

# **J.C. Bose University of Science & Technology, YMCA Faridabad**

(NAAC Accredited “A” Grade University of State Govt. established by Haryana  
State Legislative Act No.21 of 2009)

## **Department of Life Sciences (w.e.f. 2020)**



### **Scheme and Syllabi**

#### **M.Sc. Zoology**

#### **(SEMESTER- I and II)**

**(w.e.f 2020)**

## ANNEXURE-I

### Scheme of M.Sc. Biotechnology

SEMESTER-I										
Sr. No.	Course Code	Subject	Teaching Hours per Week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS-101	Cell Biology	4			25	75	100	4	DCC
2	MLS-102	Structure and Functions of Biomolecules	4			25	75	100	4	DCC
3	MLS-103	General Microbiology	4			25	75	100	4	DCC
4	MLS-104	Molecular Biology	3			25	75	100	3	DCC
5	MLS-105	Biostatistics	3			25	75	100	3	DCC
6	MLS-106	Lab Course- I (Based on MLS 101-102)			6	30	70	100	3	DCC
7	MLS-107	Lab Course- II (Based on MLS 103- 105)			6	30	70	100	3	DCC
8	MLS-108	MOOC*								
<b>Total Marks</b>								<b>700</b>	<b>24</b>	

DCC: Discipline Core Course; MOOC: Massive Online Open Course, L: Lecture; T: Tutorial; P: Practical

\*The students have to pass at least one mandatory MOOC course with 4-6 credits (12-16 weeks) from the list given on the Swayam portal or the list given by the department/ university from 1st semester to 3rd semester as notified by the university.

#### Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website <https://swayam.gov.in> in the month of June and November every year for the forthcoming semester.

2. The department coordinators will be the course coordinators of their respective departments.

3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme Duration for M.Sc./M.Tech./MA/MBA: Sem. I to Sem. III

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.

5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.

6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.

7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.

8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.

9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

## ANNEXURE-II

Scheme of M.Sc. Biotechnology										
SEMESTER-II										
Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS-201	Biotechniques	4			25	75	100	4	DCC
2	MLS-202	Metabolism	4			25	75	100	4	DCC
3	MLS-203	Bioinformatics and Biomolecular Modelling	3			25	75	100	3	DCC
4	MLS-204	Genetic Engineering	3			25	75	100	3	DCC
5	MLS-205	Environment and Ecology	4			25	75	100	4	DCC
6	MLS-206	Lab Course- I (Based on MLS 201-202)			6	30	70	100	3	DCC
7	MLS-207	Lab Course- II (Based on MLS 203- 205)			6	30	70	100	3	DCC
8	MLS-208	Audit Course**	2	0	0	25	75	100	0	AUD
	<b>Total Marks</b>							<b>800</b>	<b>24</b>	

\*\* The students have to choose one Audit course from the list provided by the department/ university.  
Only passing of the audit course is mandatory.

## Semester-I

**Course Code: MLS-101**

**Subject: Cell Biology**

**No. of Credits: 04**

**L P**

**4 0**

Maximum Marks: 100

Theory Exam: 75

Sessional: 25

**Course Objectives:** To understand structural and functional aspects of cells and basic mechanisms underlying cell signaling and cell division

### Unit-I

Biomembranes: Molecular composition and arrangement, functional consequences, Transport Recapitulation of the plasma membrane; diffusion, active transport and pumps, uniports, symports and antiports, Donnan equilibrium; ion movements and cell function: acidification of cell, organelles and stomach, Maintenance of cellular pH; cell excitation; bulk transport; Receptor mediated endocytosis, Transepithelial transport

The Extra Cellular Matrix, and Cell interactions, Cell walls, The ECM and cell-matrix, nteractions, Cell-cell interactions: adhesion junctions, tight junctions, gap junctions,

plasmodesmata Ca<sup>++</sup> Dependent and Ca<sup>++</sup> Independent Homophilic cell-cell adhesion

### Unit-II

Cytoskeleton and cell movement: Structure and organization of actin filaments, Actin, myosin and cell movements, Structure and dynamic organizations of microtubules, Microtubule motors and movement, Intermediate filaments, Cilia and flagella, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Auxin and cell expansion, Cellulose fibril synthesis and orientation, Protein sorting and transport, Protein uptake into the ER, Membrane proteins and Golgi sorting, Mechanism of vesicular transport, Lysosomes, Molecular mechanism of secretory pathway.

### **Unit-III**

Cell cycle: The eukaryotic cell cycle, Regulators of cell cycle progression, The events of M phase, Meiosis and fertilization, Genome organization, Chromosomal organization of genes and non-coding DNA, Mobile DNA, Morphological and functional elements of eukaryotic chromosomes, Cell – Cell signalling, Signaling molecules and their receptors, Function of cell surface receptors, Pathways of intracellular signal transduction, Signaling networks

### **Unit-IV**

Cell death and cell renewal: Programmed cell death, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, The development and causes of cancer, Oncogenes, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing

### **Course Outcomes:**

CO1.Students will know about the cell and its biology, which will help the students to understand the origins of cells and the generation of cell diversity, as well as the common features of cellular structure and function –how they obtain energy, synthesize new molecules, communicate, proliferate and survive.

CO2.Students will understand the structures and purposes of basic components of cell cycle.

CO3.Students will understand the cellular components underlying cell movements and cytoskeleton.

CO4.The understanding of cells is used for learning the processes such as, cell death and cell renewal, stem cells and biology of cancer etc.

### **Suggested Readings:**

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc.,USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York
3. Cell and Molecular Biology by De Robertis
4. Molecular Cell Biology, Lodish et al., W.H. Freeman and Company (8th Ed. 2016)

## Semester-I

**Course Code: MLS-102**

**Subject: Structure and Functions of Biomolecules**

**No. of Credits: 04**

**L P**

**4 0**

Maximum Marks: 100

Theory Exams: 75

Sessional: 25

**Course Objectives:** To learn about structure and bonding in water, its significance as biological solvent, study of carbohydrates, Amino acids, proteins, lipids, nucleic acids

### Unit-I

**Water :** Structure, hydrogen bonding, as a biological solvent, ionization and fitness of the aqueous environment for living organisms; pH; Buffers; Henderson-Hasselbalch equation; Physiological buffers.

**Carbohydrates :** Structure, occurrence and biological importance of important monosaccharides, oligosaccharides and polysaccharides; Ring structures and anomeric forms; mutarotation; sugar derivatives; reactions of monosaccharides; Glycosaminoglycans; Heteropolysaccharides of bacterial and algal cell walls; Proteoglycans; Glycoproteins; Lectins.

### Unit-II

**Amino acids and Proteins :** Common structural features, classification by R group, Zwitter ion structures, acid-base properties and titration curves of amino acids; Essential amino acids; Separation of amino acids; Peptides including biologically active peptides; Classification and different structural levels (Primary, secondary, tertiary & quaternary) of proteins; Ramachandran plot; Determination of amino acid composition of proteins; Characteristic amino acid composition of proteins; Determination of amino acid sequences of proteins; Effect of amino acid sequence on the function of a protein and stability of  $\alpha$ -helix; Protein folding and role of chaperons in protein folding; Chemical synthesis of polypeptides.

### Unit-III

**Lipids :** Classification, structures, nomenclature and properties of fatty acids; Essential fatty acids; Acylglycerols; Characterization of fats-Saponification value, iodine number, rancidity, acid value, Reichert-Meissel number; Structure and properties of different types of phospholipids and sphingolipids (sphingomyelins, cerebroside & gangliosides); Structure and functions of prostaglandins, Prostacyclins, Thromboxanes, and Leukotrienes; Terpenes of biological significance; Sterols and bile acids.

### Unit-IV

**Nucleic Acids:** Structure and properties of purines and pyrimidine bases; Nucleosides and Nucleotides; Biologically important nucleotides; Nucleic acids as the genetic material – experimental evidences; Chargaff's rules; The covalent backbone of nucleic acids; Double helical model of DNA structure; Structural polymorphism of DNA (A, B and Z-DNA) and RNA; Denaturation & annealing of DNA; Biological functions of nucleotides; Chemical synthesis of oligonucleotides.

### Course Outcomes:

After the successful completion of the course the learner would be able to  
CQ.1.comprehend the importance of chemical foundation in living organisms

CQ.2.analyzethe various types of weak interactions between the biomolecules and water

CQ.3.correlate how the large biomolecules such as proteins, carbohydrates, lipids, nucleic acids are made from the simple precursors

CQ.4. interpret the structure-functionrelationships ofthe proteins, carbohydrates, lipids, and nucleic acids

**Suggested Readings:**

i) *Liljas, Anders***Textbook of structural biology** New Jersey: World Scientific, cop. 2009

1) Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6 th ed. Freeman, 2006.

2) D.A. Harris. Bioenergetics at a glance. John Willey and Sons Ltd, 1995.

3) Nelson.D.L, Cox. M. M. Lehninger's .Principle of Biochemistry. 6 th ed. Freeman, 2009

4) Voet and Voet. Biochemistry.4th edition, John Wiley, 2010.

**Semester-I****Course Code: MLS-103****Subject: General Microbiology****No. of Credits: 04****L P****4 0**

Maximum Marks: 100

Theory Exam: 75

Sessional: 25

**Course Objectives:** To study the fungi, bacteria, virus, microbial; classification and taxonomy, Sterilization methods and microbial ecology

**Unit – I**

Fungi: Introduction and classification: Thallus organisation, cell structure and cell wall composition, Nutrition, reproduction (vegetative, asexual and sexual), life cycles, Classification of fungi. and Economic importance of fungi. History and contributions of various scientists to this science with particular reference to the contribution of the following scientists A.V.Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch, Alexander Fleming and Joseph Lister.

