M.Sc. Zoology
2018-19

Sem-ester	Course	Course Code	Course Name	Credits	Marks External	Internal	Total Marks
I	CC-I	MZ CC : 101	Biosystematics and Taxonomy	4	55	20	75
	CC-II	MZ CC : 102	Evolutionary Biology	4	55	20	75
	CC-III	MZCC: 103	Metabolism : Concept and Regulation	4	55	20	75
	CC-IV	MZCC:104	Molecular Cell Biology	4	55	20	75
	IDC (Choose One)	MZ IDC 105 A	Microbiology	4	55	20	75
		M ZIDC 105 B	Computers Fundamentals and Programming				
	Practical I	MZ P : 106	Biosystematics ,Taxonomy and Evolutionary Biology	2	50	-	50
	Practical II	MZ P : 107	Biochemistry and Molecular Cell Biology	2	50	-	50
	Practical III	MZ P : 105 A	Microbiology	1	25	-	25
		MZ P: 105 B	Computers Fundamentals and Programming				
				25 Credits			500
II	CC-V	MZ CC : 201	Genetics and Cytogenetics	4	55	20	75
	CC-VI	MZ CC : 202	Principles of Gene manipulation	4	55	20	75
	CC-VII	MZ CC: 203	Comparative Animal Physiology	4	55	20	75
	CC-VIII	MZ CC:204	Developmental Biology	4	55	20	75
	IDC (Choose One)	MZ IDC 205 A	Bioinformatics	4	55	20	75
		M Z IDC 205 B	Biostatistics				
	Practical IV	MZ P : 206	Genetics and Gene Manipulation	2	50	-	50
	Practical V	MZ P : 207	Animal Physiology and Developmental Biology	2	50	-	50
	Practical VI	MZ P : 205A	Bioinformatics	1	25	-	25
		MZP : 205B	Biostastistics				
				25 Credits			500

Pass percentage in Theory and Practical each is 35%

Semester – I

CORE COURSE –MZOO CC 101
BIOSYSTEMATICS AND TAXONOMY

OBJECTIVES OF THE PAPER: To give students a thorough understanding in the principles and practice of biosystematics. This course will help the students to acquire an in depth knowledge on the diversity and relationships existing in the animal world. Taxonomic concepts will help to develop a holistic appreciation of the phylogeny of animal world and of different taxonomic tools used in the classification.

Maximum Marks: 75 Credits : 4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION – A

1. Definition and basic concepts of biosystematics and taxonomy (8)
   - 1.1 Historical resume of systematics.
   - 1.2 Importance and applications of biosystematics in biology.

2.Trends in biosystematics- concepts of different conventional and newer aspects. (10)
   - 2.1 Chemotaxonomy
   - 2.2 Cytotaxonomy
   - 2.3 Molecular taxonomy.
   - 2.4 Ecotaxonomy
   - 2.5 Behavioural taxonomy.

3. Species concepts – species category, different species concepts; sub-species and other infra-specific categories. (10)
   - 3.1 Biological Species Concepts, its merits & demerits.
   - 3.2 Typological species.
   - 3.3 Nominalistic Species Concept.
   - 3.4 Evolutionary Species Concept.

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SECTION-B

4. Taxonomic characters-details account of different kinds (8)
5. Procedure in taxonomy (12)
   - 5.1 Taxonomic procedures-taxonomic collections, preservation, curation, process of identification.

5.2 Taxonomic keys-different kinds of taxonomic keys, their merits and demerits.
5.3 Systematic publications-different kinds of publications.

6. Sustainable utilization of Biodiversity(10)
   6.1 Equitable sharing & conservation of Biodiversity.
   6.2 Genetic Variations.
   6.3 Non genetic Variations.

