

**SYLLABUS**  
**for**  
**Choice Based Credit System**  
**(CBCS)**

**On the basis of**  
**Outcome Based Education**  
**(OBE)**

**M.Sc. ZOOLOGY**  
**(w.e.f. 2019-20)**

**PATNA WOMEN'S COLLEGE**  
**Autonomous**  
**PATNA UNIVERSITY**

**3<sup>rd</sup> 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.

### Program Outcome

**PO1 Disciplinary knowledge:** Acquire comprehensive knowledge of major concepts, theoretical principles and experimental findings in zoology, and some of the applied areas of study such as wildlife conservation and management; environmental science; chemical biology, genetic engineering, various techniques, instruments, used for analysis of animals' forms and functions.

**PO2 Critical Thinking and Effective Communication:** Ability to engage in independent and reflective thinking in order to understand logic connections between ideas. Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.

**PO3 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.

**PO4 Multidisciplinary Approach and Subject Knowledge:** Combine various academic disciplines and professional specializations to cross borders in order to explore solutions based on the new understanding of complex situations. Acquire knowledge at a higher level that would help to develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providing valuable insights into learning and professional networking with the aim of catering to the local, national and global developmental needs.

**PO5 Lifelong Learning and Career building:** Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world. Enable the students to avail career opportunities in teaching, industry and research.

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 immunoglobulin 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.

## **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	<b>MZOO-CC101:</b> Functional Biology of Invertebrates					
	<b>MZOO-CC102:</b> Molecular Cell Biology					
	<b>MZOO-CC103:</b> Genetics					
	<b>MZOO-CC104:</b> Practical(Core)					
2	<b>MZOO-CC205:</b> Environmental Science					
	<b>MZOO-CC206:</b> Bioinstrumentation & Biostatistics					
	<b>MZOO-CC207:</b> Biochemistry					
	<b>MZOO-CC208</b> Biosystematics and Evolution					
	<b>MZOO-CC209:</b> Practical(Core)				<b>MZOO SEC-201</b>	
3	<b>MZOO-CC310:</b> Vertebrate Immunology					<b>MAECC 302:</b> Human Values and Professional Ethics and Gender Sensitization
	<b>MZOO-CC311:</b> Gamete and Developmental Biology					
	<b>MZOO-CC312:</b> Vertebrate Endocrinology					
	<b>MZOO-CC313:</b> Animal Behaviour					
	<b>MZOO-CC314</b> Practical(Core)					

4			<b>MZOO-DSE 401:</b> Entomology	<b>MZOO-GE 401:</b> Genetic Engineering		
			<b>MZOO-DSE 402:</b> Entomology Practical	<b>MZOO-GE 401:</b> Genetic Engineering Practical		
			<b>MZOO-DSE 401:</b> Chemical Biology			
			<b>MZOO-DSE 402:</b> Chemical Biology Practical			
			<b>MZOO-DSE 401:</b> Cell and Molecular Biology			
			<b>MZOO-DSE 402:</b> Cell and Molecular Biology Practical			
			<b>MZOO-DSE 401:</b> Cytogenetics			
			<b>MZOO-DSE 402:</b> Cytogenetics Practical			

## **MZOOCC- 101 Functional Biology of Invertebrates and Chordates**

### **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.

### **Unit - I**

1.1 Organization of coelom and its significance

1.2 Patterns of feeding and digestion in invertebrates

1.3 Invertebrate larvae: Types and significance

### **Unit - II**

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

### **Unit- III**

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

### **Unit - IV**

- 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

#### **Unit - V**

- 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
- 5.5 Acoustico-lateral system and electroreception in aquatic vertebrates

#### **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.

## **MZOOCC- 102: Molecular Cell Biology**

### **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.

### **Unit- I**

#### **(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)

### **Unit - II: 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 mechanisms

### **Unit- III: 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

## **Unit - IV: 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 (Initiation, elongation and termination)

## **Unit - V: Intra cellular protein trafficking:**

- 5.1 Targeting proteins to ER: Signal hypothesis
- 5.2 Co- and post - translational modifications of proteins
- 5.3 Trafficking 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.

