

**GURU JAMBHESHAH UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR**

**Scheme of Examination for M.Sc. Zoology (Semester System) as per NEP-2020 to be implemented w.e.f. session 2023-24.**

**Distribution of Total credits**

<b>Name of M.Sc. Programme</b>	<b>Programme Elective (PE)</b>	<b>Programme Core (PC)</b>	<b>Open Elective (OE)</b>	<b>Total Credits</b>
<b>Zoology</b>	<b>12+4*=16</b>	<b>84</b>	<b>4</b>	<b>100+4*=104</b>

**Semester wise Schedule**

<b>Paper No.</b>	<b>Title of Paper</b>	<b>Nature of paper</b>	<b>Credits</b>	<b>L+T+P</b>	<b>Total Marks (T+IA)</b>
<b>Semester I</b>					
M-Z-101	Cell Biology & Genetics	PC	4	4+0+0	70+30
M-Z-102	Biochemistry and Biotechniques	PC	4	4+0+0	70+30
M-Z-103	Biology of Invertebrates	PC	4	4+0+0	70+30
M-Z-104	a) Fish Fisheries & Aquaculture b) Biosystematics and computational biology c) Animal Behaviour & Wildlife Conservation	PE  (Choose any one)	4	4+0+0	70+30
M-Z-105	Practical (Based on Papers M-Z 101 & M-Z 102)	PC	3	0+0+6	70+30
M-Z-106	Practical (Based on Papers M-Z 103 & M-Z 104)	PC	3	0+0+6	70+30
M-Z-107	Seminar/Report**	PC	1	0+1+0	25
<b>Total</b>			<b>23</b>	<b>16+1+12</b>	<b>625</b>

<b>Semester II</b>					
M-Z-201	Molecular Biology & Biostatistics	PC	4	4+0+0	70+30
M-Z-202	Population Genetics & Evolution	PC	4	4+0+0	70+30
M-Z-203	Comparative Physiology	PC	4	4+0+0	70+30
M-Z-204	Biology of Vertebrates	PC	4	4+0+0	70+30
M-Z-205	Open Elective	OE	4	4+0+0	70+30
M-Z-206	Practical (Based on Papers M-Z 201 & M-Z 202)	PC	3	0+0+6	70+30
M-Z-207	Practical (Based on Papers M-Z 203 & M-Z 204)	PC	3	0+0+6	70+30
M-Z-208*	Internship/summer training	PE	4	4 weeks	100
<b>Total</b>			<b>26+4*</b>	<b>20+0+12</b>	<b>700+100* =800</b>
<b>Semester III</b>					
M-Z-301	Population & Community Ecology	PC	4	4+0+0	70+30
M-Z-302	Molecular Endocrinology	PC	4	4+0+0	70+30
M-Z-303	Applied Zoology	PC	4	4+0+0	70+30
M-Z-304	a. Parasitology b. Protein Structure and Function c. Molecular-Reproduction	PE  (Choose any one)	4	4+0+0	70+30
M-Z-305	Seminar	PC	1	0+1+0	25
M-Z-	Practical (Based on Papers M-Z 301 & M-Z 302)	PC	3	0+0+6	70+30