SUGGESTED READING MATERIAL

1. M. Kato. The Biology of Biodiversity, Springer.2000
2. J.C. Avise. Molecular Markers, Natural History and Evolution, Springer US, 2011.
3. E.O. Wilson, Biodiversity, 1988, Academic Press, Washington
4. G.G. Simpson, Principle of Animal taxonomy, Oxford IBM Publishing Company.
5. E.O. Wilson. 1999, The diversity of Life (The College Edition), W.W. Northern & Co. .
6. Mayr, E. 1963. Animal species and Evolution. The Belknap press, Harward Univ. Press, Cambridge.
7. Mayr, E. 1969. Principles of Systematic Zoology. McGraw-Hill, N.Y.Second Edition
8. Mayr, E. 1970. Populations, species and evolution, Cambridge Mass, Harvard Univ. Press.
9. Dobzhansky, T. 1980. Genetics and origin of species, Columbia Univ. Press, N.Y.
10. Ferguson, A., 1976. Biochemical systematics and evolution, John Wiley and Sons, N.Y., Toronlo.
11. Gote, H.E. 1982. Animal Taxonomy.
12. Mayr, E. & E. Aschhok. 1991. Principles of systematic, McGraw Hill Book Co. London.
13. Minell, A. 1983. Priological systematics, The state of Art champan of Hill, London.
14. Quicke, D.L.J. 1996. Principles and Techniques of contemporary Taxonomy. Blacky Academic and Professional, London, New York.
15. Sebuh, R.T. 2000. Biological systematics: Principles & Application, Cornell University Press.

CORE COURSE : M ZOO CC:102
EVOLUTIONARY BIOLOGY

OBJECTIVES OF THE COURSE : This course is aimed at providing an understanding of evolutionary patterns and relationships. The students will be able to get insight into the process and patterns of biological evolution and the role of evolution as the central unifying concept of biology

Maximum Marks: 75 Credits : 4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION – A 30 Hrs

1 Origin of Life

1.1 Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers;

1.2 Concept of Oparin and Haldane; Experiement of Miller

1.3 The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes

1.4 Anaerobic metabolism, photosynthesis and aerobic metabolism.

2 **Theories of Evolution**

2.1 Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection

2.2 Spontaneity of mutations; Evolutionary synthesis.

3 Phylogeny

3.1 Phenetics and cladistics

3.2 Phylogenetic Hypothesis

3.3 Molecular Data in Phylogenetic Analysis

3.4 Advancements in Phylogenetic Estimations

SECTION – B

30 hrs

4 Evidences of Evolution

4.1 The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale

4.2 Major Evidences of Evolution

4.3 Fossil record (types of fossils)

4.4 Evolution of horse and camel

4.5 Human Evolution

5. Extinctions :

Back ground and mass extinctions (causes and effects), detailed example of K-T Extinction

6. **Concepts of Molecular Evolution**

6.1 Molecular divergence and molecular clocks

6.2 Molecular tools in phylogeny, classification and identification

6.3Protein and nucleotide sequence analysis

6.4 Origin of new genes and proteins

6.5 Gene duplication and divergence in context of evolution

SUGGESTED READING MATERIAL

1. Futuyma, Douglas J. 2005. Evolutionary Biology (3rd edition) Sinauer Associates, Inc., Sunderland, Massachusetts
2. Avise, John C. 2004. Molecular Markers, Natural History and Evolution (2nd Edition) Sinauer Associates, Inc., Sunderland, Massachusetts
3. Coyne, Jerry A. and Orr, AllenH. 2004. Speciation Sinauer Associates, Inc., Sunderland, Massachusetts
4. Gould, Stephen Jay. 2002. The Structure of Evolutionary Theory. Harvard University Press, Cambridge, Massachusetts
5. Gould, Stephen Jay. 1997. Ever Since Darwin, Reflections in Natural History. W.W. Norton and company Net work
6. Mayr, E. 1963. Animal Species and Evolution. Harvard University Press, Cambridge, Massachusetts
7. Freeman, S. and Harron, C. Jon.2006 Evolutionary Analysis (4th Edition) Prentice Hall, Inc. Pearson, NJ

8.Veer Bala Rastogi, Organic Evolution, Medtec publishers.

9.Stickberger`s Evolution by Brian K Hall Benedikt Hallgrimsson (4th Edition)

CORE COURSE -MZOO103

METABOLISM -CONCEPTS AND REGULATION

OBJECTIVES OF THE PAPER : The course aims at the understanding of metabolic pathways and their linkage, metabolism of primary metabolites – monosaccharides, lipids, amino acids and the mechanism of enzyme action.