Morphology and arrangement of bacterial cells, Bacterial- flagella, Fimbriae, capsule, spores and cysts, cell walls of Gram +ve and Gram –ve bacteria, Nutritional requirements and nutritional categories of microorganisms, Physical factors for growth, Enrichment culture techniques for isolation of microorganisms, pure culture techniques and preservation techniques, study of growth curve, measurement of growth.

**Unit – II**

Distinguishing features of bacteria, viruses, fungi, protozoa, algae. Introduction to Microbial Classification and Taxonomy, Taxonomic ranks, Various approaches for identification of microorganisms including molecular approaches; Gram (+) and Gram (-) bacteria of medical and industrial importance. Characteristics of Mycobacterium and Mycoplasmas; photosynthetic prokaryotes (purple bacteria, green bacteria, cyanobacteria) and actinomycetes; brief account of different types of viruses with special reference to lambda phage, herpes, adenoviruses and retroviruses, viroids and prions; fungi and algae of industrial importance.

**Unit – III**

Sterilization methods- dry heat, moist heat, radiations, filtration, and gaseous sterilization. Validation of sterilization processes; Factors affecting antimicrobial action, Mode of action of antimicrobial agents, Antibiotics and their mode of action, Microbiological assay of antibiotics (ampicillin, streptomycin, tetracycline etc.), Disinfectants, Types of toxins and their mode of action.

**Unit – IV**

Microbial ecology: Biogeochemical cycles; Physical environment: Microenvironment & Niche, Microorganisms and ecosystems. Soil microbiology: Types & functions of microorganisms in soil. Microorganism associations with vascular plants (Mycorrhizae, Rhizobia), Microorganism growth in Foods. Methods to control food spoilage, Food borne diseases



### **Course Outcomes:**

CO1. Student will understand the diversified branches of microbiology

CO2. Student will know the aspects of microbial growth and physiology

CO3. Students will learn about the morphology and physiological characteristics of different groups of microorganisms

CO4. This course will make the students to understand various sterilization methods

### **Suggested Readings:**

- 1) Jacquelyn G. Black. Microbiology-Principles and explorations 8 th edition: Publisher John Wiley & Sons 2012
- 2) Prescott, Harley and Klein- Microbiology-7 th edition; Publisher: McGraw Hill science 2007  
Gerard J. Tortora, Berdell, R. Funke, Christine L. Case
- 3) Microbiology: An Introduction. 11th edition, Publisher: Benjamin Cummings. 2012
- 4) Atlas RM. Principles of Microbiology. 2nd edition. 1997
- 5) WM.T.Brown Publishers. 2. Black JG. Microbiology: Principles and Explorations. 7th edition. Prentice Hall, 2008

## **Semester-I**

**Course Code: MLS-104**

**Subject: Molecular Biology**

**No. of Credits: 03**

**L P**

**3 0**

Maximum Marks: 100

Theory exam: 75

Sessional: 25

### **Course Objectives:**

To make students understand the complex molecular mechanisms occurring in cell and the applications of molecular technologies.

### **Unit-I**

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.

Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5'-Capformation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

### **Unit-II**

Translation: Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co- and post translational modifications of proteins.

Protein Localization: Synthesis of secretory and membrane protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

### **Unit-III**

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of Antisense and ribozymetechnologies

Homologous Recombination: Holliday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination, RecA and other recombinases Molecular Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome micro dissection and micro cloning.

**Course Outcomes:**

After the successful completion of the course the learner will get complete idea about the

CQ.1. DNA replication, recombination and repair, transcription and translation

CO2.Students will be aware of protein localization

CO3.Students will understand the biology and application of antisense and ribozyme technologies

**Suggested Readings:**

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA
3. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
4. Molecular Biology LabFax, T.A Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.

## Semester-I

**Course Code: MLS-105**

**Subject: Biostatistics**

**No. of Credits: 03**

**L P**

**3 0**

Maximum Marks: 100

Theory exam: 75

Sessional: 25

### Course Objectives:

The paper develops concepts about types of data observed in biological experiments, its handling and processing. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to carryout and process the biological data.

### Unit-I

Types of data, Collection and Graphical representation of data, Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression.

### Unit-II

Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.

### Unit-III

Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two way classification, Elementary ideas of Designs of Experiments

Important statistical softwares and their applications

### Course Outcomes:

After the successful completion of the course the learner will get complete idea about the

CQ.1. An ability to apply knowledge of statistics to design and conduct experiments, as well as to analyze and interpret data related to domain of biology

CQ.2. An ability to apply the knowledge of basic mathematical & statistical tools used in biological research/ biotechnology in industry and research lab

CQ.3. An ability to understand the principle and application of Differential Calculus, Differential Equations and various Computational Techniques

### Suggested Readings:

1. Daniel, Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences 10<sup>th</sup> Edition, Wiley Series.
2. Pagano, Marcello and Gauvreau, Kimberlee (2000) Principles of Biostatistics, 2<sup>nd</sup> Edition,

CRC Press

3. Chap T. Le, Introductory Biostatistics (2017), Wiley India Pvt Ltd.
4. P.N. Arora and P. K. Malhan, Biostatistics, Himalaya Publishing House
5. B. K. Mahajan, Methods in Biostatistics: For Medical Students and Research Workers, JPB

## **Semester-I**

**Course Code: MLS-106**

**Subject: Lab Course-1**

**No. of Credits: 03**

**L P**

**0 6**

Maximum Marks: 100

Theory exam: 70

Sessional: 30

- 1.** Preparation of mitotic and meiotic chromosomes
- 2.** Calculation of morphometric data and preparations of idiogram.
- 3.** Determination of chiasma frequency and terminalization coefficient
- 4.** Preparation of polytene chromosomes and mapping
- 5.** Titration of amino acids
- 6.** Colorimetric determination of pK
- 7.** Model building using space filling/ball and stick models
- 8.** Reactions of amino acids, sugars and lipids
- 9.** Isolation of DNA and protein
- 10.** Quantization of Proteins and Sugars
- 11.** Analysis of oils-iodine number, saponification value, acid number
- 12.** UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
- 13.** Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis

## Semester-I

**Course Code: MLS-107**

**Subject: Lab Course-II**

**No. of Credits: 03**

Maximum Marks: 100

Theory Exam: 70

Sessional: 30

**L P**

**0 6**

1. Isolation of genomic DNA
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of polyA +RNA
6. Northern blotting
7. Preparation of probes
8. In vitro Transcription
9. In vitro translation
10. Metabolic labeling of proteins and immune precipitation
11. Descriptive statistics: Systemic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators).
12. Correlations (Product Moment and Spearman's Rank Correlation) and Linear Regression Tests of significance (Mean, Standard Deviation, proportion, Correlation Coefficient)
13. Chi Square Test of Goodness of fit, test of independence of attributes, Analysis of Variance (One way and Two way)
14. Preparation of Graphs and statistical calculations using software

## ANNEXURE-II

Scheme of M.Sc. Biotechnology										
SEMESTER-II										
Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Int	Ext	Total		
1	MLS-201	Biotechniques	4			25	75	100	4	DCC
2	MLS-202	Metabolism	4			25	75	100	4	DCC
3	MLS-203	Bioinformatics and Biomolecular Modelling	3			25	75	100	3	DCC
4	MLS-204	Genetic Engineering	3			25	75	100	3	DCC
5	MLS-205	Environment and Ecology	4			25	75	100	4	DCC
6	MLS-206	Lab Course- I (Based on MLS 201-202)			6	30	70	100	3	DCC
7	MLS-207	Lab Course- II (Based on MLS 203- 205)			6	30	70	100	3	DCC
8	MLS-208	Audit Course**	2	0	0	25	75	100	0	AUD
	<b>Total Marks</b>							<b>800</b>	<b>24</b>	

\*\* The students have to choose one Audit course from the list provided by the department/ university.  
Only passing of the audit course is mandatory.



## **Annexure -B**

### **J.C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD DEPARTMENT OF LIFE SCIENCES**

#### **M.Sc. (Biotechnology) Syllabus, Semester-II**

**Course Code: MLS-201**

**Subject: Biotechniques**

**No. of credits: 4**

**L      P**

**4      0**

Maximum Marks: 100

Theory exam- 75

Sessional-25

**Course Objectives:** To learn various techniques used in biological sciences and their applications in different research works. The course also aims to make students learn about modern instruments for various analytical works.

#### **Unit-I**

Microscopy: Light Microscopy – Magnification, resolving power, Numerical aperture, Limit of Resolution, Bright field, Phase contrast, Fluorescence microscopy. Principle and applications of Electron Microscopy (SEM and TEM), Cryogenic Electron Microscopy, Confocal Microscopy, Atomic Force Microscopy, Polarised Light Microscopy  
Centrifugation Techniques: Principle of sedimentation, centrifugation, types of rotors, general applications of centrifugation, ultracentrifugation, analytical centrifugation, preparative centrifugation, precautions and safety aspects

#### **Unit-II**

Spectrophotometric Techniques: Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Raman Spectroscopy Circular dichroism (CD), Molecular structure determination using X-ray diffraction, Xray crystallography and NMR, Different types of mass spectrometry and surface plasmon resonance method

#### **Unit-III**

Principles and different types of ELISA, Radioimmune Assay (RIA), Immunoprecipitation, flowcytometry, Genomic Insitu Hybridisation (GISH). Chromosome walking, Chromosome painting. Chromosome Banding Techniques.