## **MZOCC -103 Genetics**

### **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.

### **Unit- I: 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.

### **Unit II: 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

### **Unit III: 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

### **Unit IV: 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

### **Unit V: 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

## **MZOCC- 104 (Practical )**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To prepare and demonstrate polytene chromosomes from *Chironomus/ Drosophila* larvae.

**CO2-** To calculate mitotic index by preparing slides from onion root tip and study stages of meiosis by preparing slides from grasshopper testes.

**CO3-** To enumerate RBC and WBC (TC and DC) by preparing blood smear and prepare slides of invertebrate larvae to show detailed structure.

**CO4-** To solve problems related to concept of Mendelian principle of inheritance, sex-linked inheritance and pedigree of human.

### **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 comments upon spots (cytological slides: nos.= 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)
  - (i) Gills/trachea

(ii) Nephridia	
(iii) Larval forms of <i>Fasciola hepatica</i>	
(iv) Crustacean larvae	
(v) T.S of lung of mammal	
(vi) T.S. of kidney of mammal	10
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 <i>Drosophila crosses</i> and tetrad analysis in <i>Neurospora</i>	
(c) Pedigree analysis in human	
6. Class records, charts/ models & field collection	10
7. Viva-voce	10

## **MAECC -1**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To understand the sustainable development and ecosystem and discuss the environmental pollution, climate change, ozone layer depletion, threats of encroachment on habit and habitat of flora and fauna.

**CO2-** To understand biodiversity and its conservation, three 'R', environmental education, awareness programme and ecological economics.

**CO3-** To understand the importance of swachhata, sanitation and hygiene. Describe the Gandhian approach towards social and environmental moral values.

**CO4-** To study the case of sanitation and effect of cleanliness.

#### **A- Environmental Sustainability (3 Credit)**

#### **B- Swachha Bharat Abhiyan Activities (2 Credit)**

**A-Unit- 1** Environmental ethics & ecosystem: Concept of sustainable development with reference to human values in western and Indian perspective, sustainable development & conservation of natural resources (Nature, factors, structure, development and people participation) development, environment- rural and urban, concept of Ecosystem

**A-Unit-2** Development and its effect on environment: Environment pollution- water, air, noise etc. due to Urbanization, Industrial civilization, Concept of Global Warming, Climate change, Green House Effect, Acid rain, Ozone layer depletion, Menace of encroachment to impact on habit & habitat on indigenous flora & fauna

**A- Unit- 3** Concept of Biodiversity and its conservation: environment; degradation and conservation Govt Policies, Social effects and role of social reforms in this direction. Role of scientific conservation of environmental concept of Three 'R' (reduce, reuse, recycle). Need of environmental education and awareness programme and ecological economics.

**B-Unit- 4** Swachha Bharat Abhiyan: The concept of Swachhata as personal, Gandhian approach towards social and environmental moral values & concept of swachhata and its relation to moral Upgradation of society and freedom struggle, Awareness programme related to Swachhata. Role of ‘Swachhagrahis’ in Swachha Bharat Abhiyan.

Sanitation and hygiene, why sanitation is needed, sanitation and human rights, plantation, values of nature, concept of community participation and role of state agencies. Case study of Sanitation, effects of cleanliness, diseases- infectious and vector- born ideas of spread of diseases through body and other biological fluids and excreta.

**B-Unit- 5** Assignment/ Practical/ field work based on Unit- 4

or

Alternative to unit – 4 and unit- 5, a student can also enrol for Swachha Bharat Internship programme of MHRD

## **MAECC -2**

### **Course Outcome**

At the end of the course students will be able:

**CO1-** To understand the variety of moral issues, principles of ethics and morality and duties and rights of employees and employers.

**CO2-** To understand the vedantic ethics, ethics in finance, intellectual property rights, computer and professional ethics, management patterns.

**CO3-** To study the case of typical holistic technologies.

**CO4-** To define gender and understand the gender spectrum, gender-based division of labour-domestic work and use value. and know about the gender justice, human rights, constitutional and legal perspectives, emerging issues and challenges.