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M-Z-307	Practical (Based on Papers M-Z 303 & M-Z 304-etc)	PC	3	0+0+6	70+30
M-Z-307	Project I**	PC	2		50
<b>Total</b>			<b>25</b>	<b>16+1+12</b>	<b>675</b>
<b>Semester IV</b>					
M-Z-401	Development Biology	PC	4	4+0+0	70+30
M-Z-402	Vertebrate Immunology	PC	4	4+0+0	70+30
M-Z-403	Environmental Toxicology	PC	4	4+0+0	70+30
M-Z-404	a) Aquatic Resources & their Conservation b) Environment, Epigenetics & Hormone Biology c) Insect Diversity, Society & Evolution	PE (Choose any one)	4	4+0+0	70+30
M-Z-405	Practical (Based on Papers M-Z 401 and M-Z 402)	PC	3	0+0+6	70+30
M-Z-406	Practical (Based on Papers M-Z 403 and M-Z 404)	PC	3	0+0+6	70+30
M-Z-407	Project II***	PC	4		100
<b>Total</b>			<b>26</b>	<b>16+0+12</b>	<b>700</b>
<b>Grand Total = 2700 +100 *</b>					
<p><b>*Note: Students willing to exit the programme after second semester have to undertake the Internship/summer training in other than parent institution and will be awarded PG Diploma in Zoology</b></p> <p><b>**Evaluation will be done by a committee constituted by Chairperson/Head of the Department in Affiliated colleges</b></p> <p><b>***Evaluation will be done by External Examiner.</b></p>					

## M-Z-101 Cell Biology and Genetics

Credit 4 (4+0+0)  
Maximum Marks: 100  
Internal Marks: 30  
External Marks: 70  
Time: 3 Hours

**Note:** Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

### Unit-I

Biomembranes: molecular composition and arrangement, functional consequences, cellular 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. Maintenance of cellular pH; cell excitation; bulk transport; Receptor mediated endocytosis, transepithelial transport, Cytoskeleton and cell movement; introduction to cytoskeleton and its role, molecular structure of actin, myosin and their organization, structure and dynamic organizations of microtubules, microfilaments and intermediate filament, structure and functions of Cilia and flagella.

### Unit-II

Cell interactions and cell-matrix adhesions: cell walls, the ECM and cell-matrix interactions, 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  
Cell cycle; eukaryotic cell cycle, Regulators of cell cycle progression, Role of Meiosis in Genetic Variation, Cell – Cell signaling, Signaling molecules and their receptors, Pathways of intracellular signal transduction. Basic biology of Cancer, the development and causes of cancer, oncogenes, tumor suppressor genes.

### Unit-III

Gene mutation, DNA repair: types of gene mutations, methods for detection of induced mutations; P- element insertional mutagenesis in *Drosophila*; DNA damage, repair. Regulation of Gene Expression: Regulation of gene activity in lac and trp operons of *E. coli*. General introduction to gene regulation in eukaryotes at transcriptional and post-transcriptional levels; Organization of a typically eukaryotic gene, transcription factors, enhancers and silencers, non-coding genes.

### Unit IV

Sex determination and dosage compensation: sex determination-in humans, *Drosophila* and other animals; dosage compensation of X-linked genes– hyperactivation of X-linked gene in male *Drosophila*, inactivation of X-linked genes in female mammals; human genetics- karyotype and nomenclature of metaphase chromosome bands; chromosome anomalies and diseases- chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms'tumor); genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping.

**Suggested Reading:**

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 Biology by A.K. Berry, EMKAY Publications
4. Molecular Cell Biology, Lodish et al., W.H. Freeman and Company (8th Ed. 2016)
5. Molecular Biology, Weaver R. F., McGraw-Hill Education (5th Ed. 2011)
6. Principles of Genetics, Snustad and Simmons, John Wiley & Sons, USA [Latest edition]
7. Genetics, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA [Latest edition]

**Paper:M-Z-102 Biochemistry and Bio-techniques**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.**

**Unit-I**

General Principles of Biochemistry and chemical composition of Life: General Introduction to Biomolecules, Protein Biology: Primary, Secondary, tertiary and quaternary structure of proteins: i) Domain, ii) Reverse turn of Ramachandran plot and its significance, Enzyme: Classification and nomenclature, Co-enzymes and Cofactors, Induced fit and Molecular Mechanism of Enzyme action, Enzyme feedback mechanism, Isozymes, Nucleic acids: Structure and functions, DNA structure and functions RNA structure and functions, DNA choreography, Qualitative and quantitative estimation of DNA

**Unit-II**

Metabolism: Glycolysis, citric acid cycles its regulation and role as metabolic hub, Hexose monophosphate\_ pathway its regulation and significance, Cholesterol biosynthesis, its metabolism and steroidogenesis, Bile acids and their metabolism, Saturated and unsaturated fatty acid and their metabolism.