Maximum Marks: 75 Credit : 4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION – A

Overview of Metabolism 10

Catabolism *vs* Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Carbohydrate Metabolism 10

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

Lipid Catabolism 10

β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; **Lipid Anabolism** :Biosynthesis of palmitic acid; Ketogenesis and its physiological significance in Diabetes mellitus and Alcohlism

SECTION – B

Protein Metabolism 10

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Bioenergetics: 8

Mitochondrial Electron transport chain. Mechanism of Mitochondrial oxidative phosporylation: Chemiosmotic theory.

Structure and Functions of Enzymes: 12

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.

- Murray, R.K., Bende*r, D.A.*, Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.

- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

CORE COURSE -MZOO104
MOLECULAR CELL BIOLOGY

OBJECTIVES OF THE PAPER :To acquaint the students with the understanding of the mechanism and regulation of cell cycle and the regulatory mechanisms of the cell.

Maximum Marks: 75
Theory: 55
Internal Assessment: 20
Minimum Pass Marks: 35%

Credits : 4
Time Allowed: 3 hrs

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION A

Transport across the cell membrane:
Recapitulation of the plasma membrane; mechanism of diffusion, facilitated diffusion, active transport with suitable examples; movement of water; Donnan equilibrium; ion movements and cell function: acidification of cell organelles and stomach; transepithelial transport; maintenance of cellular pH; cell excitation; bulk transport: receptor mediated endocytosis; protein sorting and targeting to organelles; molecular mechanism of the secretory pathway; secretion of neurotransmitters.

Cellular shape, motility and energetics-
cytoskeletal elements in cell shape and motility: structure and dynamics; role in cell locomotion and mitosis; Intercellular communication: extracellular matrix; cell- cell and cell-matrix adhesion; gap junctions; cellular energetics: oxidation of glucose and fatty acids; the proton motive force; F0F1 ATP synthase; mechanism and regulation of ATP synthesis.

Life cycle of a cell –
cell cycle and its regulation; checkpoints in the mammalian cell cycle; tumor suppressors and role of helicases; regulation of cell proliferation and differentiation by hormones, neuropeptides and growth factors; cell differentiation; apoptosis; turnover of cellular components: targeting of proteins to lysosomes for degradation; degradation of cytosolic proteins; cells in culture: requirements for cell culture; aseptic technique; primary culture; cell lines; organotypic cultures; cytotoxicity assays.

Cell regulatory mechanisms- regulatory and control mechanisms in a mammalian cell at the biochemical level; key concepts about cellular signaling mechanisms: proliferative, survival and death pathways; G- protein coupled receptors; receptor tyrosine kinases; MAP kinase

cascade; second messenger systems; desensitization of receptors; signaling and toxins; Signaling pathways in malignant transformation of cells; cell transformation: role of oncogenes. siRNA and miRNA basics, regulation of transcription and translation of proteins by miRNA.

SUGGESTED READING MATERIAL

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach***,** V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.
- Lodish et. al., (2007), Molecular Cell Biology, W.H. Freeman and Company, New York, USA
- Alberts et. al., (2008), Molecular Biology of the Cell, Garland Science, Taylor & Francis Group, New York, USA.

IDC-MZOO -I A 105
MICROBIOLOGY

Maximum Marks: 75 Credits :4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION –A

1. General Microbiology :

1.1 Microbiology: Introduction, history, scope, importance and applications.
1.2 Major microbial groups: bacteria, virus, protozoan, algae, Fungi and their classification

2. Microbial characteristics:

2.1 Growth and characteristics of Bacteria
2.2 Cell wall: Structure and staining
2.3 Respiration and energy production: metabolism
2.4 Nutrient requirement: growth medium, culture plates

3. Microbial Genetics: Reproduction

3.1 Organization of genome
3.2 Bacterial recombination
3.3 Transformation
3.4 Conjugation
3.5 Transduction
3.6 Lytic and lysogenic cycles: viruses
3.7 Types of reproduction in: fungi, algae, protozoans

SECTION –B

4. Microbial Ecology, types and distribution

4.1Extremophiles
4.2Microbial interactions: positive and negative interactions
4.3Parasitic and pathogenic microbes

5. **Environmental, Food, Industrial Microbiology**

5.1 Microbial flora of soil and their role in Nitrogen and Carbon transformation.
5.2 Micro-organisms of domestic and waste water.