#### **Unit-IV**

Principles and applications of Chromatography. Ion exchange chromatography, Gel filtration chromatography, Hydrophobic interaction chromatography, Affinity chromatography, GC, HPLC.

Electrophoresis-Agarose Gel electrophoresis, Polyacrylamide Gel Electrophoresis (Native, SDS PAGE), 2-Dimensional Gel electrophoresis,

**Course Outcomes:**

CO-1- To impart knowledge and application of various bioanalytical techniques

CO-2- Students will learn centrifugation and electrophoretic techniques involved in isolation, purification and analysis of biomolecules.

CO-3- Students will learn spectrophotometric techniques for qualitative and quantitative analyses of biomolecules.

CO-4- Students will gain the knowledge and will analyses the biophysical techniques for the Isolation, Identification and Quantification of Biomolecules

**Suggested Readings:**

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Andreas Hofmann and Samuel Clokie (8<sup>th</sup> Edition).
2. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, Harald Ganther (3<sup>rd</sup> Edition)
3. Crystallography Made Crystal Clear - Gale Rhodes, academic Press (3<sup>rd</sup> Edition).
4. Molecular Biology and Biotechniques: the fundamental approach- Aga Syed Sameer (2<sup>nd</sup> Edition).
5. Biotechniques- Theory and Practice, S.V.S Rana, Rastogi Publication (1<sup>st</sup> Edition).
6. Principles of Immunodetection and Immunotechniques: Preview and Emerging Applications, Shelza Thakur, Navnit Kumar Mishra, Hardeep Singh Tuli, Anil K. Sharma (1<sup>st</sup> Edition)

## Semester-II

**Course Code: MLS-202**

**Subject: Metabolism**

**No. of credits: 4**

**L P**

**4 0**

Maximum Marks: 100

Theory exam- 75

Sessional-25

**Course Objectives:** Students will learn about different metabolic pathways related to carbohydrate, proteins, nucleic acid and fatty acids, including its significance and regulation in biological system.

### Unit I

An overview of metabolism including catabolism and anabolism, Bioenergetics, ATP synthesis, Electron transport chain, Phosphorylation, Oxidative phosphorylation, Substrate phosphorylation and photophosphorylation.

### Unit II

Carbohydrates – Fermentation, Pathways and regulations of glycolysis (Entner-Doudoroff pathway), citric acid cycle, pentose phosphate pathway, gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate pathways, Cori cycle, anaplerotic reactions, glucuronate pathway. Energetics of metabolic cycle.

### Unit III

Fatty acid metabolism including catabolism and anabolism. Ketone bodies metabolisms, keto acids, fatty acid synthesis and oxidation, cholesterol synthesis and regulation, Biosynthesis and degradation of tri-acyl-glycerol and phospholipids, diseases caused by abnormal metabolic pathway.

### Unit IV

Catabolism of amino acids, glucogenic and ketogenic amino acids, disorders of amino acid metabolism. Biosynthesis of urea and urea cycle, related disorders, Nucleotides, de novo synthesis and breakdown of purine and pyrimidine nucleotides, regulation, salvages pathway, inhibitors of nucleotide metabolism, disorders of nucleotide metabolism and Vitamins and role in metabolic synthesis.

### Course Outcomes:

CO-1- To comprehend various biochemical changes in living system.

CO-2- Recognize how the catabolic and anabolic breakdown of the substances is associated with the release during synthesis of biomolecules

CO-3- Assessing the role of different inhibitors in metabolic pathways.

CO-4- Provide deeper insight in the understanding, application and regulation of various metabolic pathways

**Suggested Readings:**

1. Biochemistry and Molecular Biology, Elliott and Elliott, Oxford University press, New York, USA (4<sup>th</sup> edition).
2. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, McGraw Hill, New York, USA. (28<sup>th</sup> edition)
3. Biochemistry, Voet and Voet, John Wiley (4<sup>th</sup> edition).
4. Nelson DL Cox, MM Lehninger's Principal of Biochemistry (7<sup>th</sup> edition).
5. Biochemistry, Satyanarayana U, Chakrapani U, Elsevier (5<sup>th</sup> edition).
6. Fundamentals of Biochemistry, JL Jain, Sanjay Jain, Nitin Jain, S Chand (4<sup>th</sup> edition)

## Semester-II

**Course Code: MLS-203**

**Subject: Bioinformatics and Biomolecular Modelling**

**No. of credits: 3**

**L      P**

**3      0**

Maximum Marks: 100

Theory exam- 75

Sessional-25

**Course Objectives:** This course is meant to impart knowledge to students for analysing and interpreting vast biological data using computational techniques. The course is designed in such a way that it gives a walkthrough of the major aspects of bioinformatics such as the development of databases and computationally derived hypothesis. We will focus on DNA and protein sequence databases and analysis, secondary structures and 3D structural analysis.

### Unit I

**Introduction to bioinformatics and Biological databases:** Introduction to genomics and proteomics databases- nucleic acid sequence databases; GenBank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases; Swiss-Prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results), BLAST vs FASTA, file formats- FASTA, ClustalW, Databank search- data mining, data management and applications.

### Unit II

**Sequence alignment:** Nucleic acid and protein sequence information, composition and properties, Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM 250, BLOSUM 62, global and local sequence alignment, similarity searching (FASTA and BLAST), Identification of genes in genomes, primer designing, Phylogenetic analysis with reference to nucleic acids and protein sequences using PHYLIP, DISTANCES, and GROWTREE, Identification of ORFs, Identification of motifs.

### Unit III

**Protein structure and Molecular Interaction:** Introduction to protein structure, secondary structure prediction, tertiary structure prediction, protein modelling; principles of homology and comparative modelling, threading, structure evaluation and validation and Modelling, applications; Molecular docking, Autodoc.

Applications of Bioinformatics in various fields: Environment, biotechnology, molecular biology, neurobiology, agriculture, drug designing, biomedical genome medicines, medical microbiology.

### Course Outcomes:

CO-1- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis

CO-2- To gain knowledge about various Biological databases that provide information about nucleic acids and protein

CO-3- Understanding of the concept of pairwise sequence alignment and tools for pairwise alignment, also students will learn about Multiple Sequence Alignment, its significance,

algorithms and tools used for MSA.

CO-4- The students will learn about biological macromolecular structures and structure prediction methods

**Suggested Readings:**

1. Bioinformatics: Sequence and Genome Analysis, David W. Mount, Cold Spring Harbor Laboratory Press, New York, USA (2<sup>nd</sup> Edition).
2. Bioinformatics: A primer, P. Narayan, New Age International Publishers (1<sup>st</sup> Edition).
3. Bioinformatics Principles and Applications, Harshawardhan P. Bal, Tata McGraw- Hill Publishing Company (1<sup>st</sup> Edition).
4. Understanding Bioinformatics, Marketa Zvelebil and Jeremy O. Baum, Garland Science (1<sup>st</sup> Edition).
5. Bioinformatics: Methods and Applications (Genomics, Proteomics and Drug Discovery), S. C. Rastogi, Namita Mendiratta and Parag Rastogi, Prentice Hall of India (4<sup>th</sup> Edition).
6. Fundamental Concepts of Bioinformatics, Dan E. Krane and Michael L. Raymer Pearson Education (1st Edition).
7. Bioinformatics For Dummies, Jean Michael Claverie and Cerdic Notredame, Wiley India Pvt Ltd (2<sup>nd</sup> Edition).

## Semester-II

**Course Code: MLS-204**

**Subject: Genetic Engineering**

**No. of credits: 3**

<b>L</b>	<b>P</b>
<b>3</b>	<b>0</b>

Maximum Marks: 100

Theory exam- 75

Sessional-25

**Course Objectives:** To understand the basic concepts in Gene cloning; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications of genetic engineering as well as genome editing tools.

### Unit-I

Recombinant DNA technology: Restriction and modification enzymes; Restriction Digestion- Partial as well as complete digestion, Linkers and adaptors. Vectors - Plasmids, Cosmids, bacteriophage and other viral vectors, bacterial and yeast artificial chromosomes; Expression vectors, shuttle vectors. Plasmid incompatibility. Introduction of DNA into living cells. Selectable and Screenable markers. Selection of transformed and recombinant cells. Insertional inactivation of genes. Ti plasmid and Agrobacterium mediated Gene transfer. Functions of different of Vir genes.

### Unit-II

The construction of cDNA and Genomic libraries. Genomics and its application, Expressed sequence tags, Human genome project- strategies and implications, Gene therapy: principles, strategies. DNA sequencing methods, Maxam and Gilbert's chemical and Sanger's chain termination methods, and Pyrosequencing.

Polymerase chain reaction and its application in research. TA cloning. Real time/quantitative PCR.

### Unit-III

Differential gene expression profiling by Microarray. Differential protein expression profiling. The Southern, Northern, Western blotting. Analysis of DNA-Protein Interactions- Electromobility shift assay, ChIP assay, DNase Foot printing. Protein-protein interactivestudy: The yeast two hybrid system, Random amplification of polymorphic DNA (RAPD), RFLP (Restriction fragment Length Polymorphism), Site-directed mutagenesis.

### Course Outcomes:

CO-1- Provide deeper insight in the understanding, application of the tools of restriction digestion and modification system as well as cloning.

CO-2- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences



CO-3- To train students in strategizing research methodologies employing genetic engineering techniques.

