

M.Sc. Zoology

Syllabus

(CBCS Pattern as per UGC)
Effective from the session 2023-24



M.P.C Autonomous College
Takhatpur, Baripada-757003
Odisha

M.Sc Zoology

(CBSC Pattern as per UGC)

Effective from the Session 2023-24

Semester I					
Course Code	Title of Paper	Credit	Maximum Marks		Total
			Mid-Sem	End-Sem	
CC-101	Animal Diversity (Non-chordates and Chordates) and Animal Behaviour	4	20	80	100
CC-102	Biochemistry	4	20	80	100
CC-103	Cell Biology and Genetics	4	20	80	100
CC-104	Microbiology and Bioethics	4	20	80	100
CC-105	Practical	6	20	80	100
	Total	22			500
Semester II					
Course Code	Title of Paper	Credit	Maximum Marks		Total
			Mid-Sem	End-Sem	
CC-201	Physiology, Endocrinology and Comparative Anatomy	4	20	80	100
CC-202	Bioinstrumentation and Bioinformatics*	4	20	80	100
CC-203	Chronobiology, Ecology and Evolution	4	20	80	100
CC-204	Immunology and Cancer Biology	4	20	80	100
CC-205	Practical	6	20	80	100
	Total	22			500
Semester-III					
Course Code	Title of Paper	Credit	Maximum Marks		Total
			Mid-Sem	End-Sem	
CC-301	Developmental Biology and Animal Biotechnology	4	20	80	100
CC-302	Molecular Biology and Genetic Engineering	4	20	80	100
CC-303	Practical	6	-	100	100
CC-304	Research Methodology	4	-	100	100
OEC-305	Open Elective	6	-	100	100
	Total	24	60	440	500
Semester-IV					
Course Code	Title of Paper	Credit	Maximum Marks		Total
			Mid-Sem	End-Sem	
DEC-401 A/B	Environmental Toxicology/ Advanced Cytogenetics	4	20	80	100
DEC-402 A/B	Taxonomy and Biosystematics/Entomology and Applied Zoology	4	20	80	100
DEC- 403	Practical	6	-	100	100
DEC-404	Dissertation	8	-	200	200
	Total	22	40	460	500
	Grand Total	90			2000

*Introduced as Skill Enhancement Course

- i. CC-compulsory Core Course for all students of the subject concerned.
- ii. DEC-Discipline-specific Elective Course (Special paper)
- iii. OEC-Open Elective Course to be offered to students of other Departments
- iv. DEC 401 and DEC 402: A student has to choose any one from each

SEMESTER I

Paper CC-101

Animal Diversity (Non-Chordates & Chordates) & Animal Behavior

Credits 4

Marks 80+20

UNIT-I (Animal diversity-I: Non-chordates)

Nutrition in protozoa - Types and mode of feeding, Protozoan parasites in brief (Trypanosoma, Plasmodium), Canal system in Sponges, Coral reef formation and significance, Polymorphism in Coelenterates, Excretory structures and functions in Annelids, Helminth parasites (*Taenia*, *Ancylostoma*), Vision In insects.

UNIT-II (Animal diversity-II: Non-chordates & Protochordates)

Torsion in Gastropoda, Nervous system in Cephalopods, Water vascular system in Echinoderms, Reproduction and development in Echinoderms with evolutionary significance, General characters & interrelationship of Proto-chordates and Siphon mechanism in Tunicates

UNIT-III (Animal diversity-III: Chordates)

General characters of Cyclostomes , Accessory respiratory organs in fishes, Origin of Amphibia, Adaptive radiation in reptiles, Classification of reptiles based on skull pattern, Flight adaptation in Birds General characters of Prototheria and Metatheria, Adaptive radiation in mammals

UNIT-IV (Animal behaviour)

Classification & analysis of behaviour patterns, Tools and Techniques in behavioural study, Neural & hormonal control of behavior, Communication in animals, Social organization of insects and mammals, Biological rhythms: Circadian, Parental care, Orientation & navigation: Migration of fish and bird