### **Human values and professional Ethics (3 credits)**

#### **Gender Sensitization (2 credits)**

**(One credit requires ten hours of theory and twenty hours of practical/assignment/field work)**

#### **Unit: 1 Variety of Moral Issues, principals of Ethics and Morality**

Understanding the harmony in the society (society being an extension of family), Integrity, Work ethics, Courage, Empathy, Self Confidence, Professional Ideas and Virtues, Ethics as a Subset of Morality, ethics and Organizations, Duties and Rights of employees and employers.

#### **Unit : 2 Holistic approach to corporate ethics**

Vendantic ethics- Tagore, Vivekananda, Gandhi and Aurobondo on ethics, Ethics in Finance, Business and Environment, Professional Rights, Intellectual property rights, Corporate responsibility, Social Audit and Ethic Investing, Computer and Ethics.

### **Unit : 3 Professional Ethics**

Augmenting Universal Human Order, Characteristics of people- friendly and eco-friendly production, Strategy for Transition from the Present state to Universal Human Order, At the level of Individual- as Socially and Ecologically Responsible Technologists and managers, at the Level of Society- as Mutually Enriching Institutions and organizations. case studies of typical holistic technologies and management patterns.

### **Unit: 4 Gender- An overview**

Gender: Definition, nature and evolution, culture, tradition, history, Gender spectrum: biological sociological, psychological conditioning, Gender based division of labour- domestic work and use value.

### **Unit: 5 Gender- Contemporary perspectives**

Gender justice and human rights: international perspectives, Gender: constitutional and legal perspectives, media and gender, Gender: emerging issues and challenges

## **MZOOCC -205 Environmental Science**

### **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.

### **Unit - I: Concept and Dynamics of ecosystem**

1.1 Abiotic factors and Biotic factors.

1.2 Energy flow

(a) Lindemann's rule of trophic dynamics

(b) Energy flow models

1.3 Biogeochemical cycles: Nitrogen, carbon, sulphur and phosphorous cycle

1.4 Hydrological cycles

### **Unit II: 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

### **Unit III: 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 logistic 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

### **Unit- IV: Global Environmental Issues**

4.1 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) National and International efforts for conservation (CITIES, IUCN, CBD)
  - (c) National parks and sanctuaries
  - (d) Biosphere reserves
  - (e) Wildlife protection Acts

### **Unit V: Pollution Biology**

- 5.1 Pollutants, their sources and classification
- 5.2 Causes, effects and control of Water and Air Pollution
- 5.3 Biomagnification and Eutrophication
- 5.4 Thermal and Radioactive pollution
- 5.5 Emerging pollutants: POPs, Pharmaceuticals
- 5.6 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

## **MZOOCC- 206 Bio-instrumentation & Biostatistics**

### **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.

### **Unit - I**

- 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.

### **Unit - II**

#### **(A) Separation techniques**

- 2.1 L 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)

### **Unit-III**

- 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)

### **Unit-IV**

- 4.1 Correlation (Karl Pearson and Rank's correlation)
- 4.2. Regression

### **Unit -V**

- 5.1 Rules of probability
- 5.2 Binomial probability distribution
- 5.3 Poisson probability distribution
- 5.4 Normal probability distributions
- 5.5 Test 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.

## **MZOCC- 207 Biochemistry**

### **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, glyconeogenesis 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.

### **Unit-I: 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

### **Unit-II: 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

### **Unit-III: 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  $\beta$ -Oxidation of long chain fatty acids

### **Unit - IV: 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

### **Unit - V: 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.

## **MZOOCC- 208 Biosystematics and Evolution**

### **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.

### **Unit- 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 Intraspecific 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

### **Unit - 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

### **Unit - 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

### **Unit- 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

### **Unit 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

## **MZOOCC- 209 (Practical)**

### **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 O<sub>2</sub>, free CO<sub>2</sub>, carbonate & bicarbonate alkalinity and total hardness. To understand the composition & assess taxonomic diversity or biodiversity in a habitat (of grassland, arid & wetland).