CO-4- To expose students to methods and application of DNA sequencing in biotechnological research

**Suggested Readings:**

1. Gene Cloning and DNA analysis- an introduction - T. A Brown, Wiley-Blackwell (7<sup>th</sup> Edition)
1. Molecular Biotechnology: Principles and applications of Recombinant DNA- Bernard R Glick, Jack J Pasternak (3<sup>rd</sup> Edition)
2. Principles of Biotechnology- Christina A. Crawford, Grey House Publishing (1<sup>st</sup> Edition)
3. Principles of Gene Manipulation and Genomics- Primrose, S. B., & Twyman, Wiley-Blackwell (7<sup>th</sup> Edition)
4. Biotechnology-David P. Clark, Nanette J. Pazdernik, Elsevier Science (2<sup>nd</sup> Edition)
5. Plant Biotechnology and Genetic Engineering- C M Govil, Ashok Aggarwal, Jitender Sharma, PHI Learning (1<sup>st</sup> Edition)

## Semester-II

**Course Code: MLS-205**

**Subject: Ecology and Environment**

**No. of credits: 4**

L	P
4	0

Maximum Marks: 100

Theory exam- 75

Sessional-25

**Course Objectives:** The objective of this course to make awareness among the young students about the surrounding environment, basic concepts of ecology, the impact of climate change and its mitigation, biodiversity and conservation.

### UNIT I

**Environment:** Introduction to ecology and basic environmental concepts; Physical environment, biotic environment, laws and limiting factors, ecological models, biotic and abiotic interactions, climate and soil pattern of world.

Habitat ecology: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement and major habitat types of the subcontinent.

### UNIT II

**Population ecology:** Characteristics of a population; population growth curves; population dynamics and regulation; life history strategies (*R* and *K* selection), age structured populations, Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions, Species interactions; Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; Mechanisms of litter fall decomposition and climatic factors associated with decomposition.

### UNIT III

**Community ecology:** Nature, structure and attributes of community, analysis of communities (analytical and synthetic characters), levels of species diversity and its measurement, edges and ecotones, ecological succession: types, mechanisms, changes involved in succession, concept of climax, models of succession, ecological adaptations.

Ecosystem ecology: Structure and function, energy flow through ecosystems, food webs, biogeochemical cycles, resilience of ecosystem, primary production and methods of measurement, global pattern and controlling factors, ecosystem management/restoration.

### UNIT IV

**Environment and Development:** Environmental Challenges faced by India and the world; Climate change and global warming, different types of pollution – air, water and soil, energy crisis and resource conservation, National and global environmental education programs and organisations, Environment Impact Assessment (EIA), Environmental Laws and policies.

Biodiversity: Assessment, international conventions, changing environment. conservation and management, biodiversity act and related sustainable development, natural resource management in changing environment

**Course Outcomes:**

CO-1- Students will be exposed to the fundamental aspects of ecology.

CO-2- They will get idea about the interactions and interdependence of abiotic and biotic factors in nature. They will also learn about the impact of anthropogenic activities on the environment and need for conservation

CO-3- Student will develop an understanding of the ecological principles that link individuals at populations, community and ecosystem levels.

CO-4- Students will learn about the environmental issues faced by India and world, various national and global organisations working towards environment protection and biodiversity conservation.

**Suggested Readings:**

1. Ecology: From Individuals to Ecosystems, Michael Begon, Colin R. Townsend, John L. Harper, Wiley-Blackwell (3<sup>rd</sup> Edition).
2. Ecology: Principles and Applications, J. L. Chapman and Michael Reiss, Cambridge University Press, U.K. (1<sup>st</sup> Edition).
3. Ecology and Environment, P.D. Sharma, Rastogi Publications, India (13<sup>th</sup> Edition).
4. A text book of Ecology, R. S. Ambasht and N. K. Ambasht, CBS Publ. & Distr. New Delhi. (15<sup>th</sup> Edition).
5. Fundamentals of Ecology, E. P. Odum and G. W. Barrett, Brooks/Cengage Learning India Pvt. Ltd., New Delhi (5<sup>th</sup> Edition).
6. Concepts of Ecology, E. J. Kormondy, Prentice Hall of India, New Delhi (4<sup>th</sup> Edition).
7. Ecology, N. S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, New Delhi (2<sup>nd</sup> Edition).
8. Ecology: Theory and Applications, P. Stiling, PHI Learning Pvt. Ltd. New Delhi (4<sup>th</sup> Edition).
9. Essentials of Ecology and Environmental Sciences, S V. S. Rana, PHI Learning Pvt. Ltd. New Delhi (4<sup>th</sup> Edition).

## Semester-II

Course Code-MLS -206

Subject: Lab Course-I (Based on MLS 201-202)

No. of Credits-3

L      P

0      6

1. Isolation of total protein by acetone precipitation from biological sample and its quantitation by Bradford method.
2. Analysis of proteins. Native PAGE and SDS PAGE, Visualization of protein bands by Coomassie staining
3. Determination of molecular weight of a given protein by Gel filtration
4. To check the validity of Lambert-Beer's law
5. Determination of concentration and purity of DNA by spectrophotometer
6. Estimation of RNA by orcinol method
7. Estimation of DNA by DPA method
8. Determination of starch in plant tissues
9. Determination of total soluble sugars by ferricyanide method
11. Quantitative determination of free amino acid content in germinating seeds
12. Estimation of beta carotene in carrots by spectrophotometry
13. Estimation of ascorbic acid in lemon juice by calorimetric method

***\*\*Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

## Semester-II

**Course Code-MLS -207**

**Subject: Lab Course-II (Based on MLS 203-205)**

**No. of Credits-3**

<b>L</b>	<b>P</b>
<b>0</b>	<b>6</b>

1. PCR amplification of DNA from unknown source
2. Preparation of restriction enzyme digests of DNA samples
3. Determination of nucleotide sequence of DNA by dideoxy chain termination method
4. To study physical and chemical characteristics of soil and water samples collected from different locations
5. Assessment of density, frequency and abundance of plants/ animals in a community using various techniques i.e., transect, quadrat etc.
6. To determine the dissolved oxygen/free carbon dioxide/nutrients, hardness, alkalinity pH and conductivity of water samples collected from different locations
7. To record the biotic and abiotic components of water in different ecosystems
8. Determination of species diversity index and importance value index of local vegetation
9. Retrieve sequences from different Nucleic acid and protein databases
10. Data mining for sequence analysis by use of Bioinformatics' tools
11. Pair wise and multiple alignments of sequences using different softwares
12. Evolutionary studies / phylogenetic analysis of DNA and protein sequences

***\*\*Addition or deletion of the lab experiments can be done as per the availability of resources in lab.***

# **J.C. Bose University of Science & Technology, YMCA Faridabad**

(NAAC Accredited “A” Grade University of State Govt. established by Haryana State  
Legislative Act No.21 of 2009)

## **Department of Life Sciences (w.e.f. 2021)**



### **Scheme and Syllabi for M.Sc. Zoology (SEMESTER- III and IV)**

## PROGRAM OUTCOMES OF PG PROGRAM OF FACULTY OF LIFE SCIENCES

<b>PO1</b>	<b>Knowledge</b>	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
<b>PO2</b>	<b>Research Aptitude</b>	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
<b>PO3</b>	<b>Communication</b>	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
<b>PO4</b>	<b>Problem Solving</b>	Capability of applying knowledge to solve scientific and other problems
<b>PO5</b>	<b>Individual and Team Work</b>	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
<b>PO6</b>	<b>Investigation of Problems</b>	Ability of critical thinking, analytical reasoning and research-based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
<b>PO7</b>	<b>Modern Tool usage</b>	Ability to use and learn techniques, skills and modern tools for scientific practices
<b>PO8</b>	<b>Science and Society</b>	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
<b>PO9</b>	<b>Life-Long Learning</b>	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
<b>PO10</b>	<b>Ethics</b>	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
<b>PO11</b>	<b>Project Management</b>	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

### **PROGRAM SPECIFIC OUTCOMES (PSOs)**

The program specific outcomes (PSO's) are the statement of competencies/abilities that describes the knowledge and capabilities of the post-graduate will have by the end of program studies.

After successful completion of M.Sc. Zoology, the students will be able to

<b>PSO1</b>	Strengthen their foundation on various zoology concepts and phenomena through theoretical and practical knowledge
<b>PSO2</b>	Upgraded themselves with new discoveries in biological world and inculcate continuous learning and self-improvement and gets motivated for higher studies and research.
<b>PSO3</b>	Tackle detailed problem-solving and analytical tasks associated with pure and applied zoological questions, in areas that include evolution, ecology and conservation
<b>PSO4</b>	Develop independent thinking, good communication and scientific skills and to acquaint them with professional ethics so that they can work well in an industrial or academic environment



SEMESTER-III										
Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Internal	External	Total		
1	MZO-301	Structure and functions of non-Chordates	4			25	75	100	4	DCC
2	MZO-302	Animal Behaviour and Applied Zoology	4			25	75	100	4	DCC
3	MZO-303	Immunology	4			25	75	100	4	DCC
4	MZO-304	Genetics	4			25	75	100	4	DCC
5	MZO-305	Lab Course- I (Based on MZO 301-302)			6	30	70	100	3	DCC
6	MZO-306	Lab Course- II (Based on MZO 303- 304)			6	30	70	100	3	DCC
7	MZO- 307	Seminar				25		25	1	DCC
8	XXX	*Open Elective Course	3	0	0	25	75	100	3	OEC
<b>Total</b>								<b>725</b>	<b>26</b>	
DCC- Discipline core course										
*OEC – <b>Open Elective Course-</b> The students have to choose one Open elective course related to another branch of Science/Engg. /other discipline required for enhancing professional performance as provided by the department/university-										
<b>OES-301A- Waste Management in Daily Life</b>										
<b>OES-302A- Environmental Conservation</b>										
<b>OCH 307A- Chemistry for sustainable Development</b>										
L – Lecture; T-Tutorial, P – Practical										