**Unit-III**

Chemical and Biological assays (in-vitro and in-vivo assays), Principles and uses of analytical instruments: Microscopes and imaging, Spectrophotometer, NMR spectrophotometer. Microbiological and cell culture Techniques: Setting of microbiological laboratory, Sterilization and Media preparation techniques, Inoculation and growth monitoring (Standard plate count technique), Isolation of a microbial colony and slant preparation, Design and functioning of tissue culture laboratory, Basics of cell/tissue culture, Culture media preparation, Cell proliferation measurements, Cell viability testing and Cell harvesting

methods, Biosafety and levels Cryotechniques: Cryopreservation for cells, tissue, organisms, Cryotechniques for microscopy.

#### **Unit-IV**

Separation techniques in biology: Molecular separations by chromatography, electrophoresis, precipitation etc. Organelle separation by centrifugation. Density gradient centrifugation, Ultra Centrifugation, unit gravity centrifugation, affinity adsorption, anchorage-based techniques etc., Cell separation by flowcytometry and FACS, Radioisotope and mass isotope techniques in biology: Sample preparation for radioactive counting, Autoradiography, Biosensors, DNA fingerprinting.

#### **Suggested Reading**

1. Animal Cell Culture – A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Braun, McGraw Hill International editions
3. A Biologists guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K.H. Goulding, ELBS Edn.
4. Lehninger AL, Nelson DL & Cox MM (1993) Principles of Biochemistry, 2nd edn. New York: Worth.
5. Stryer L (1995) Biochemistry, 4th edn. New York: WH Freeman.
6. Voet D, Voet JG & Pratt CW (1999) Fundamentals of Biochemistry. New York: Wiley.

### **M-Z-103 Biology of Invertebrates**

**Credit 4 (4+0+0)**

**Maximum Marks: 100**

**Internal Marks: 30**

**External Marks: 70**

**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.**

#### **Unit-I**

Introduction to invertebrates with their general characters, Basic body plan, Concept of Invertebrate 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, Pseudo metamerism. Minor Phyla: Concept and significance, organization and general characters of Acoelomate, Pseudocoelomatos and Coelomates. Minor phyla (with special emphasis on Ctenophora, Rotifera, Endoprocta, Ectoprocta, Phoronida, Sipunculida and Echiuroidea).

#### **Unit-II**

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, Molluscs and Echinodermata. Respiration: Organs of respiration: Gills, lungs, trachea, skin etc. Respiratory pigments, Mechanism of respiration.

#### **Unit-III**

Excretion: Organs of excretion: Coelom, coelomoducts, Nephridia and Malpighian tubules. Mechanism of separation and osmoregulation. Nervous system: Primitive nervous system:

Coelenterata and Echinodermata, Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) Mollusca (Cephalopoda), Trends in neural evolution, social life in insects, social life in Isoptera and Hymenoptera

#### **Unit-IV**

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 Reading**

1. Hyman, L.H. The invertebrates, Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J. London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol.2. McGraw Hill Co., New York. 18
5. Hyman, L.H. The Invertebrates. Vol.8. McGraw Hill. Co., New York.
6. Barnes, R.D. Invertebrate Zoology, IIIrd edition. W.B. Saunders Co., Philadelphia.
7. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London.
8. Hyman, L.H. the Invertebrates smaller coelomate groups, Vol. V. McGraw Hill Co., New York
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student text book of Zoology. Vol. I, II and III Central Book Depot, Allahabad
11. Parker, T.J., Haswell, W.A. Text book of Zoology, McMillan Co., London.