### **First Sitting**

- |   |    |
|---|----|
| 1. 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:<br>PAS, Alcian Blue, Sudan Black B, Sudan III/IV, Feulgen, Methyl green- Pyronin,<br>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)	10
(i) Measurement of pH	
(ii) Estimation of dissolved O <sub>2</sub>	
(iii) Estimation of free CO <sub>2</sub>	
(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	
5. Biostatistics:	10
Standard deviation, standard error, correlation, regression, t-test	
6. Class record	10
7. Viva-voce	10

## **MZOO SEC- 201 Solid Waste Management**

### **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.

<b>Unit</b>	<b>Topics</b>
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

## **MZOO SEC- 201 Solid Waste Management (Practical)**

## **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.

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

## **MZOOCC -310 Vertebrate Immunology**

### **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.

### **Unit I: Innate and Acquired Immunology**

1.1 cell types of innate and adaptive immunity, Lymphocyte trafficking

1.2 Phagocytosis and inflammation

1.3 Humoral immunity:  $\beta$  cell activation and differentiation, primary and secondary humoral response

1.4 Cell mediated immunity: T - cell development and T-cell activation, CTL and NK cell mediated immunity

### **Unit 2: (A) Nature of Antigens**

2.1 Antigenicity and immunogenicity, and the factors influencing it.

2.2 Characteristics of  $\beta$  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

### **Unit 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.

#### **Unit 4: Organization and expression of Ig genes**

- 4.1 Organization of Ig genes
- 4.2 Generation of antibody diversity
- 4.3 BCR and Generation of T-cell receptor diversity

#### **Unit 5: Immunology and Diseases**

- 5.1 Hypersensitivity (Type I, II, III, IV).
- 5.2 Auto-immunity
- 5.3 Immune responses to infectious agents - bacterial, viral and parasitic infection (Protozoa and Helminth parasites).
- 5.4 Immunodeficiencies

#### **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 Lichtman 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

## **MZOCC-311 Gametes and Developmental Biology**

### **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.

### **Unit-I: Gamete Biology**

1.1 Cellular basis of spermatogenesis and Biochemistry of semen

1.2 Ovarian follicular growth and differentiation

1.3 Oogenesis and vitellogenesis

1.4 Ovulation and ovum transport

1.5 Molecular events during fertilization

### **Unit- II:**

(A) Multiple ovulation and Embryo transfer technology

2.7 In vitro oocyte maturation

2.2 Super ovulation

2.3 In vitro-fertilization

(B) Assisted Reproduction technologies

2.4 Collection and preservation of gametes

2.5 ICSI GIFT & Immuno - contraception

### **Unit- III: 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.

### **Unit- IV: Differentiation, morphogenesis and organogenesis**

4.1 Cell 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

### **Unit- V: 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

## **MZOOCC-312 Vertebrate Endocrinology**

### **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.

### **Unit- I**

- 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

### **Unit- II**

- 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

### **Unit-III**

- 3.1 Biosynthesis of steroid hormones
- 3.2 Biosyntheses of amino acid derived hormones (T4, Iipinephrine)
- 3.3 Biosynthesis of simple peptide hormones. Pre and Prohormones.

### **Unit- IV Hormone Receptors:**

- 4.1 p-adrenergic receptor
- 4.2 Insulin receptor
- 4.3 Steroid hormone receptor

### **Unit-V: 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

### **MZOOCC-313 Animal Behaviour**

#### **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.

### **Unit-I: 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

### **Unit- II: 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

### **Unit- III: Reproductive Behavior**

- 3.1 Evolution of sex and reproductive strategies
- 3.2 Mating system
- 3.3 Courtship & Parental Behaviors: Parental care and parental Investment

### **Unit- IV. Biological Rhythms**

- 4.1 Circadian, Circannual, Lunar, Tidal and Epicycles
- 4.2 Navigation including orientation

### **Unit-V. 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.

### **MZOCC- 314: (Practical )**

#### **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/Testosterone/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.

