**Practical + Dissertation) F.M.=70

Time : 6 hrs

Course Outcome

On completion of the course students will be able:

CO1- To perform experiments on chromatography.

CO2- To perform experiments to synthesize nanoparticles.

CO3- To perform experiments on isolation and purification of DNA and RNA from a given sample.

CO4- To perform experiments on esterification/hydrolysis reaction.

Practical=30 marks (10 marks CIA + 20 marks ESE)

Dissertation= 70 marks (20 marks CIA + 50 marks ESE)

Existing Syllabus	
1. Any one of the experiments (From 1,2 and 3): (i) Experiment on chromatography OR (ii) Synthesis of nanoparticles OR (iii) Green synthesis of nanomaterials	10
2. (a) Isolation and purification of DNA from bacteria/animal tissue/plant tissue OR (b)Isolation and purification of RNA from a given sample	10
3. Click chemistry experiment OR Esterification/hydrolysis reaction experiment	10
4. Records	05
5. Viva Voce	05
6. Dissertation	50

Semester - IV

MZOODSE- 401: Cell and Molecular Biology

Time:3 hrs Full Marks - 70

Questions to be set in three parts representing all the five units. Part A, will consist of 10 objective questions of 1 mark each. Part B will consist of six short questions (Four to be answered) of 6 marks each. Part C will consist of five long questions (three to be answered) of 12 marks each.

Course Outcome

On completion of the course students will be able:

CO1- To outline the mechanisms of gene expression and various regulatory pathways involved in both prokaryotes and eukaryotes at molecular level.

CO2- To summarize the cell cycle and proteins involved in the regulation and molecular defects leading to cancer.

CO3- To discuss various signal transduction pathways and their regulation at molecular level in a cell.

CO4- To investigate the new developments in molecular biology and its implications in human welfare using Recombinant DNA Technology.

Units	Existing Syllabus
1.	**Regulation and levels of regulation of gene expression in bacteria** 1.1 Basic concept of Prokaryotic gene regulation 1.2 Eukaryotic gene regulation (A) Post - transcriptional control involving alternate polyadenylation and alternate splicing (B) Translational control involving Ribosome selection, translation inhibition, mRNA degradation and gene silencing (RNA interference) 1.3 Post - transcriptional control involving alternate polyadenylation and alternate splicing 1.4Translational control involving Ribosome selection, translation inhibition, mRNA degradation and gene silencing (RNA interference)
2.	**Cancer Biology** 2.1 Cytology of cancer cells and types of cancer 2.2 Genetic basis: Oncogenes and tumour - suppressor genes 2.3 Chromosomal anomalies associated with cancer
3.	**Structural and functional organization of Nucleus** 3.1 Functional architecture of interphase nucleus and nuclear envelope 3.2 Ultra structure of nucleolus: organization of rDNA

	3.3 Nucleolar function: synthesis of rRNA, its processing and biogenesis of ribosomes 3.4 Mechanism of nuclear cytoplasmic exchange
4.	**Recombinant DNA Technology** 4.1 Tools and techniques (enzymes, vectors, cloning strategies) 4.2 Construction and screening of DNA libraries 4.3 Application of recombinant DNA technology
5.	**Transposable genetic elements and Epigenetics** 5.1 Discovery and definition: Ac/Ds elements in maize 5.2 Prokaryotic elements: Insertion sequences and transposons 5.3 Retrotransposons and DNA transposons in eukaryotes 5.4 Mechanism of transposition (conservative and replicative) 5.5 Epigenetics: Definition, molecular basis, mechanism and functional consequences

Suggested Readings:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter:*Molecular Biology of the Cell*, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.

Semester - IV

MZOODSE- 402: Cell and Molecular Biology (Practical +Dissertation)

F.M. = 70

Time: 6 hrs

Course Outcome

On completion of the course students will be able:

CO1- To perform experiments on vital staining of secretory granules and mitochondria.

CO2- To demonstrate cytochemical properties of proteins, lipids, carbohydrates and nucleic acids.