SEMESTER-IV										
Sr. No.	Course Code	Subject	Teaching Hours per week			Maximum Marks			Credits	Category Code
			L	T	P	Internal	External	Total		
1	MZO-401	Structure and functions of Chordates	4			25	75	100	4	DCC
2	MZO-402	Developmental Biology	4			25	75	100	4	DCC
3	MZO-403	Evolutionary Biology	4			25	75	100	4	DCC
4	MZO-404	Lab Course- I (Based on MZO 401)			6	30	70	100	3	DCC
5	MZO-405	Lab Course- II (Based on MZO 402- 403)			6	30	70	100	3	DCC
6	MZO- 406	Project Report	0	0	12	-	-	100	6	
<b>Total</b>								<b>600</b>	<b>24</b>	

**Course Code: MZO 301**

**Subject: Structure & Functions of Non-Chordates**

**No. of credits: 4**

**L P**

**4 0**

**Maximum Marks: 100**

**Theory exam: 75**

**Sessional:25**

**Course Objectives:** The aim of the course is to develop understanding of the students about how life evolved from simple to complex organization by division of labour & enhancing efficiency in Invertebrates. Apart from this it will give an in depth knowledge of minor phyla and their organization and relationship with other invertebrates phyla

### **Unit 1**

Introduction to invertebrates with their general characters, Basic body plan, Concept of invertebrata v/s Vertebrata and Non-Chordata v/s Chordata; Organization of coelom, Concept and structure of Acoelomate, Pseudocoelomates and Coelomates. Protostomia and Deuterostomia, Metamerism in Annelida, Pseudometamerism.

**Minor Phyla:** Concept and significance, Organization and general characters of Acoelomate, Pseudocoelomates and Coelomates minor phyla (with special emphasis on Ctenophora, Rotifera, Endoprocta, Ectoprocta, Phoronida, Sipunculida and Echiuroidea).

### **Unit 2**

**Locomotion:** Flagella and ciliary movement in Protozoa, Hydrostatic movement in Coelenterata, Annelida and Echinodermata; **Nutrition and Digestion:** Patterns of feeding and digestion in lower metazoan, Filter-feeding in Polychaeta, Mollusca and Echinodermata;

**Respiration:** Organs of respiration: Gills, lungs, trachea, skin, Cloacal chamber, Buccopharyngeal area etc., Respiratory pigments, Mechanism of respiration

### **Unit 3**

**Excretion:** Organs of excretion: Coelom, coelomoducts, Nephridia and Malpighian tubules, Mechanism of excretion and osmoregulation

**Nervous system:** Primitive nervous system: Coelenterata and Echinodermata, Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda), Trends in neural evolution.

### **Unit 4**

**Invertebrate larvae:** Larval forms of free living invertebrates, Strategies and Evolutionary significance of larval forms, Conservation of invertebrates. **Introduction to insects:** Mouthparts of Insects, Mechanism of insect flight and hovering, Metamorphosis in insects, Hormonal control of moulting; Economic importance of Invertebrates; Various Adaptations in Invertebrates

### **Suggested Readings:**

1. Kotpal, R.L. (2019). Modern text book of Zoology: Invertebrates. Rastogi Publications. 11<sup>th</sup> Edition
2. David Hickman, Jr., Cleveland; Roberts, Larry; Keen, Susan; Larson, Allan; Eisenhour (2021). Animal Diversity. McGraw Hill Education, 9<sup>th</sup> Edition.
3. Barnes, R.S.K., Calow, P.P., Olive, P.J., Golding, D.W. and Spicer, J.I., (2009). The invertebrates: a synthesis. John Wiley & Sons, 3<sup>rd</sup> Edition
4. Moore, J., (2006). An introduction to the invertebrates. Cambridge University Press. 2<sup>nd</sup> Edition
5. Pechenik, J. A. (2015). Biology of the Invertebrates. McGraw Hill, 7<sup>th</sup> Edition
6. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, Holt Saunders International Edition, 8<sup>th</sup> Edition

**Course Outcomes:**

After successfully completion of this course students will be able to:

- CO1** Understand the progressive evolutionary history and adaptations which forms the basis of huge complex and diverse life forms.
- CO2** Acquire a clear understanding about organization of minor phyla and their relationship with other animal phyla
- CO3** Know the structure and significance of various systems of Invertebrates
- CO4** Develop a deep understanding about adaptations and significance of Invertebrates

**Mapping of CO and PO for MZO 301**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	2	3	1	2	1	3	3	3	2	3	3	3	3
<b>CO2</b>	3	2	2	3	1	2	1	3	2	3	2	3	3	3	3
<b>CO3</b>	2	2	2	3	1	2	1	3	3	3	2	3	3	3	3
<b>CO4</b>	3	3	2	3	1	3	1	3	3	3	2	3	3	3	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO 302**

**Subject: Animal Behaviour & Applied Zoology**

**No. of credits: 4**

**100**

**L P**

**4 0**

**Maximum Marks:**

**Theory exam: 75**

**Sessional:25**

**Course Objectives:** This course exposes students to the broad field of animal behavior and applied zoology. After studying this the student will come to know the historical foundations of the animal behaviour, as well as current theories and evidence for a broad range of behavioral topics. In context to applied zoology the student get an in-depth knowledge about various practices followed by the humans as a source of income from animals.

### **Unit 1. Introduction to Animal behavior**

History of the study of animal behavior, concepts and objectives of behaviour, mechanism of behavior: Neural control of behavior, sensory processes and perception, ecology of senses.

Complex behavior- Instinct and learning, Innate releasing mechanisms: key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM. Fixed action pattern- characteristics and evolutionary features. Mimicry, mimetic releaser and code breakers.

### **Unit 2. Mechanism of orientation**

Primary and secondary orientation; kinesis and taxis. Learning and cognition: habituation, classical conditioning, operant conditioning, latent learning, social learning, Homeostasis and behaviour: motivational system and their physiological basis, motivational conflict and decision making, displacement activity, Hormonal regulation of behaviours.

### **Unit 3: Apiculture, Lac culture and Sericulture**

Species of honey bee and their social organization, Methods of bee keeping, economic importance of honey; Life cycle of lac, Cultivation of Lac, Enemies of lac cultivation and economic importance; Life cycle of silk moth, Rearing of silk worm, Disease of silk worm, Status of sericulture industry in India.

Economics related to establishment of Apiculture, lac culture, and sericulture and cost benefit ratio

### **Unit 4: Pearl Culture, Poultry Farming and Fish Culture**

Pearl Producing Molluscs, Pearl Formation, Programming of Pearl Industry; Habitat of fowl, Fowl House, Food and feeding of Fowl, Rearing of Chickens, Disease of poultry, Processing and preservation of eggs; Fish culture- breeding pond, Nursery and rearing ponds and fish seed, types of hatching pits, methods of preservation of fish;

Economics related to establishment of Pearl Culture, Poultry Farming, and fish culture and cost benefit ratio. Pharmaceuticals from animals and their use in animal welfare. Recent Wild Life of India.

### **Suggested Readings:**

1. Aubrey Manning and Marian Stamp Dawkins (2012) An Introduction to Animal Behavior, Cambridge University Press. 6<sup>th</sup> Edition
2. John Alcock, (2009) Animal Behaviour: An Evolutionary Approach, Sinauer Associate Inc., USA. 9<sup>th</sup> Edition
3. Dustin R. Rubenstein and John Alcock (2018) Animal Behaviour, Sinauer Associate Inc., USA. 11<sup>th</sup> Edition
4. Dunham R.A. (2004) Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
5. Mathur, S. (2009) Economic Zoology Biostatistics and Animal Behaviour. Deep and Deep Publications. 1<sup>st</sup> Edition
6. G.S.Shukla and V.B.Upadhyay (2017) Economic Zoology: A textbook for University students, Rastogi publication, Meerut. 5<sup>th</sup> Edition

**Course Outcomes:**

After successfully completion of this course students will be able to:

**CO1:** Acquire a clear understanding about behavior patterns in animals

**CO2:** Understand the basis on different behavior pattern found in animals

**CO3:** Explain the basic concepts of sericulture, apiculture, lac culture and other animal industries along with economics of pest management techniques.

**CO4:** Awareness about use of certain animals and their products for human welfare *vis-à-vis* animal welfare will be created.

**Mapping of CO and PO for MZO 302**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	2	2	1	2	1	3	3	3	2	3	3	3	3
<b>CO2</b>	3	2	2	2	1	2	1	3	3	3	2	3	3	3	3
<b>CO3</b>	3	3	2	3	3	2	1	3	3	3	3	3	3	3	3
<b>CO4</b>	3	3	2	3	3	3	1	3	3	3	3	3	3	3	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO-303**

**Subject: Immunology**

**No. of credits: 4**

<b>L</b>	<b>P</b>
<b>4</b>	<b>0</b>

**Maximum Marks: 100**

**Theory exam: 75**

**Sessional: 25**

**Course Objectives:** This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired. How the immune system recognizes self from non-self. B and T cell maturation and specific responses.