- |  |    |
|--|----|
| 1. Any one of the immunological experiments  | 10 |
| (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/Testosterone/Oestrogen by ELISA reader                         |    |
| 2. Identify and comment upon the given spots   | 10 |
| (a) Endocrinological slides-03   |    |
| (b) Embryological slides (Frog) -02  |    |
| 3. Prepare a permanent mount of chick embryo   |    |
| or   | 10 |
| Identify and comment upon the exposed endocrine glands in a mammal                           |    |
| 4. Comment upon the behavioural aspects of specimens provided                                | 10 |
| (any two)  |    |
| (a) Parental care (Hippocampus, Cichlids, <i>Alytes</i> , <i>Hyla</i> , <i>Ichthyophis</i> ) |    |
| (b) Caste system (Honey bee/termites/ants) and its significance                              |    |
| (c) Dance as means of communication in honey bees  |    |

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

## **MZOODSE - 401 Entomology**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To compare and differentiate the morphology and anatomy of Insects.

**CO2-** To summarize the histological importance of the following systems: digestive, respiratory, nervous, circulatory, excretory and reproductive system.

**CO3-** To explain the importance of following systems: The Sense organs, Endocrine glands and Exocrine glands.

**CO4-** To discuss the importance of Integrated Pest Management, fundamentals of agricultural, veterinary and forensic entomology.

### **Unit- I: (A) Classification and morphology**

- 1.1 Origin of insects and outline of classification of class Insecta upto suborders
- 1.2 General organization of insect body
- 1.3 Comparative study of Antennae and their modification
- 1.4 Comparative study of Mouth parts: structure, modification and function
- 1.5 Comparative study of Legs and their modification
- 1.6 Compound eye: structure including image formation
- 1.7 Integument: Structure and moulting

### **Unit- II: Insect Physiology and neuro-endocrinology**

- 2.1 Alimentary canal: Structure and physiology of digestion.
- 2.2 Tracheal system: Structure and physiology of Respiration.
- 2.3 Excretory system: Structure and types of Malpighian tubules, Physiology of Excretion and osmoregulation.
- 2.4 Haemolymph: Composition and function
- 2.5 Brain: Protocerebrum, Deutocerebrum & Tritocerebrum
- 2.6 Ventral nerve cord and ganglia
- 2.7 Neuro-endocrine glands: Types, structure & function
- 2.8 Neuro-haemal organs: corpora cardiaca and Aorta

### **Unit- III: Insect Control and Management, chemical secretions and functions**

- 3.1 Chemical Control: Types (Chitin synthesis inhibitor, ecdysoids, juvenoids and antihormones) merits and demerits
- 3.2 Biological control: Types (parasites, parasitoides and predators) merits and demerits
- 3.3 Integrated Pest Management (IPM): Definition, tool, basic principle and importance
- 3.4 Pheromones
- 3.5 Diapauses
- 3.6 Attractants, repellants and anti-feedants

### **Unit- IV: Reproduction and Development**

- 4.1 Male reproductive organs: Testes, Vas deferens, ejaculatory duct, accessory glands & seminal vesicles
- 4.2 Female reproductive organs: ovaries, types of ovarioles, oviduct & common oviduct and accessory glands
- 4.3 Types of Larvae and their metamorphoses

### **Unit -V: Agricultural, veterinary and Forensic Entomology**

- 5.1 Pests of paddy: Life history and control measures
- 5.2 Pests of Wheat: Life history and control measures
- 5.3 Pests of Sugarcane: Life history and control measures
- 5.4 Pests of Vegetable: Life history and control measures
- 5.5 Insect of medical importance associated with disease transmission (Malaria, Filaria and Kala-azar): Biology and control
- 5.6 Insects of Forensic importance

### **Suggested Readings:**

1. Insect Biology: A textbook of Entomology by Howard E Evans. Publisher: Addison-Wesley;
2. The Insects: Structure and Function by R F Chapman. Publisher: Cambridge University Press
3. Principles of Insect Morphology by RE Snodgrass. Publisher: NCROL
4. Insects: An outline of Entomology by PJ Gullan. Publisher: Springer;

## **MZOODSE - 402 Entomology (Practical)**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To dissect grasshopper or honey bee or wasp to expose and investigate its general anatomy and nervous system.