5.3 Microbial flora of fresh food, spoilage and preservation of food.
5.4 Fermented foods.
5.5 Micro-organisms as food.

6. Aerobic and anerobic bacteria:

6.1 Facultative aerobes
6.2 Facultative anaerobes
6.3Obligate aerobe
6.4 Microaerophiles
6.5 Aerotolerant anaerobes

7. Genetic research and microorganisms:

7.1 Genetic transformation
7.2 vaccine developments

SUGGESTED READING MATERIAL

1. General Microbiology by R.V. Stainer, J.L. Ingraham, M.L. Wheelis and P.R. Painter, Mac Millan, Hong Kong, 1992.
2. General Microbiology by H.G. Schegel, Cambridge University, Press, U.K. 1995
3. Microbiology by Pelczar, M.J., Chan, C.S. and Krieg, D.R. McGraw-Hill offices, New York, 2000
4. Principles of Microbiology by R.M. Atlas, Mosby, St. Louis, 1995.

IDC-MZOO -I B 106

COMPUTER FUNDAMENTALS AND PROGRAMMING

OBJECTIVES OF THE COURSE :To understand the basics of computer and basics of programming so that they able to solve computational problems

Maximum Marks: 75 Credits :4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

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SECTION –A

Computer Fundamentals: Definition, Characteristics, Application of Computer, Number Systems: Binary, Octal and Hexadecimal Conversion, Binary Arithmetic, Computer Languages: Machine Language, assembly language, high level language, assembler, compiler and interpreter.

Programming Fundamentals: Algorithms, characteristics and Examples of algorithms, Flowcharts, symbols used in flowcharts, Examples of flowcharts, Pseudocode, character set, Identifiers and keywords, constants, variable. Data Types: Declaring(integer, float and character), Defining and Initializing Variables, Scope of Variables, Using Named Constants, Casting of Data Types, Storage Classes Operators and expressions: Arithmetic, Unary, Logical and Relational operators, assignment operators, Conditional operators.

SECTION-B

Control statements: Branching constructs, looping constructs, nested control structures, switch, break and continue statements. Functions: Declaration, Definition, Call, passing arguments, call by value, call by reference,Recursion, Use of library functions; Storage classes: automatic, external, register and static variables. Arrays: Using one dimensional and two dimensional arrays, Passing array to a function, Solving matrices problem using arrays; Strings: input/output of strings, string handling functions.

References:

1. Let Us C by YashavantKanetkar, (BPB Publications, New Delhi).
2. Programming in ANSI by E. Balgurusamy, Tata McGraw-Hill Publishing Co. I.T.,

Practical: MZOO P: 101
BIOSYSTEMATICS, TAXONOMY AND EVOLUTIONARY BIOLOGY
CREDIT :2
M.M. 50 Time Allowed : 4hrs

1. Techniques of collection and preservation with respect to insects and fishes,
2. To prepare identification keys of various animal groups
3. To study external morphological features of various animal groups (beaks & claws, scales of fishes, wing venation and external genitalia of insects).
4. Identification methods for insects, fishes, birds
5. Study of organisms with reference to their evolutionary significance (adaptations, connecting links, modifications, missing links, living fossils, continuous and discontinuous distribution).
6. Study of Evolution of man , horse and camel through charts / Models
7.Phylogenetic analysis in context with phenetics and cladistics.

PRACTICAL : MZOOP: 102
BIOCHEMISTRY AND MOLECULAR CELL BIOLOGY
CREDIT :2
M.M. 50 Time Allowed : 4hrs

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids
2. Estimation of total protein in given solutions by Lowry's method
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase.
5. Study of the permeability of plasma membrane.
6. SDS-PAGE of Proteins
7. Determination of Saponification value Acid value and Iodine number of fat
8. . Identification of sugars in fruit juice using TLC.
9. Analysis of urine for its abnormal constituents