Recommended Books

1. Invertebrate structure by Barrington & Nelson
2. Invertebrates by Pough
3. The invertebrates Vol I to VI by LH Hyman
4. Protozoology by R Kudo
5. A text book of zoology (vol-I & II) by TJ Parker & WA Haswell
6. Phylum Chordata by H Newman
7. The life of vertebrates by JZ Young
8. Biology of Animals. By Ganguly, BB., Sinha, A.K., Adhikari, S., New Central Book Agency, Kolkata
9. Invertebrate Zoology. By R D Barnes
10. The Invertebrates: Function and Form. By Sherman W and and Sherman VG
11. Animal Behavior by J Alcock
12. Principles of animal communications by JW Bradbury

Paper CC-102

Biochemistry

Credits 4

Marks 80+20

UNIT-I (Amino acid and Protein)

Amino acids: Classification and properties, Acid–base properties, The Peptide bond, ionization behavior of peptides, biologically active peptides. Structure of proteins (Secondary, tertiary and quaternary structures, structural patterns: motifs and domains), Protein denaturation and folding.

Amino acid catabolism (transamination, oxidative deamination and urea cycle) and anabolism (arginine and leucine). Protein degradation (proteosomal pathway)

UNIT – II (Carbohydrates)

Carbohydrates: Classification, configuration and conformation of monosaccharides, sugar derivatives, important disaccharides. Structure and storage polysaccharides, proteoglycans, glycoproteins and glycolipids; Carbohydrate metabolism: Glycolysis, TCA cycle, pentose-phosphate pathway. Gluconeogenesis, glycogen metabolism, regulation of carbohydrate metabolism.

UNIT –III (Enzymes)

Enzymes: General properties, nomenclature and classification, extraction and assay. Michaelis-Menten kinetics and its significance, determination of V_{max} and K_m . Mechanism of enzyme action: general acid-base catalysis, covalent catalysis, metal catalysis. Enzyme inhibition: competitive, non-competitive inhibition, determination of K_i , allosteric regulation, covalent modification

UNIT – IV (Nucleic acids and Lipids)

Nucleic acids: Chemical composition and structure of Nucleic acids, Nucleic acid synthesis (de novo & salvage pathway).

Lipids: Classification, storage lipids, structural lipids (glycerophospholipid and sphingolipids), signaling lipids, Coenzymes and vitamins. Biosynthesis and oxidation of fatty acids, regulation of fatty acid metabolism.

Recommended Books

1. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition
2. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition
3. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition
4. Principle of Biochemistry, Voet and Voet
5. Biochemistry, Campbell

Paper CC-103

Cell Biology and Genetics

Credits 4

Marks 80+20

UNIT –I (Cell structural components)

Plasma membrane: Composition and dynamics, membrane carbohydrates and their role in cell recognition; Social context of cells: Cell junction, cell adhesion and extra-cellular matrix; Cell motility; Cytoskeleton: Microtubules, intermediate filaments and microfilaments, Biogenesis, structure and function of Lysosome and Peroxisomes, Mitochondria, Endoplasmic Reticulum and compartmentalization of Golgi

UNIT-II (Nucleus, cell cycle and cell division)

Nucleus: Structure and function of nuclear envelope, nucleolus & Chromatin organization and its packaging role of nuclear matrix in chromosome organization and function, Lampbrush chromosome, Polytene chromosome; Cell cycle: Molecular models and events. Regulators and checkpoints in cell cycle, Molecular mechanisms of cell division

UNIT – III

Mendelian Genetics, Neo-Mendelism, Pleiotropy, genomic imprinting, penetrance and expressivity, Linkage and crossing over, construction of linkage maps, identification of particular linkage groups with specific chromosome, physical distance and map distance Interference and coincidence Mitotic Recombination, Recombination within gene, Extra-chromosomal Inheritance, Pedigree analysis, Complementation tests

UNIT – IV

Structural and numerical alterations in chromosomes: Spontaneous and induced mutations, physical and chemical mutagens, chromosomal aberrations, deletion, duplication, inversion and translocation. Euploids and aneuploids-classification, origin, induction, role of polyploidy in evolution and practical significance in crop improvement

Recommended Books

1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin
2. Molecular Biology of the Cell, Alberts et al., (2008), Garland Science, New York, USA
3. The cell: A molecular approach, Geoffrey, M. Cooper, R.E. Hausman (2004) ASM Press
4. Cell and Molecular biology , Gerald Karp (2015)John wiley and sons

Paper CC-104

Microbiology and Bioethics

Credits 4

Marks 80+20

UNIT –I (History, concept and culture)

Scope of Microbiology, Classification of microorganisms (Whittakar's five kingdom concept, Carl Woese's 3 domain classification), General features of Bergy's manual for classification of microbes, Isolation, culture and maintenance of microorganisms, Microbial growth curve, continuous culture (chemostat), Factors influencing growth of microbes, Fermentation and Industrial microbiology.