**CO2-** To prepare permanent slides of different parts of insects.

**CO3-** To identify and comments upon morphological and histological slides of insects.

**CO4-** To summarize the life history of pests.

Ist sitting

- |   |         |
|---|---------|
| 1. Any one of the following experiments:  | 10      |
| (i) Dissection of grasshopper or honey bee or wasp to expose general anatomy and nervous system |         |
| or  |         |
| (ii) Identification of any two Insects (5x2)  |         |
| 2. Permanent slide preparation of any one   | 10      |
| (i) Whole specimen (small insect)   |         |
| (ii) Mouth parts  |         |
| (iii) Antennae  |         |
| (iv) Legs   |         |
| (v) Wings   |         |
| (vi) poison apparatus   |         |
| (vii) External genitalia  |         |
| (viii) Spiracles  |         |
| (ix) Gills of aquatic insect  |         |
| 3. Identification and comments upon spots 1-5   | 2x5= 10 |
| (i) Morphological slides -2   |         |
| (ii) Histological slides -2   |         |
| (iii) Damaged material by a pest- 1   |         |

## 2nd sitting

4. Identification and life history of any one pest	10
5. Field works and records	05
6. Viva voce	05
7. Dissertation	20

### **MZOODSE - 401 Chemical Biology**

#### **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.

#### **Unit – I: (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 Central dogma of molecular biology, chemical properties and synthesis of biomacromolecules.

1.6. Enzymes: catalysis, enzyme inhibitors, kinetics & regulation, catalytic triad.

#### **Unit – II: 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).

#### **Unit – III: 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., Sulphanilamide-PABA), QSAR parameters.

#### **Unit – IV: 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.

#### **Unit –V: (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

## **MZOODSE - 402 Chemical Biology (Practical)**

### **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.

### Ist Sitting

1. Any one of the following experiments: 15
  - (i) Experiment on chromatography
  - OR
  - (ii) Synthesis of nanoparticles
  - OR
  - (iii) Green synthesis of nanomaterials
  
2. (a) Isolation and purification of DNA from bacteria/animal tissue/plant tissue
- OR
- (b) Isolation and purification of RNA from a given sample 15

### 2<sup>nd</sup> Sitting

3. Click chemistry experiment	10
OR	
Esterification/hydrolysis reaction experiment	
4. Records	05
5. Viva Voce	05
6. Dissertation	20

## **MZOODSE - 401 Cell and Molecular Biology**

### **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.

### **Unit I: Regulation and levels of regulation of gene expression in bacteria**

1.1 Inducible system: Lac operon with negative control and Positive control (CAP/ cAMP regulation)

1.2 Repressible system: Tryptophan operon and mechanism of attenuation in *E. coli* & *B. subtilis*

1.3 Transcriptional control involving chromatin remodelling and genome imprinting

1.4 Post - transcriptional control involving alternate polyadenylation and alternate splicing

1.5 Translational control involving Ribosome selection, translation inhibition, mRNA degradation and gene silencing (RNA interference)

### **Unit II: Cancer Biology and Apoptosis**

2.1 Cytology of cancer cells and types of cancer

2.2 Genetic basis: Oncogenes and tumour - suppressor genes

2.3 Machinery of programmed cell death

2.4 Extrinsic and intrinsic pathways

2.5 Control of programmed cell death

### **Unit-III: 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

### **Unit-IV: 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

### **Unit-V: 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.

## **MZOODSE - 402 Cell and Molecular Biology(Practical)**

### **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

#### 1st sitting

1. Vital staining of secretory granules and mitochondria 15

OR

Cytochemical demonstration of proteins, lipids, carbohydrates and nucleic acids

2. Identify and comments upon spots (1-5): Cytological slides 10

#### 2nd sitting

3. Any one of the following: 15

- 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)

4. Practical records (including charts and model)	05	
5. Viva-voce		05
6. Dissertation		20

## **MZOODSE – 401 Cytogenetics**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To summarize the cell cycle and proteins involved in the regulation and genetic basis of cancer.