### **M-Z-104 (a) Fish, Fisheries and Aquaculture**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.**

#### **Unit-I**

Definition of Fish, Fisheries and aquaculture: Types of Aquacultures, Classification of fishes with distinguishing characters and examples of each group, Estuarine, Marine, Riverine and wetland fisheries: characteristic species and their exploitation, Culture fisheries: Cultivable organisms for aquaculture, Criteria of selection of cultivable fishes, Design, construction and

maintenance of fish culture ponds, Ecology of fish pond ecosystem, Physico-chemical conditions of ponds water and soil, Biological conditions of water and productivity of fish ponds.

#### **Unit-II**

Fish integument: Exoskeleton and colouration, Fins: origin, types and functions, Food and feeding habits of fishes, Digestion in fishes, Respiratory system Gill structure and functions, Accessory respiratory organs swim bladder and webberian ossicles, Osmoregulation in fishes, Receptors in fishes: Chemoreceptors, Lateral line organs, Eye, Ear, Pineal organ, Hormones and reproduction: Induced breeding in carps and catfishes.

#### **Unit-III**

Introduction to fish biotechnology, selection and hybridization, androgenesis and gynogenesis-natural and induced, polyploidy techniques, sex reversal and sterility, transgenesis, transgenes and application, cryopreservation and gametes and embryo, Fish by products

#### **Unit-IV**

Different systems for aquaculture: pond culture, cage culture, raceway culture, culture of important fish species (major carps, common carps, Chinese carps, cat fish, culture and tilapia culture), integrated aquaculture and wastewater aquaculture, pearls culture, prawn culture-fresh and brackish water, methods of fishing: crafts and gear technology, fish diseases and their control

#### **Suggested Reading**

1. Encyclopedia of Fish Physiology. 2011. Anthony P. Farrell, E.D. Stevens, J.J. Cech & J.G. Richards (Eds). Academic Press, UK.
2. APHA (1995) Standard Methods of Examination of Water and Wastewater. American Public Health Association, AWWA, WCPWF, Washington DC.
3. Bardach, JE, Ryther & McLarney, Wo (1972) Aquaculture, New York: Wiley-Interscience. 896pp. 58
4. Boulenger, GA & Bridge, TW (1910) Fishes (Vol. VII of the Cambridge Natural History) Cambridge Univ. Press, London.
5. Das, P, Verma, SR, Dhaje, RJ & Malik DS (2002) Coldwater Fish Genetic Resources and their Conservation. National Conservators publication, 7, 325pp.
6. Datta Munshi, JS & Srivastava, MP (1998) Natural History of Fishes and Systematics of Freshwater Fishes of India. Narendra Publishing house, Delhi, 403pp.
7. Jayram, KC (2013) The Freshwater Fishes of the Indian Region (Corrected 2nd Edition) Narendra Publishing house, Delhi, 616pp, XXXIX plates.
8. Lagler, KF, Bardach, JE, Miller, RR & Passino, DRM (1977) Ichthyology, 21st Edition, New York.

### **M-Z-104 (b) Biosystematics and Computational Biology**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will**



be of 14 marks.

### **Unit-I**

Biosystematics and taxonomy: definition and perspectives, historical resume, importance and applications of systematics in biology, concepts of newer aspects of biosystematics in biology: chemotaxonomy, cytotaxonomy, molecular taxonomy, dimension of speciation and taxonomic characters, subspecies and other intra specific categories, theory of biological classification hierarchy of categories, taxonomic characters different kinds weighing of characters

### **Unit-II**

Methodology: taxonomic collections preservation, curation processes and identification, taxonomic keys different kinds of taxonomic keys their merits and demerits, systematic publications: different kinds of publications, international code of zoological nomenclature: principles, objectives and rules: stability, priority, concept of availability, formation of names synonymy homonymy the type methods kinds of type specimen type designation. Principles of bioethics in biodiversity.