Practical Paper: Microbiology MZOOP :103

CREDIT : 1

MM: 25 Time Allowed: 3 hrs

1. Sterilization of glassware used in microbiology laboratory and preparation of nutrient broth and nutrient agar.

2. Preparation of nutrient agar plates and swabbing to obtain colonies
3. Study of morphology, texture, colour, margin of bacterial colonies.
4. Differential staining of given culture to identify gram positive and gram negative bacteria.
5. Perform hanging drop mount method to examine the motility of bacteria.
6. Determine the quality of given milk sample by using methylene blue test.
7. Perform stormy clot fermentation test to detect the presence of anaerobic bacteria in given milk sample.
8. Demonstration of Catalase activity for H_2O_2 production in the given bacterial colony.
9. Determine the growth curve of given bacteria

PRACTICAL : MZOOP: 104 COMPUTER FUNDAMENTALS AND PROGRAMMING

CREDIT : 1 **M.M. 25**

LAB WORK TO BE PERFORMED ON A COMPUTER:

LIST OF PROGRAMS

● Use of input and output functions

● Use of data types and operators

● Use of conditional and loop statements

● Program to find the area of right angle triangle.

● Program to swap value of two variables without using third variable.

● P to test whether a given no. is even or odd

. ● Program to check if a no. is divisible by 5 and or not.

● Program to calculate greatest of 3 numbers.

● Program to print n prime numbers.

● Program to print whether a given number is prime or not.

● Program to calculate factorial of a number.

● Program to calculate roots of a quadratic equation.

● Program to calculate the compound interest.

● Program to check the H.C.F of n numbers using recursion.

● Program to reverse a given number and check whether a given number is same as that of reverse number.

● Program to find the entered year is leap year or not.

● Program to find sum of first 20 odd natural numbers.

SEMESTER II

MZOO CC :201
GENETICS AND CYTOGENETICS

OBJECTIVES OF THE COURSE :The course will enable the students to understand Mendelian and post Mendelian modes of inheritance, Mutation and Genetic analysis.

Maximum Marks: 75 Credits :4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

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SECTION –A

1. Mendel's laws and their chromosomal basis; extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance, allelic series, testing gene mutations for allelism
2. Gene action- from genotype to phenotype– penetrance and expressivity, gene interaction, epistasis, pleiotropy
3. nature of the gene and its functions: evolution of the concept of the gene, fine structure of gene (rII locus)
4. methods of gene mapping: 3- point test cross in *Drosophila*, gene mapping in humans by linkage analysis in pedigrees.
5. Gene mutation and DNA repair: types of gene mutations, methods for detection of induced mutations, P- element insertional mutagenesis in *Drosophila*, DNA damage and repair
6. Regulation of gene activity in *lac* and *trp* operons of *E. coli*, general introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels, organization of a typical eukaryotic gene, transcription factors, enhancers and silencers, non coding genes.

SECTION B

7. 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;

8. 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);
9. Genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping.
10. Genetics and cancer: oncogenes- tumor inducing retroviruses and viral oncogenes; chromosome rearrangement and cancer; tumor suppressor genes- cellular roles of tumor suppressor genes, pRB, p53, pAPC, genetic pathways to cancer.

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach.*III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York and London.

CCVIII-MZOO 202

PRINCIPLES OF GENE MANIPULATION

OBJECTIVES OF THE COURSE : To acquaint students the knowledge of recombinant gene technology and its applications.

Maximum Marks: 75
Theory: 55
Internal Assessment: 20 Time allowed: 3 hrs.

Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION A

1. Basic recombinant DNA techniques, cutting and joining DNA molecules, restriction modification systems, various enzymes used in recombinant DNA technology, restriction maps and mapping techniques;
2. nucleic acid probes, blotting techniques, DNA fingerprinting, footprinting, methyl interference assay. Polymerase chain reaction– methods and applications.
3. Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors and other advanced vectors in use.
4. Gene cloning strategies: methods of transforming *E. coli* and other cells with rDNA; methods of selection and screening of transformed cells; construction of genomic and cDNA libraries; strategies of expressing cloned genes; phage display.

SECTION B

5. Principles of DNA sequencing, automated sequencing methods; synthesis of oligo- nucleotides, primer design; micro-arrays
6. confocal microscopy; changing genes- directed evolution, protein engineering in microbes
7. Manipulating genes in animals: gene transfer to animal cells, genetic manipulation of animals, transgenic technology,
8. application of recombinant DNA technology; genetically modified organisms: gene knockouts, mouse disease models, gene silencing, gene therapy, somatic and germ- line therapy.