UNIT –II (Archaea, Eubacteria and Bacteria and Virus)

General features of Archaea, Structure, Nutrition and Reproduction of Eubacteria, Genetic recombination in bacteria (Transformation, Conjugation and Transduction); Virus: General characteristics and classification of viruses, nature, transmission of virus, virus-vector relationship, replication of Bacteriophage, Oncoviruses & HIV, Treatment and prevention by anti-virals and vaccine, Viroids and Prions.

UNIT-III (Toxins and antibiotics)

Microbial toxins: types, mode of actions and pathogenicity; Bacterial toxins: Endo and exotoxins; Fungal toxins: ergot alkaloids, aflatoxins, ochratoxins, fumonisins, trichothecenes and zearalenone; Antibiotics and their mode of action; Chemotherapeutic agents.

UNIT –IV (Bioethics)

IPR and genetic resources, Patent, Trade, Copyright and trade mark, Indian Patent Act, filing of patent application, Biopiracy, CPCSEA Guidelines, Basic biosafety practices in the laboratory, Biological hazards, Basic idea on Genetically modified organisms

Recommended Books

1. Brock TD., Milestones in Microbiology, Infinity Books.
2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application.,Tata McGraw Hill.
3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology, Publisher: MacMillan.
4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: PrenticeHall, Inc USA.
5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
6. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings.Microbiology
7. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.

Paper CC-105

Practical

Credits 6

Marks 100

1. Study of museum specimens and micro-slides from phylum protozoa to mammalia

Protozoa- Euglena, Plasmodium, Paramecium; Porifera- Sycon, Hyalonema, Euspongia; Coelenterata- Physalia, Gorgonia, Pennatula, Aurelia; Platyhelminthes- Dugesia, Fasciola, Ascaris, Taenia; Annelida- Hirudinea, Sabella, Aphrodite, Nereis, Heteronereis, Trochophore larva; Arthropoda- Lepas, Sacculina, Eupagurus, Larval forms in Arthropoda; Mollusca- Chiton, Dentalium, Larval forms in Mollusca, Sepia, Nautilus, Loligo; Echinodermata- Larval forms , Antedon, Asterias, Echinus, Sea cucumber

Hemichordata- Balanoglossus; Cephalochordata- Amphioxus; Urochordata- Salpa, Doliolum, Ascidea; Cyclostomata- Petromyzon , Myxine; Pisces- Torpedo, Trygon, Exocoetus, Echines, Eel, Clarias, Hippocampus; Amphibia- Hyla, Alytes, Ichthyophis, Axolotl Larva, Salamander, Necturus; Reptilia- Chelone, Varanus, Draco, Russel viper, Naja naja, Gavialis; Aves- Psittacula, Dinopium, Type of Beaks, claws and feet; Mammalia- Echidna, Macropus, Pteropus, Rattus, Squirrel

2. Study of stages of mitosis and meiosis and temporary slide preparation (onion root tip or grasshopper testis)
3. Estimation of protein by Biuret/Folin-Lowry method.
4. Estimation of Carbohydrate
5. Estimation of lipid
6. Assay of Enzyme activity of alkaline phosphatase (Effect of temperature, Substrate, Concentration and time)
7. Sterilization and Media Preparation for bacterial culture
8. Isolation of bacteria from soil or water sample
9. Antibiotic sensitivity
10. Gram staining

SEMESTER II

Paper CC-201

Physiology, Endocrinology and Comparative anatomy

Credits 4

Marks 80+20

UNIT-I (Circulatory, Respiratory System)

Composition of blood, RBC anatomy, RBC Breakdown cycle, Structure of haemoglobin, blood groups and mechanism of platelet plug formation and blood coagulation,

Circulatory System: Structure of heart, cardiac cycle & its regulation; Pulmonary ventilation, regulation of respiration, transport of gases, acid-base balance,

UNIT-II (Excretory, Nervous and Muscular System)