### **Unit-III**

Basic components of computers– hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MS EXCEL- use of worksheet to enter data, edit data, copy data, move data; Use of in- built statistical functions for computations of mean, S. D., correlation, regression coefficients etc., Use of bar diagram, histogram, scatter plots, etc., Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD; word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc; Introduction to Power Point, image and data handling.

### **Unit-IV**

The era of computerized biology information: review of relevant definitions in molecular biology, overview of challenges of molecular biology computing, proteins, secondary structure and folding, RNA secondary structures, Introduction to phylogenetic analysis; introduction to bioinformatics; introduction to genomics and proteomics databases- nucleic acid sequence database: Genbank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swiss- prot, PDB, BLAST, PSI- BLAST (steps involved in use and interpretation of results) and HMMER, BLAST vs FASTA, file formats- FASTA, GCG and ClustalW. Databank search- data mining, data management and interpretation, multiple sequence alignment, genes, primer designing; Protein modeling, protein structure analysis, docking, LigPlot interactions, phylogenetic analysis with the program PHYLIP, DISTANCES, GROWTREE etc

## **M-Z-104 (c) Animal Behaviour & Wildlife Conservation**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will**

be of 14 marks.

### **Unit-I**

Concept of animal behaviour; Mile-Stones in the history of animal behaviours and scope Stereotyped and acquired behaviour patterns: Tropisms, Taxes, Reflexes, Instincts, learning & reasoning; Change in major modes of adaptive behaviour in phylogeny, Perception of the environment: Mechanical, Electrical, chemical, olfactory, auditory, visual, biological rhythms and concept of biological clock. Brief study of social behaviours in animals

### **Unit-II**

Motivation Introduction, goal-oriented behaviour, biological drives-Primary and Secondary drives, Concept of learning: law of learning, types of learning-Habitation, trial & error learning, latent learning, Insight, Imprinting, Classical conditioning & Instrumental learning, Concept of Migratory behaviour, Hormones and animal behaviour,

### **Unit-III**

Wildlife: Definition, significance and Biogeographic/wildlife zones of India, Biodiversity of the Indian Subcontinent and World, Protected Area Systems: Concept, Historical background, categories and management objectives of protected areas, world growth of protected areas, and Present status of National PA-Systems, Theory and practice of Biosphere Reserves of the world: biosphere Reserves of India, Wildlife conservation techniques.

### **Unit-IV**

Natural Heritage Sites of the world, Natural Heritage sites in India. Important National Park and Wildlife Sanctuaries of India, Wildlife and livelihood; Wildlife and illegal trade & control; Role of WWF, IUCN, UNEP, Red Data Book; Categories of Endangered Wildlife Species, Wildlife census and programs for conservation.

### **Suggested Reading**

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOLWattenslip, Pratunam Bangkok, 10400, Thailand
3. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun. 6. E.P. Gee, The Wildlife of India.

## **M-Z-201 Molecular Biology & Biostatistics**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.**

### **Unit-I**

DNA Replication: Prokaryotic and Eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication, Transcription: Prokaryotic and Eukaryotic transcription, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing, Post-transcriptional Modifications in RNA, 5'-Cap formation, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability

Translation: Genetic code and deciphering of genetic code, Prokaryotic and Eukaryotic translation, The translational machinery, Adaptor hypothesis, Kozak rule, Mechanism of initiation, elongation and termination, Regulation of translation, Transport of Protein: Co and Post-translational transport of proteins, Co- and Post-translational modification of proteins, Protein trafficking/sorting.

### **Unit-II**

Recombination and Repair: Holiday junction, gene targeting, gene disruption, Cre/lox recombination, RecA and other recombinases, DNA repair mechanisms, Antisense and Ribozyme technology: Molecular mechanisms of antisense molecules. Molecular mapping of genome: genetic and physical maps, Physical mapping and map-based cloning, Southern end fluorescence in situ hybridization for genome analysis, Chromosome micro-dissection and micro-cloning, Molecular markers in genome analysis RFLP, RAPD and AFLP analysis and their applications. Molecular markers linked to disease resistance genes rDNA Technology: Gene-cloning, Vectors, cDNA and genomic libraries, Blotting techniques, Chromosome walking, Application of rDNA technology.