SUGGESTED READING MATERIAL

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNAmAnalysis*. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y.,USA.
- Primrose, S. B. and Twyman, R. M., (7th Ed. 2006), 2. Principles of Gene Manipulation and Genomics Blackwell Publishing, West Sussex, UK
- Bernard R. and Jack Molecular Biotechnology: Principles and application of recombinant DNA, , ASM Press, Herndon, USA.

SUGGESTED READINGS

1. Xiong, Jin.2006. Essential Bioinformatics. Sinauer Associates, Inc., Sunderland, Massachusetts

2.Gibas, Cynthia and Jambeck, Per. 2006. Developing Bioinformatics computer skills. O'Reilly, Cambridge

3.Rastogi, S.C., Mendiratta, Namita and Rastogi, Parag. 2003. Bioinformatics: Concepts , Skills and Applications . CBS Publishers and Distributors

4.Scientific American, Editors at Scientific American. 2001 Understanding Nanotechnology

5.Shelley. Toby. 2006. Nanotechnology: New Promises, New Dangers (Global Issues). Zed Books, U.K

6.Walker, J.M. and Rapley, R.2000. Molecular Biology and Biotechnology (4^{th} edition) . The Royal Society of Chemistry, Cambridge, U.K

7. Avise, John C. 2004. Molecular Markers, Natural History and Evolution (2^{nd} Edition) Sinauer Associates, Inc. , Sunderland , Massachusetts

MZOO CC: 203

COMPARATIVE ANIMAL PHYSIOLOGY

OBJECTIVES OF THE COURSE : This course will provide students with the understanding of basic physical and chemical principles underlying the physiological processes and how animals adapt physiologically to the environment changes.

Maximum Marks: 75 Credits : 4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION A

Internal Transport and Gas Exchange – Systems of circulation, Peripheral circulation, Regulation of heart beat and blood pressure, Transport and exchange of gases, Neural and chemical regulation of respiration, Gas transfer in air and water, Gas exchangers, Circulatory and respiratory responses to extreme conditions, Acid –base balance, Regulation of body pH.

Osmoregulation Osmoregulation in aquatic and terrestrial environments, Kidney functions and diversity, Extra-renal osmoregulatory organs, Patterns of nitrogen excretion.
Thermoregulation - Heat balance in animals, Adaptations to temperature extremes, torpor, Aestivation and hibernation, Counter current heat exchangers.
Adaptations to Stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones.

SECTION B

Sensing the Environment- chemoreception, mechanoreception, echolocation, Endogenous and exogenous biological rhythms, Chromatophores and bioluminescence.
Feeding mechanisms and their control, effect of starvation.
Muscle physiology – striated and smooth muscle, Adaptations of muscles for various activities, Neuronal control of muscle contraction, Electric organs.

SUGGESTED READING MATERIAL

- Dantzler, W.H. (ed.) Comparative Physiology (Handbook of Physiology): Vol. 1, 2Oxford University Press, New York, USA
- Nelson K. S. (ed) Animal Physiology: Adaptation and Environmental, Cambridge University Press, Cambridge, UK
- Davson, H. 1964. A Text Book of General Physiology, Little Brown & Co., Boston
- Ganong, W.F. 2003. Review of Medical Physiology, 21st Edition. Applenton & Lange (A Publishing Division of Prentice Hall).
- Giese, A.C. (Third Edition), 1979: Cell Physiology W.B. Saunders Company, Toppan Company Ltd., Tokyo.
- Guyton, A.,G. 1986, Text Book of Medical Physiology 7th edition Sanders Publication.
- Hoar, W.S. 1983. Comparative Animal Physiology, 3rd Edition. Prentise Hall Inc. Indian Print by Jay Print Pack Pvt. Ltd., New Delhi.
- Martin, D.W., Meyes, P.A. and Rodwell, V.W., Harper's Review of Biochemistry, Lange Medical Publications, Maruzen Asia (Pvt) Ltd.
- Prosser, C.L. 1973. Comparative Animal Physiology W.B. Saunders Co. (Indian Print by Asia Playing Cards Co., Agre in 1984

MZOO CC: 204

DEVELOPMENTAL BIOLOGY

OBJECTIVES OF THE PAPER : To make students understand the concept of cell signaling, Axis and pattern formation in development .