CO3- To identify and comment upon cytological slides.

CO4- To identify and analyze Barr body from buccal epithelial cells. To estimate sperm, count from epididymal wash of laboratory mammals and study abnormal sperms

Practical=30 marks (10 marks CIA + 20 marks ESE)

Dissertation= 70 marks (20 marks CIA + 50 marks ESE)

Existing Syllabus	
Any one experiment (From 1 and 3) 1.Vital staining of secretory granules and mitochondria	05
OR	
Cytochemical demonstration of proteins, lipids, carbohydrates and nucleic acids	
2. Identify and comments upon spots (1-5): Cytological slides	05
3. Any one of the following: a. Identification of Barr body from buccal epithelial cells. b. Estimation of sperm count from epididymal wash of laboratory mammals c. study of abnormalities in the head morphology of vertebrate sperms d. Isolation of DNA and its separation by agarose gel electrophoresis (demonstration only)	05
4.Practical records (including charts and model)	05
5.Viva-voce	05
6. Dissertation	50

Semester - IV

MZOOGE 401: Genetic Engineering

Time: 2 hrs Full Marks – 40

Course Outcome

On completion of the course students will be able:

CO1- To summarize various types of bacterial vectors (e.g., pBR322, pUC), Phage vectors (e.g., Lambda, M13) and Plant vectors (e.g., Ti, Ri) relevant to genetic engineering.

CO2- To apply the concept of cDNA and genomic libraries and various blotting techniques.

CO3- To demonstrate various molecular biology tools and techniques used in genetic engineering.

CO4- To apply the principles and techniques of molecular biology for further education and employment.

Units	Existing Syllabus
1.	Introduction and historical background of Restriction enzymes and other enzymes used in DNA manipulation; Cohesive and blunt end ligation
2.	Bacterial vectors- pBR322 and pUC vectors; Phage vectors – Lambda, M13, Cosmid and Phagemid; Artificial chromosomes – YAC, BAC, PAC, HAC; Expression vectors and Shuttle vectors. Plant vectors- Ti and Ri; Animal virus derived vectors- SV40, Vaccinia, Retro viral vectors.
3.	Introduction of foreign DNA into host cells; Construction of libraries; cDNA and genomic libraries; cDNA and genomic cloning. Immunological screening of expressed genes. Site directed mutagenesis.
4.	Primer design; Transfection techniques; Gene silencing techniques; Principle and applications of gene silencing; Gene knockouts; Gene therapy; Gene targeting; Transgenics; Possible risks and safety aspects of genetic engineering.
5.	Molecular techniques in prenatal diagnosis. Pharmaceutical products (Vaccine, Humilin etc). Application of gene cloning in Agriculture (GMO, crop improvement) and animal husbandary. Gene cloning in forensic science. Impact of gene cloning and bioethics

Suggested Readings:

1. Sambrook, J., Fritsch, E.F., and Maniatis, T., “Molecular cloning: A laboratory Manual”, Cold Spring Harbor Laboratory.

2. Brown, T.A., “Gene Cloning and DNA Analysis”, Blackwell Science.

3. Winnacker, E.L., “From Genes to Clones: An Introduction to Gene Technology”, VCH.

4. Old, R.W. and Primrose S.B., “Principles of Gene Manipulation”, Blackwell Scientific Publication.

5. Gupta, P.K., “Biotechnology and Genomics”, Rastogi Publications.

MZOOGE-402: Genetic Engineering (practical)

Time:3 hrs Full Marks - 30

Existing Syllabus	**Revision Requested**
1. Any two of the following experiments 10X2=20 i. Isolation of DNA from given tissue sample OR Isolation of plasmid by alkaline lysis method ii. Gel Electrophoresis of DNA samples and its observation iii. Determination of molecular weight of DNA iv. Preparation of competent bacterial cell by calcium chloride method v. X Ray diffraction studies of macromolecules. 2.Class Records 05 3.Viva voce 05	