### **Unit-III**

Measures of central value: arithmetic mean, mean, mode and median, definition, calculation and properties, measures of dispersion: range, interquartile range, quartile deviation, mean deviation and standard deviation standard error, correlation types and method studying correlation scatter diagram method graphic method Karl pearson coefficient of correlation, rank correlation, regression analysis (regression lines and regression equation), chi-square analysis.

### **Unit-IV**

Concept of sampling and sampling methods: definition and law of sampling, judgment sampling, random sampling, stratified sampling, systematic sampling, multi stage sampling and quota sampling, test of significance for large samples and small samples (student t test, F-test ANOVA), probability and law of probability, theoretical probability distribution: Binomial distribution, poisson distribution, normal distribution. Components of computers, basic functioning of computers use of statistical software in biology.

### **Suggested Reading**

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. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
4. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
5. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A Meyers (Ed.), VCH Publishers, Inc., New York.
6. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis,

Cold Spring Harbor Laboratory Press, New York.

7. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
8. Molecular Biology LabFax, T.A Brown (Ed.), Bios Scientific Publishers Ltd., Oxford

## **M-Z-202 Population Genetics & Evolution**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note:** Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

### **Unit-I**

Concepts of evolution and theories of organic evolution with an emphasis on Darwinism, Emergence of Neo-Darwinism. Neo Darwinism; Hardy-Weinberg law of genetic equilibrium. A detailed account of destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration (v) Meiotic drive

### **Unit-II**

Quantifying genetic variability, Genetic structure of natural populations, Phenotypic variations, Models explaining changes in genetic structure of populations, factors affecting human disease frequencies, Molecular population genetics, Patterns of change in nucleotide and amino acid sequences, Ecological significance of molecular variations, Genetics of quantitative traits in populations; Analysis of quantitative traits, Estimation of heritability, Genotype-environment interactions, Inbreeding depression and heterosis. Molecular analysis of quantitative traits. Phenotypic plasticity.

### **Unit-III**

Genetics of speciation: Concept of species, Patterns and mechanisms of reproductive isolation, Modes of speciation (Allopatric, Sympatric, Parapatric, Peripatric), Molecular Evolution: Gene Evolution; Evolution of gene families, Molecular drive, Assessment of molecular variations, Origin of higher categories, Phylogenetic gradualism and punctuated equilibrium, Major trends in the origin of higher categories, Micro-and Macro-evolution.

### **Unit-IV**

Molecular phylogenetics: Concept of phylogenetic trees, Methods of construction of Phylogenetic trees, Population genetics and ecology; Metapopulations, Monitoring natural population, Populations size and extinction, Loss of genetic variations, Conservation of genetic resources in diverse taxa.

### **Suggested Reading:**

1. Dobzhansky, T. (1951). Genetics and the origin of Species: Columbia

- University. New York.
2. Futuyma, D. J. (1998). Evolutionary Biology (3rd ed.). Sunderland, MA: Sinauer Associates.
  3. Hartl, D. L. (1988). A primer of population genetics. Sinauer Associates, Inc. Massachusetts.
  4. Smith, J.M. (1998) Evolutionary Genetics (2nd ed.). Oxford University Press, New York.
  5. Strickberger, M. W. (2005). Evolution. Jones & Bartlett Learning.