### **Unit I**

Cells and organs of immune system. Primary, secondary and tertiary lymphoid organs. Types of immunity - Innate and adaptive, Humoral and cell-mediated, Active and passive, PAMP: TLR, Clonal selection theory. Immunological memory, Antigens and immunogens, B and T cell epitopes; Haptens. Structure and functions of antibodies. Classes of immunoglobulins. CDRs, Valence, affinity and avidity. Antibody variants - Isotypes, allotypes and Idiotypes

### **Unit II**

The immunoglobulin genes: organization and assembly; generation of immunological diversity; Allelic exclusion. Major histocompatibility complex (MHC): structure and organization of MHC. Antigen processing and antigen presentation. T cell Receptor: Superantigens. B cell activation and maturation. T cell development and activation. Cytotoxic T cell mediated killing. Complement system and mechanism of its fixation. Complement deficiencies. V(D)J recombination, somatic hypermutation and class switch recombination of immunoglobulins: mechanism and regulation

### **Unit III**

Immunological tolerance. Autoimmunity and associated disorders. Allergy and hypersensitivity, types of Hypersensitivity. Transplantation immunology - Graft rejection, graft versus host reaction. Immune response to infectious diseases – viral, bacterial, protozoal. Immunosuppression - immunodeficiency diseases. Communicative Viral Diseases.

### **Unit IV**

Role of cytokines, lymphokines and chemokines. Vaccine and its different types. Different types of Vaccines for COVID-19 . Hybridoma Technology: Production of murine monoclonal antibodies (MoAbs)-Fusion strategies, HAT Selection; Strategies for production of human MoAbs- Humanization and antigenization of MoAbs-Chimeric, CDR-grafted

#### **Suggested Readings:**

1. Punt J, Stranford SA, Jones PP, and Judith AO (2019) Kuby immunology. WH Freeman. 8<sup>th</sup> edition.
2. Abbas AK, Lichtman AH, and Pillai S (2016) Cellular and Molecular Immunology. Saunders. 9<sup>th</sup> edition.
3. Male DK, Brostoff J, Roth D, and Ivan R (2012) Immunology. Gower Medical Publishing London. 8<sup>th</sup> edition.
4. Gupta SK (2010) Essentials of Immunology. Arya Publication. 2<sup>nd</sup> edition.
5. Khan FH (2009) The Elements of Immunology. Pearson Education India. 1<sup>st</sup> edition.

**Course Outcomes:**

After completion of the course the learners will be able to:

**CO1-** Understood the concept of innate and adaptive immunity.

**CO2-** Understood the various mechanisms that regulate immune responses and maintain tolerance.

**CO3-** Elucidated the reasons for immunization and awareness of different vaccination.

**CO4-** Understood the stages of transplantation response and success of various transplant procedures.

**Mapping of CO and PO for MZO 303**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	3	2	2	2	2	3	3	3	2	3	3	2	3
<b>CO2</b>	3	2	3	2	2	2	2	3	3	3	2	3	3	2	3
<b>CO3</b>	3	2	3	2	2	3	2	3	3	3	3	3	3	2	3
<b>CO4</b>	3	2	3	2	2	3	3	3	3	3	3	3	3	2	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO-304**

**Maximum Marks: 100**

**Subject: Genetics**

**Theory exam: 75**

**No. of credits: 4**

**Sessional: 25**

**L      P**

**4      0**

**Course Objectives:** To develop and demonstrate an understanding of the structure and function of genes and the organization of the human genome; the patterns of inheritance and clinical manifestations of genetic diseases; chromosomes, chromosomal abnormalities, and the clinical features of common chromosomal disorders.

### **Unit I**

Mendelian vs. non-Mendelian inheritance, monohybrid and dihybrid crosses, Mendelian Principles-Dominance, Segregation and Independent assortment. Extensions of Mendelian principles: Codominance, Incomplete dominance, Multiple Allelism. Gene interactions-Epistasis, Collaboratory gene action, Duplicate genes, Complementary Gene action, Complementation Test. Pleiotropy. Phenocopy. Probability and Pedigree analysis. sex limited and sex influenced characters. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL. Extrachromosomal Inheritance, Maternal effect.

### **Unit II**

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Linkage maps, recombination, tetrad analysis (Ordered and unordered Tetrad analysis), mapping with molecular markers, mapping by using somatic cell hybrids. Linkage Group

### **Unit III**

Cytogenetics: Chromosome: structure and nomenclature, centromere and telomere; Structural and numerical alterations of chromosomes: Deletion, duplication, Pericentric and Paracentric inversion, Inversion heterozygotes, Inversion homozygotes. Reciprocal and nonreciprocal translocation, Homozygotes as well as Heterozygote Trans locants. ploidy (Aneuploidy and Euploidy) and their genetic implications.

### **Unit IV**

Mutation: Types, causes and detection, mutant types – lethal, conditional, Base substitution and frame shift Mutation. Biochemical, loss of function, Gain of function, Germinal versus Somatic mutants, Ames Test.

Epigenetics: Introduction, methylation, histone modifications.

Allele frequency, Gene Frequency, Hardy Weinberg Equilibrium



### Suggested Readings:

1. Gardner EJ (2005) Principles of Genetics. John Wiley & Sons Ltd. 8<sup>th</sup> edition.
2. Tamarin RH (2017) Principles of Genetics. Tata McGraw-Hill Publishing Comp. Ltd. 7<sup>th</sup> edition.
3. Pierce BA (2016) Genetics – A conceptual approach. WH Freeman Company. 6<sup>th</sup> edition.
4. Snustad DP and Simmons MJ (2015) Principles of Genetics. John Wiley and Sons. 7<sup>th</sup> edition.
5. Hartl and Jones (2017) Genetics-Principles and Analysis. Jones & Bartlett. 9<sup>th</sup> edition.
6. Gupta PK (2018). Genetics. Rastogi publication.

### Course Outcomes:

After completion of the course the learners will be able to:

**CO1-** Understood the building block for genetics i.e., life cycles of model organisms, basic genetic experiments, polyploidy, and QTL.

**CO2-** Learn the organization of genome and specialized chromosomes, chromosomal theory of inheritance, linkage, inheritance modes in nature, maternal inheritance, crossing over, and recombination.

**CO3-** Understood the important hereditary diseases, their inheritance patterns, and pedigree analysis

**CO4-** Understood the significance and impact of mutations.

### Mapping of CO and PO for MZO 304

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	2	3	2	3	2	3	3	3	3	3	3	2	3
<b>CO2</b>	3	2	2	3	2	3	2	3	3	3	3	3	3	2	3
<b>CO3</b>	3	3	2	3	2	3	2	3	3	3	2	3	3	3	3
<b>CO4</b>	3	2	2	3	2	3	2	3	3	3	2	3	3	3	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO 305**

**Subject: Lab Course - I (Based on MZO 301–302)**

**Number of Credits: 3**

**L P**

**0 6**

- Permanent Preparation of: *Euglena*, *Paramecium*
- Study of prepared slides/specimens of *Entamoeba*, *Giardia*, *Leishmania*, *Trypanosoma*, *Plasmodium*, *Fasciola*, *Cotugnia*, *Taenia*, *Rallietina*, *Polystoma*, *Schistosoma*, *Echinococcus*, *Enterobius*, *Ascaris* and *Ancylostoma*
- Permanent Preparation of *Cimex* (bed bug), *Pediculus* (Louse), *Haematopinus* (cattle louse), fresh water annelids, arthropods; and soil arthropods.
- Larval stages of helminths and arthropods.
- Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly.
- Permanent preparation of ticks/mites, abdominal gills of aquatic insects viz. *Chironomus* larva, dragonfly and mayfly nymphs, preparation of antenna of housefly
- Life history of silkworm, honeybee and lac insect.
- Study of different types of important edible fishes of India.
- Slides of plant nematodes.
- Project Report/ model chart making.
- **Dissections:** through multimedia/models
- **Cockroach:** Central nervous system

#### **Virtual Labs**

<https://www.vlab.co.in>

<https://zoologysan.blogspot.com>

[www.vlab.iitb.ac.in/vlab](http://www.vlab.iitb.ac.in/vlab)

<https://www.vlab.co.in>

<https://zoologysan.blogspot.com>

[www.vlab.iitb.ac.in/vlab](http://www.vlab.iitb.ac.in/vlab)

[www.onlinelabs.in](http://www.onlinelabs.in)

[www.powershow.com](http://www.powershow.com)

<https://vlab.amrita.edu>

<https://sites.dartmouth.edu>

*\*A minimum of eight practicals should be done from the above mentioned list.*

*\*\* Addition or deletion of the lab experiments can be done as per the availability of resources in lab.*

#### **Skill Developed-**

At the end of laboratory course,

CO1: Understand the diversity of invertebrates in terms of their classification and characteristic features

CO2: Learn about the biology of important invertebrate species

CO3: Know the economic importance of some animal species

### Mapping of CO and PO for MZO 305

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3
<b>CO2</b>	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3
<b>CO3</b>	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code-MZO -306**

**Subject: Lab Course-II (Based on MZO 303-304)**

**No. of Credits-3**

<b>L</b>	<b>P</b>
<b>0</b>	<b>6</b>

1. To perform experiment using ammonium sulphate precipitation of antibodies in serum.
2. To perform experiment on the preparation of antigen -adjuvant (FCA) emulsion.
3. To perform experiment on the collection of blood from mice and separation of serum.
4. To perform experiment on antibody purification from the serum collected from immunized mice: affinity purification/chromatography.
5. To perform experiment on double diffusion and Immune-electrophoresis
6. To perform experiment on radial immune diffusion
7. To perform experiment of Band analysis of different types of plasma antibodies by SDS PAGE
8. To perform agglutination Reaction: a) Tube Agglutination Reaction b) Slide Agglutination Reaction c) Indirect Agglutination Inhibition Reaction
9. To perform experiment for Identification of histological slides of lymphoid tissue - Spleen, thymus, lymph node and bone marrow
10. To perform experiment of Mitosis - Onion root tip squash preparation- Preparation of Karyotypes, Determination of Mitotic index.
11. To perform experiment on Mendelian Inheritance and gene interactions using suitable examples/ seeds
12. To perform experiment on study of Linkage, Recombination, gene mapping using the available data
13. To perform experiment of centromere mapping by tetrad analysis
14. Analysis of pattern of inheritance of given pedigree.
15. Calculation of recombination frequency
16. To perform experiment on Bacterial gene mapping by interrupted conjugation method
17. Calculation of co-transformation and co-transduction frequency
18. Calculation of deviation in phenotypic ratios of different intergenic gene interactions
19. To perform experiment on comparison of ploidy level with respect to given example.