**CO2-** To explain and compare the molecular mechanism of mutation and recombination and disease related to them.

**CO3-** To discuss and perform experiments on various tools and techniques in molecular biology used for genetic analysis.

**CO4-** To explain the genetics of development in model organism: *Caenorhabditis elegans*.

### **Unit-I**

- 1.1 Chromatin remodelling in eukaryotes
- 1.2 Human karyotype, chromosome banding
- 1.3 Epigenetics and human disease
- 1.4 Genetics of cancer: Oncogene, tumour suppressor gene

### **Unit - II**

- 2.1 Mutation: Molecular mechanism, and detection
- 2.2 Molecular mechanism of recombination
- 2.3 Inbreeding and heterosis
- 2.4 Mitochondrial and plastid genetic system

### **Unit-III**

- 3.1 Gene amplification and position effect in *Drosophila*
- 3.2 Nucleic acid hybridization: DNA-DNA, DNA-RNA hybridization, FISH
- 3.3 Southern and Northern blotting
- 3.4 Genetic polymorphism

### **Unit- IV**

- 4.1 Restriction fragment length polymorphism (RFLP)
- 4.2 Random amplification of polymorphic DNA (RAPD)
- 4.3 Single nucleotide polymorphism (SNP)
- 4.4 Physical and genetical mapping
- 4.5 Next generation DNA sequencing

#### **Unit - V**

- 5.1 Genetics of development: Genetic control of embryonic development in *C. elegans*
- 5.2 Immunogenetics: Antibody diversity, clonal selection and immunogenic memory.
- 5.3 Gene cloning: Restriction endonuclease, vectors, DNA libraries
- 5.4 Application of recombinant DNA technology

#### **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

## **MZOODSE – 402 Cytogenetics (Practical)**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To examine meiosis in grasshopper testis.

**CO2-** To investigate polytene chromosomes and its banding pattern.

**CO3-** To detect micronuclei in cheek cell/fish erythrocytes.

**CO4-** To solve genetic problems related to Mendelian laws, linkage & crossing over, sex linked inheritance.

1. Study of meiosis in grasshopper testis	10
2. (i) Cytological study of polytene chromosomes and its banding pattern	10
(ii) Detection of micronuclei in cheek cell/fish erythrocytes	
(iii) Isolation of DNA from the tissue provided	
3. Designing of experiment and its interpretation of results in <i>Drosophila</i> OR solving a genetic problem related to Mendelian laws, linkage & crossing over, sex linked inheritance.	10
4. Identification and comments upon various items of cytological and genetic interest	2X5=10
5. Class record	05
6. Viva-voce	05
7. Project work	20

## **MZOOGE 401 Genetic Engineering**

### **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.

### **Unit I**

Introduction and historical background of Restriction enzymes and other enzymes used in DNA manipulation; Cohesive and blunt end ligation; Preparation of DNA and RNA probes; colony hybridization; Methyl interference assay

### **Unit II**

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.

### **Unit III**

Introduction of foreign DNA into host cells; Construction of libraries; cDNA and genomic libraries; cDNA and genomic cloning. Blotting techniques- Southern/ Northern/ Western. Immunological screening of expressed genes. Site directed mutagenesis.

## **Unit IV**

Polymerase chain reaction (PCR); Primer design; Transfection techniques; Gene silencing techniques; Introduction of siRNA; siRNA technology; MicroRNA; Construction of siRNA vectors; Principle and applications of gene silencing; Gene knockouts; Gene therapy; Gene targeting; Transgenics; Possible risks and safety aspects of genetic engineering.

## **Unit V**

Molecular techniques in prenatal diagnosis, gene therapy. 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)**

### **Course Outcome**

On completion of the course students will be able:

**CO1-** To learn to perform experiments for isolation of genomic DNA and plasmid from given sample.

**CO2-** To determine molecular weight of DNA.

**CO3-** To prepare competent bacterial cell by calcium chloride method.

**CO4-** To perform experiments X Ray diffraction of macromolecules.

## **MZOOGE-401: Genetic Engineering (practical)**

Time:3 hrs

Full Marks - 30

Q1. 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.

Class Records

05