### **M-Z-203 Comparative Physiology**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.**

#### **Unit-I**

Digestion: Feeding mechanisms and regulation, Comparative physiology of digestion and absorption in different animal groups. Respiration: Respiratory organs, Types of respiration, mechanism of breathing, Transport of respiratory gases, Respiratory pigments through different phylogenetic groups, Physiological response to oxygen deficient stress. Excretion: Patterns of nitrogen excretion among different animal groups, Functional anatomy of renal unit; mechanisms of ultrafiltration, Counter Current mechanism, Dialysis, Osmoregulation in different animal groups: definition and basic classification of organisms on the basis of osmoregulation, osmotic challenges of different environments, mechanisms of osmoregulation in fresh water, estuarine and marine animals, osmoregulation in migratory organisms control and regulation of osmoregulation.

#### **Unit-II**

Thermoregulation: homeothermic animals, poikilotherms, hibernation and aestivation, physical, chemical, neural regulation, physiological adaptations acclimatization and acclimation in response to high, low ambient temperature. Circulation of body fluids and their regulation among different animal groups: systems of circulation, heart beat and blood pressure, cardiac cycle, cardiac output and its regulation. Receptor physiology: a comparative study of mechanoreception, photoreception, chemoreception and equilibrium reception, muscle and contractile physiology: contractile elements cells and tissues among different phylogeny groups, muscle structure and function-correlation, electric organs and tissues.

#### **Unit -III**

Comparative testicular physiology in animals: morphology, differentiation, function and its regulation, comparative ovarian physiology and differentiation in vertebrates, neuronal physiology: structure and classification of neurons and glial cells, synaptic action, dendritic properties and functional operation of spinal cord, brain stem, autonomic nervous system.

#### **Unit-IV**

Principles of synaptic transmission: Ca<sup>2+</sup> and transmitter release; post synaptic transmission mechanism, diversity of neurotransmitters: acetylcholine, catecholamine, serotonin, GABA, glycine, histamine, peptides, NO and opioids. Physiological adaptations to different environments: physiological adaptations acclimatization and acclimation in response to high low ambient temperature, physiological adaption at high altitude and in deep sea environment, stress physiology concept of stress and strain, stress hormones and stress regulatory mechanisms.

#### **Suggested Reading:**

1. Prosser, C. L., & Brown, F. A. (1961). Comparative animal physiology. W.B. Saunders & Company.
2. Randall, D. J., Burggren, W., French, K., & Eckert, R. (2002). *Eckert animal physiology*. W.H. Freeman & Company.
3. Moss, M. L. (1966). General and comparative physiology.(815 pp.) WS Hoar Prentice- Hall, Inc., Englewood Cliffs, NJ 1966.
4. Guyton, A.X., (1986) Text Book of Medical Physiology, 7th edition, Saunders Company

### **M-Z-204 Biology of Vertebrates**

**Credit 4 (4+0+0)**  
**Maximum Marks: 100**  
**Internal Marks: 30**  
**External Marks: 70**  
**Time: 3 Hours**

**Note: Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.**

#### **Unit-I**

Introduction to Chordates with their general characters: Origin of Chordates, Concept of Protochordata 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-II**

Skeletal system: Forms, 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. Respiratory system, Comparative account of respiratory organs

#### **Unit-III**

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. Evolution of Urino-genital system in vertebrates' series: Structure and functions of different types of kidneys, Urino-genital ducts, Flight adaptation in birds, Migration in fishes and Birds

#### **Unit-IV**

Nervous system: Comparative anatomy of the brain in relation to its functions, Comparative 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 Reading:**

1. Barrington, E.J.W. (1965) *The Biology of Hemichordata and Protochordata*. Oliver and Boyd, Edinburgh.
2. Bourne, G.H. (1972) *The structure and functions of nervous tissue*. Academic Press, New York.
3. Carter, G.S. (1967) *Structure and habit in vertebrate evolution*. Sedgwick and Jackson, London.
4. Kingsley, J.S. *Outlines of Comparative Anatomy of Vertebrates*. Central Book Depot, Allahabad.
5. Kent, G. C. & Carr, Robert K. (2009) *Comparative Anatomy of the Vertebrates*.