*\*A minimum of eight practical's should be done from the above-mentioned list.*

*\* Addition or deletion of the lab experiments can be done as per the availability of resources in lab.*

**Skill Developed-**

At the end of laboratory course, learners-

**CO 1-** understood the basic Immunological aspects to be performed in the laboratory.

**CO 2-** learnt to analyze genetic problems and will be able to approach a research problem statistically.

**CO 3-**understood the centromere mapping as well as to calculate phenotypic ratios of different gene interactions

### Mapping of CO and PO for MZO 306

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
<b>CO2</b>	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
<b>CO3</b>	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

### Seminar:

Seminar will be of 30- 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.



## J. C. Bose University of Science and Technology, YMCA, Faridabad

(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22)

Accredited 'A' Grade by NAAC

### DEPARTMENT OF LIFE SCIENCES

#### Program M.Sc. Zoology

Mapping of the Courses with the Employability/Entrepreneurship/Skill Development

#### M.Sc. Zoology Semester III (Program Code: 757)

Sr. No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1	MZO-301	Structure and functions of non-Chordates	√		√
2	MZO -302	Structure and functions of non-Chordates	√		√
3	MZO -303	Immunology	√		√
4	MZO -304	Genetics	√		√
6	MZO -305	Lab Course I (based on MLS 301 - 302)	√	√	√
7	MZO -306	Lab Course II (based on MLS 303 - 304)	√	√	√
8	MZO - 307	Seminar		√	√
9	XXX	Audit Course- Research Methodology	√		√

<b>SEMESTER-IV</b>										
<b>Sr. No.</b>	<b>Course Code</b>	<b>Subject</b>	<b>Teaching Hours per week</b>			<b>Maximum Marks</b>			<b>Credits</b>	<b>Category Code</b>
			<b>L</b>	<b>T</b>	<b>P</b>	<b>Internal</b>	<b>External</b>	<b>Total</b>		
1	MZO-401	Structure and functions of Chordates	4			25	75	100	4	DCC
2	MZO-402	Developmental Biology	4			25	75	100	4	DCC
3	MZO-403	Evolutionary Biology	4			25	75	100	4	DCC
4	MZO-404	Lab Course- I (Based on MZO 401)			6	30	70	100	3	DCC
5	MZO-405	Lab Course- II (Based on MZO 402- 403)			6	30	70	100	3	DCC
6	MZO- 406	Project Report	0	0	12	-	-	100	6	
<b>Total</b>								<b>600</b>	<b>24</b>	

**Course Code: MZO 401**

**Subject: Structure & Functions of Chordates**

**No. of credits: 4**

**L P**

**4 0**

Maximum Marks: 100

Theory exam- 75

Sessional-25

**Course Objective:** This paper deals with the comparative and evolutionary trends in structure and function of the organ systems of the vertebrate series. The student will be able to understand what are the general characters and different categories of chordates animal as well as the origin and evolutionary relationship in different subphylum of chordates.

### **Unit 1**

**Introduction to Chordates with their general characters, Origin of Chordates, Concept of Protochordate or pre-vertebrates, Classification of Vertebrates upto orders.**

**Integument and its derivatives:** Development, general structure and functions of skin and its derivatives, Glands, scales, horns, claws, nails, hoofs, feathers and hair

### **Unit 2**

**Skeletal system:** Form, function, body size and skeletal elements of the body, Comparative account of jaw suspensorium, Vertebral column, Limbs and girdles; **Digestive system:** Dentition, Stomach, Digestive Glands, Anatomy of gut in relation to feeding habits- herbivores, carnivores and omnivores, Comparative physiology of digestion and absorption; **Respiratory system:** Characters of respiratory tissue, Internal and External Respiration, Comparative physiology of respiratory systems with special emphasis on respiratory organs

### **Unit 3**

**General plan of circulation in various groups:** Components of Blood, General plan of circulation in reptiles, birds and mammals, Evolution of heart, aortic arches and Portal systems, Comparative physiology of circulatory systems; **Evolution of Urinogenital system in vertebrates:** Structure and functions of different types of kidneys, Urino-genital ducts, Comparative physiology of excretory systems, Flight adaptation in birds, Migration in fish and Birds

### **Unit 4**

**Nervous system:** Comparative anatomy of the brain in relation to its functions, Comparative physiology of nervous systems with special emphasis on anatomy of spinal cord, Nerves-Cranial, Peripheral and Autonomous nervous systems; **Sense organs:** Simple receptors, Organs of Olfaction and taste, Lateral line system, Electroreception

### **Suggested Readings:**

1. Kotpal, R. L. (2019). Modern Text Book of Zoology: Vertebrates. Rastogi Publications, 4<sup>th</sup> Edition
2. David Hickman, Jr., Cleveland; Roberts, Larry; Keen, Susan; Larson, Allan; Eisenhour (2021). Animal Diversity. McGraw Hill Education, 9<sup>th</sup> Edition.
3. Young, J. Z. (2004). The Life of Vertebrates. Oxford university press. 3<sup>rd</sup> Edition
4. Pough, F. H., Janis, C. M., & Heiser, J. B. (2013). Vertebrate life. Pearson Higher Ed. 9<sup>th</sup> Edition.
5. Hildebrand, M., Goslow, G. E., & Hildebrand, V. (1998). Analysis of vertebrate structure, Wiley, 3<sup>rd</sup> Edition
6. Kardong, K. V. (2019). Vertebrates: comparative anatomy, function, evolution. McGraw-Hill Education. 8<sup>th</sup> Edition

### **Course Outcomes:**

After successfully completion of this course students will be able to:

**CO1** Understand various biological functions, the evolution of life from most primitive to most advanced form with respect to their habit and habitat.

**CO2** Develop a deep understanding in various systems, adaptations and other special features in



chordates.

**CO3** Do the classification of phylum chordate based on distinguish features of different classes

**CO4** Explain the important features of animals that comes under phylum chordata

### Mapping of CO and PO for MZO 401

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	2	3	1	2	1	3	3	3	2	3	3	3	3
<b>CO2</b>	3	2	2	3	1	2	1	3	2	3	2	3	3	3	3
<b>CO3</b>	2	2	2	3	1	2	1	3	3	3	2	3	3	3	3
<b>CO4</b>	3	3	2	3	1	3	1	3	3	3	2	3	3	2	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO 402**  
**Subject: Developmental Biology**  
**No. of credits: 4**  
**L P**  
**4 0**

**Maximum Marks: 100**  
**Theory exam: 75**  
**Sessional: 25**

### **Unit 1. Basic concepts of developmental biology and model systems**

Cell division, cell differentiation, signaling, patterning; Evolution of developmental patterns; Vertebrates model organism- *Xenopus laevis*, chicken, mammals, zebrafish; invertebrate model organism- *Drosophila melanogaster*, Sea urchin, *Caenorhabditis elegans*.

### **Unit 2. Embryonic development and Morphogenesis**

Early embryonic development of vertebrates and invertebrates: structure of the gametes– the sperm, the egg; cleavage and gastrulation; axes and germ layers; Morphogenesis: cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation, cell migration; Axis specification in *Drosophila*: role of maternal genes, patterning of early embryo by zygotic genes- gap genes, pair-rule genes, segment polarity genes, homeotic selector genes- bithorax and antennapedia complex.

### **Unit 3. Organogenesis and Postembryonic development**

Development and patterning of vertebrate limb, homeobox genes in patterning, signaling in patterning of the limb; Insect imaginal discs—organizing center in patterning of the leg and wing, the homeotic selector genes for segmental identity; insect compound eye; Postembryonic development: growth, cell proliferation, growth hormones; aging- genes involved in alteration in timing of senescence; **Regeneration**: Epimorphic regeneration of reptile (salamander) limb; Morphogenesis regeneration in hydra; embryonic stem cells and their applications

### **Unit 4. Endocrinology**

**Histology of endocrine glands**- pineal, pituitary, thyroid, parathyroid, pancreas, and adrenal glands; and functions of hormones secreted by them; **Male reproductive system** – Structure of Testes, Biosynthesis of testosterone, Regulation and functions; **Female reproduction system** – Structure of Ovary, Biosynthesis of estrogen, Feedback regulation and functions; **Female Reproductive Cycle**– Estrous, Menstrual, Placental hormones–parturition – Lactation.