Theory: 75
External Evaluation : 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION –A

1 Principles of Developmental Biology
- 1.1 Environmental developmental Biology
- 1.2 Developmental dynamics of cell specification
- 1.3 Morphogenesis and cell adhesion

2. Cell to cell communication in development:
- 2.1 Induction and competence
- 2.2Paracrine factors
- 2.3Cell surface receptors and their signal transduction pathways

3. Axis specification
- 3.1 Genetics and axis specification in Drosophila
- 3.2Axis specification in amphibians and birds

SECTION – B

4. Morphogenesis and organogenes:
- 4.1 Organogenesis: formation in *Caenorhabditis elegans*
- 4.2 Limb development in tetrapods

5. Environmental Regulation of Animal Development
- 5.1Role of environment in development
- 5.2Phenotypic Plasticity
- 5.3Role of Tetratogens in development

1. Developmental Mechanisms of Evolutionary change
- 6.1Homologous Pathways of Development
- 6.2 Modularity : The Pre-requisite for evolution through development
- 6.3Developmental correlation and development Constraints

SUGGESTED READING MATERIAL

- 1 Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Carlson R. F.(1988) Pattern's Foundations of Embryology, Mcgraw-Hill Publishers.
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University
- Urspaung, H. : Major Problems in Developmental Biology, Academic Press, New York, 1966.
- Verma, P.S. and Aggarwal, V.K. Chordate Embryology,(1997), S.Chand& Company Ltd.

MZOO IDC IA 205
BIOINFORMATICS

OBJECTIVES OF THE COURSE: To make the student familiar with the fundamentals of computer and Bioinformatics. To become familiar with Sequence Analysis and Phylogenetic Trees & their construction

Maximum Marks: 75 Credits : 4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7 marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION A

Bioinformatics: Introduction, its goals and Applications, Role of Computers in Bioinformatics.

Biological Databases: Characteristics and Classification of Databases- Primary (INSDC), secondary (PROSITE), Composite (UNIPROT) and Specialised Databases (REBASE).

Sequence Analysis: Introduction, methods of sequence analysis, Local and Global alignment; Dot plot & Dynamic Programming

SECTION B

Heuristic methods: algorithm and versions of FASTA& BLAST. Scoring matrices: PAM & BLOSSUM.

Multiple Sequence Alignment: Methods and Applications of multiple seq. alignment.

Phylogenetic Trees & their construction: Branches. Nodes, Clade, Taxa, OUT, Rooted and Unrooted tree. Forms of Tree representation: Phylogram, Cladogram, Dendrogram.Methods used for construction and evaluation of phylogenetic trees.

Books Recommended:

1. Xiong, Jin.2006. Essential Bioinformatics. Sinauer Associates, Inc., Sunderland, Massachusetts
2. Gibas, Cynthia and Jambeck, Per. 2006. Developing Bioinformatics computer skills. O'Reilly, Cambridge
3. Rastogi, S.C., Mendiratta, Namita and Rastogi, Parag. 2003. Bioinformatics: Concepts , Skills and Applications . CBS Publishers and Distributors
4. Scientific American, Editors at Scientific American. 2001 Understanding Nanotechnology
5. Shelley. Toby. 2006. Nanotechnology: New Promises, New Dangers (Global Issues). Zed Books, U.K
6. Walker, J.M. and Rapley, R.2000. Molecular Biology and Biotechnology (4^{th} edition) . The Royal Society of Chemistry, Cambridge, U.K
7. Avise, John C. 2004. Molecular Markers, Natural History and Evolution (2^{nd} Edition) Sinauer Associates, Inc. , Sunderland , Massachusetts

MZOO IDC I A 206
BIOSTATISTICS

OBJECTIVES OF THE PAPER: To acquire and be able to apply knowledge of basic statistical methods. To critically evaluate statistics to their validity, reliability and to the right information

Maximum Marks: 75 Credits : 4
Theory: 55 Time Allowed: 3 hrs
Internal Assessment: 20
Minimum Pass Marks: 35%

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three sections: A, B & C. Section A & B will have four questions in each section from the respective sections of the syllabus and will carry 7marks each. Section C will consist of 9 short-answer type questions will cover the entire syllabus uniformly and each will carry 3 marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions from each section A & B of the question paper and the entire section C.