### **Suggested Readings:**

1. Michael J.F. Barresi and Scott F. Gilbert, (2020). Developmental Biology, Sinauer Associates Inc., Massachusetts, USA. 12<sup>th</sup> Edition
2. Wolpert, L., Beddington, R., Brockes, J., Jessell, T., & Lawrence, P. (2019). Principles of Development Oxford University Press. New York. 6<sup>th</sup> Edition
3. Analysis of Biological Development, Kalthoff, (2000), McGraw-Hill Science, New Delhi, INDIA. 2<sup>nd</sup> Edition
4. Slack, J. M. (2012). Essential developmental biology. John Wiley & Sons. 3<sup>rd</sup> Edition
5. Wolpert, L., Tickle, C., & Arias, A. M. (2015). Principles of development. Oxford University Press, USA. 5<sup>th</sup> Edition
6. Mac E. Hadley and Jon E. Levine (2009) Endocrinology. Pearson Education, 6<sup>th</sup> Edition.
7. Tortora, G.J. & Grabowski, S. (2020) Principles of Anatomy & Physiology. XI Edition John Wiley & sons, 16<sup>th</sup> Edition

### **Course Outcomes:**

After successfully completion of this course students will be able to:

- CO1: Develop a systematic and organized learning about the concepts of growth and development.  
CO2: Explain the concepts of embryological development and morphogenesis in animals  
CO3: Understand the process of organogenesis and post embryonic development.  
CO4: Describe biological processes and their importance for living organisms.

## Mapping of CO and PO for MZO 401

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	2	2	2	2	1	3	3	3	1	3	3	3	3
<b>CO2</b>	3	2	2	2	2	2	1	3	3	3	2	3	3	2	3
<b>CO3</b>	3	2	2	2	2	2	1	3	3	3	1	3	3	2	3
<b>CO4</b>	3	2	2	2	2	2	1	3	3	3	2	3	3	2	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO 403**  
**Subject: Evolutionary Biology**  
**No. of credits: 4**  
**L P**  
**4 0**

**Maximum Marks: 100**  
**Theory exam: 75**  
**Sessional: 25**

**Course Objectives:** The aim of the course is to provide students with a deeper insight into the evolutionary processes - both selective and random - which can explain the genetic composition of populations, form, behavior and distribution of organisms, and to teach students the basic methods of analyzing the evolutionary relationships.

### **Unit 1: Origin of Life and Evidence of Evolution**

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes; Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism, Evidences of Evolution: Fossil record- types of fossils, transitional forms, geological time scale, evolution of horse, Molecular - universality of genetic code and protein synthesizing machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c

### **Unit 2: Population Genetics**

Hardy-Weinberg Law (statement and application of law to human Population); Evolutionary forces upsetting H-W equilibrium. Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies

### **Unit 3: Product of evolution**

Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches); Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction

### **Unit 4: Human Evolution**

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin, Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

### **Suggested Readings:**

1. Ridley, M (2004). Evolution, Blackwell publishing 3<sup>rd</sup> Edition
2. Hall, B.K. and Hallgrimson, B (2008). Evolution. Jones and Barlett Publishers. 4<sup>th</sup> Edition
3. Futuyma, D. J., & Kirkpatrick, M. (2017). Evolution, Sinauer Associates. 4<sup>th</sup> Edition
4. Muehlenbein, M. P. (Ed.). (2010). Human evolutionary biology. Cambridge University Press. 1<sup>st</sup> Edition
5. Bradshaw, J. L. (2014). Human evolution. Psychology Press. 1<sup>st</sup> Edition

### **Course Outcomes:**

After successfully completion of this course students will be able to:

CO1: Understand and explain the main forces of evolution along with evidences of evolution.

CO2: Comprehend the knowledge population genetics and consequences of selection, mutation, migration, inbreeding, genetic drift, an important evolutionary force.

CO3: Explain the concepts of macro evolution and micro evolution.

CO4: Get complete understanding about human evolution

## Mapping of CO and PO for MZO 403

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	2	2	2	2	3	1	3	3	3	2	3	3	3	3
<b>CO2</b>	3	2	2	2	2	2	1	3	3	3	2	3	3	3	3
<b>CO3</b>	3	2	2	2	2	3	1	3	3	3	1	3	3	3	3
<b>CO4</b>	3	2	2	2	2	2	1	3	3	3	1	3	3	3	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO 404**

**Subject: Lab Course - I (Based on MZO 401)**

**Number of Credits: 3**

**L P**

**0 6**

1. Protochordates (Museum specimens and slides) – Salpa sexual, Salpa-sexual, Botryllus, Herdmania.
2. Fishes (Museum specimens and slides) - *Rhinobatus*, *Chimaera*, *Acipenser*, *Amia*, *Periophthalmus*, *Tricanthus*, *Notopterus notopterus*, *Scatophagus*, *Aargus*, *Trichurus*, *Mastacembalus armatus*, *Exocoetus* (flying fish), *Diodon hyterix*, *Echeneis*, *Neucrates*.
3. Amphibians (Museum specimens and slides) – *Necturus*, *Siren*, *Ichthyophis*, *Geganophis*, *Rhacophorus*, *Rana tigrina*, *Amblystoma uraetypplus*, *Cryptobranchus*, *Axolotl Larvae*, *Salamander*, *Amphiuma*, *Trilon*.
4. Reptiles (Museum specimens and slides) – Chameleon, *Phrynosoma*, *Chelone mydas*.
5. Birds (Museum specimens and slides) – Indian Oriole, Indian Koel (male), India koel (female), Indian tailor birds, Kite, jungle fowl.
6. Mammals (Museum specimens and slides) – Indian otter, Marmoset, Loris, Bat (*Megaderma lyra*), Pangolin, Echidna, *Ornithorhynchus*, Hedgehog, Scaly-ant eater, Porcupine, Mongoose.
7. Skull and lower jaw of Chelonia, Crocodile, Bird, Carnivore-mammal (dog), Herbivore mammal (horse).
8. Comparative Osteology of Vertebrates (Frog, Chicken, Rat, Rabbit etc.): Girdles, Limb-bones
9. To prepare stained/unstained slide of placoid scales.
10. Different types of important edible fishes of India.
11. Study of an aquatic ecosystem, its biotic components and food chain.
12. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig).

### **Virtual Labs**

<https://www.vlab.co.in>

<https://zoologysan.blogspot.com>

[www.vlab.iitb.ac.in/vlab](http://www.vlab.iitb.ac.in/vlab)

<https://www.vlab.co.in>

<https://zoologysan.blogspot.com>

[www.vlab.iitb.ac.in/vlab](http://www.vlab.iitb.ac.in/vlab)

[www.onlinelabs.in](http://www.onlinelabs.in)

[www.powershow.com](http://www.powershow.com)

<https://vlab.amrita.edu>

<https://sites.dartmouth.edu>

*\*A minimum of eight practical should be done from the above mentioned list.*

*\*\* Addition or deletion of the lab experiments can be done as per the availability of resources in lab.*

### **Course Outcomes:**

After the successful completion of this course students will be able to:

CO1: Understand the salient features of hemichordates and protochordates

CO2: Learn about the biology of some important vertebrate species

CO3: Classify vertebrates and will get complete knowledge about the diversification of vertebrates around the world

### Mapping of CO and PO for MZO 404

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	3	3	3	3	3	1	3	3	3	3	3	2	3	3
<b>CO2</b>	3	3	3	3	3	3	1	3	3	3	3	3	2	3	3
<b>CO3</b>	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)

**Course Code: MZO 405**

**Subject: Lab Course - II (Based on MZO 402-403)**

**Number of Credits: 3**

**L P**

**0 6**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Permanent preparation of chick embryo developmental stages.
4. Study of the developmental stages and life cycle of *Drosophila*
5. Morphological studies on the developmental stages of snail, fish, frog, chick and mouse c
6. Histological slides of various organs and systems during development using stained serial sections
7. Identification of whole mounts and histological sections of embryos larvae, pupae and nymphs
8. Study of fossils from models
9. Study and verification of Hardy-Weinberg Law by chi square analysis
10. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
11. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
12. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip) and its interpretation.

*\*A minimum of eight practical should be done from the above mentioned list.*

*\*\* Addition or deletion of the lab experiments can be done as per the availability of resources in lab.*

### **Course Outcomes:**

After the successful completion of this course students will be able to:

CO1: Develop a deep understanding about various stages of embryological development

CO2: Analyze the biological specimens along with their characterization

CO3: Interpret evolutionary relationship among different species of animals

### **Mapping of CO and PO for MZO 405**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	3	3	3	3	3	3	1	3	3	3	3	3	2	3	3
<b>CO2</b>	3	3	3	3	3	3	1	3	3	3	3	3	2	3	3
<b>CO3</b>	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

**\*\*Mapping Scale: 1 to 3 (3: Strong; 2: medium; 1: weak)**



**Course Code: MZO-406**

**Subject: Project Report**

**No. of credits: 6**

**Course Objectives:**

The objective of this course is to provide students with a hands-on training in specialized area of sciences

**Contents:**

- The student will be reading and analysing the published information in the chosen area of science under direct mentoring of a faculty member and will participate in research activity.
- Preparation and submission of Review article

**Course Learning Outcomes:**

Students will acquire the following:

- Knowledge on techniques and tools of research
- Quantitative and qualitative data analysis
- Analysis and interpretation of data in the perspective of existing knowledge



## J. C. Bose University of Science and Technology, YMCA, Faridabad

(Established by Haryana State Legislative Act No. 21 of 2009 & Recognized by UGC Act 1956 u/s 22)

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### DEPARTMENT OF LIFE SCIENCES

#### Program M.Sc. Zoology

Mapping of the Courses with the Employability/Entrepreneurship/Skill Development

#### M.Sc. Zoology Semester IV (Program Code: 757)

Sr. No.	Course Code	Course Name	Employability	Entrepreneurship	Skill Development
1	MZO -401	Structure and functions of Chordates	√		√
2	MZO -402	Developmental Biology	√		√
3	MZO -403	Evolutionary Biology	√		√
4	MZO -404	Lab Course- I (Based on MZO 401)	√	√	√
6	MZO -405	Lab Course- II (Based on MZO 402- 403)	√	√	√
8	MZO - 406	Project Report	√	√	√