SECTION A

Introduction to biostatistics: Basic definitions and applications, sampling (representative sample, sample size, sampling bias), sampling techniques

Data collection and presentation: Types of data, collection of primary and secondary data histogram, polygon and pie diagram

Measures of central tendency: Mean, median, mode

Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation

Correlation and regression: Positive and negative correlation, Karl- Pearsons co-efficient of correlation, Linear regression and regression equation and multiple linear regressions

SECTION B

Tests of significance: Small sample test (Chi-square test, t- test, F- test), large sample test (Z test)

Introduction to probability theory and distributions: concept of theory and distribution without derivation, binomial, Poisson and normal (only definitions and problems)

Analysis of variance-I: Analysis of variance with linear models

Analysis of variance-II: Analysis of variance for one-way classified data, analysis of variance for two-way classified data with one observation for cell

Analysis of variance-III: Analysis of variance for two-way classified data with multiple but equal number of observations per cell (data analysis only)

Books Recommended:

1. Bailey N T J. *Statistical Methods in Biology*, English University Press, London
2. Banerjee PK. *Introduction to biostatistics*, S. Chand Publishers, New Delhi.
3.Singh S, Bansal ML, Singh TP and Kumar R. *Statistical Methods for Research Workers*, Kalyani Publishers, New Delhi.
4. Bliss, C I.K. *Statistics in biology*, Mac-Graw Hill Publishers, NewYork

PRACTICALS

MZOO P : 201 CYTO GENETICS AND GENE MANIPULATION PRACTICALS (CREDITS 2)

M.M. 50

Time Allowed : 4hrs

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation, transformation and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited trait.
7. Isolation of DNA
8. Quantiative Estimation of DNA using spectrophotometer
9. Separation of DNA by Electrophoresis and visualisation through Gel Documentation

9. DNA replication using PCR
10. Designing of a primer (through Hypothetical Data)
11. Transformation of *E. coli* with standard plasmids, calculation of transformation efficiency.
12. Visit to cytogenetics and Molecular research Lab

MZOO P: 202 PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY
CREDITS 2
M.M. 50
Time Allowed : 4hrs

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. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicropgraph/ slides)
5.Study of teratogenic agents and their effect on developments in humans through pictures/ Videos .
6. Project report on *Drosophila* culture/chick embryo development
7.To determine the median threshold concentration of sucrose for housefly population.
8. Determination of Blood pressure by sphygmomanometer
9.Recording of frog's heart beat under *in situ* and perfused conditions*
10. Demonstration of ECG and Kidney Dialysis
11..Study of Isotonic and Isometric muscle contractions

(*As per UGC Guidelines on practical work in lab)

PRACTICAL MZOO P: 203 BIOINFORMATICS
Credits 1
M.M. 25
Time Allowed : 4hrs

List of Practicals:

1. Flat file format of GENBANK
2 Describe databases that can be used to access text information about human diseases.

3 Compare the use of Entrez and ExPasy to retrieve information about a protein sequence.
4 Perform pairwise alignments of the proteins using PAM 30, Pam 70 and PAM 250 matrices.
5 Compare sequence and taxonomy information from BLAST, PSI-BLAST, PHI-BLAST
6 Creation of molecules and calculation of energy minimization, torsion angles, band distance, bond angle, Ramachandran plot
7.Molecular modeling of given protein structure (3D) database using various software

PRACTICAL MZOO P: 204 BIOSTATISTICS

Credit: 1 **M. Marks : 25**

Time allowed for Examination: 4 Hrs. **Pass Marks : 35%**

List of Practicals:

1. Representation of Statistical data by
   a) Histograms b) Ogive Curves c) Pie diagrams
2. Determination of Statistical averages/ central tendencies.
   a) Arithmetic mean b) Median c) Mode
3. Determination of measures of Dispersion
   a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
4. Tests of Significance-Application of following
   a) Chi- Square test b) t- test c) Standard error