Excretory system: Urine formation, glomerular filtration, tubular function, renal Mechanism of concentrating & diluting urine (selective reabsorption & secretion)

Nervous System: General organization of central nervous system, Type of neuronal cells, Structure and function of neuron and glia, Types of ion channels, Action potential, Electrical and Synaptic transmission, Neurotransmitters & Neuropeptides, Neuromuscular Junction, Blood brain barrier

Muscles: Ultra structure of muscles, Regulatory, Structural and Contractile proteins, mechanism of contraction in Skeletal, Smooth and Cardiac muscle

UNIT-III (Endocrinology)

Chemical messengers, Hormones & their feedback systems, Mechanism of hormone action (fixed membrane- and mobile receptor mechanisms), Anatomy, biosynthesis & function of hormones of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, pineal

UNIT-IV (Comparative Anatomy)

Evolution of heart and aortic arches, accessory respiratory organs, jaw suspensorium, evolution of kidney, urinogenital ducts, types of uteri, cranial nerves in mammals

Recommended Books

1. Guyton's Physiology
2. Human physiology- Tortora
3. Endocrinology - Hadley
4. Endocrinology - Turner & Bagnora
5. Bentley, P. J. Comparative vertebrate endocrinology
6. Bern, H. A. Text book of comparative endocrinology

Paper CC-202

Bioinstrumentation, Biostatistics and Bioinformatics

Credits 4

Marks 80+20

UNIT I (Bioinstrumentation)

Light and Electron microscopy, Centrifugation, Affinity chromatography (Paper and TLC), Adsorption chromatography (Ion exchange and Gel), UV/Vis Spectrophotometry, Autoradiography, Application of Radioisotopes in Biology

UNIT II (Biostatistics I)

Biostatistics, Levels of Measurements: Variables, Nominal scale, ordinal scale, interval and ratio scale of measurements; Tabular and graphical representation of data; Descriptive statistics: Central tendency (Mean, Mode, Median, Percentile); measurement of variance (Range, IQR, MAD, Variance, Standard Deviation, SEM, CV and CD), Moments, Skewness and Kurtosis

UNIT III (Biostatistics II)

Confidence Intervals, Statistical Hypothesis Testing, significance level, pvalue, Relationship between Confidence Intervals and Statistical Significance, difference between parametric and non-parametric test, Student's t test, F test and ANOVA test (one way and two way), Chi-square test; Probability distributions- Normal, Binomial and Poisson; Simple correlation and Regression

UNIT IV (Bioinformatics)

Introduction to Bioinformatics, DNA and protein database, Searching for sequence database like FASTA and BLAST algorithm, Sequence alignment, Structural viewers of protein (PyMOL), multiple sequence alignment (CLUSTALW/CLUSTAL X), Basic idea about MEGA, Construction of phylogenetic tree

Recommended books

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Lesk, A.M. (2002). Introduction to Bioinformatics. Oxford University Press
3. Wayne W. Daniel, Biostatistics: A foundation for analysis in the Health Sciences.
4. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley
6. Modern Spectroscopy, JM Hollas, Wiley Publication
7. Molecular Structure and Spectroscopy, G. Aruldash
8. Experimental Biochemistry, Wilson and Walker
9. Fundamental of light microscopy and electronic Imaging, Douglas Murphy

Paper CC-203

Chronobiology, Ecology and Evolution

Credits 4

Marks 80+20

UNIT- I (Clock, rhythms and calendar)

Introduction, milestones and scope of chronobiology; Geophysical environment seasons; Proximate and ultimate factors; Biological clocks, types, constant conditions, model systems; Entrainment theory: masking, synchronization; Photoreception, phototransduction; Photoperiodic time measurement, Anatomy and physiology of the time keeping system, Sleep and neural relation; Clock misalignment; jet lag, shift work, Seasonal migration

UNIT-II (Ecology)

Abiotic and biotic components, Energy flow (with one example aquatic ecosystem), Methods of measuring productivity. Biogeochemical cycles - Carbon, Nitrogen; Population growth curves, regulation of population density (density dependent and independent regulation), competitive exclusion; Ecotone and edge effect, Competition theory and coexistence Succession - models of succession (monoclimax and polyclimax theories), Mechanism of succession; Environmental pollution: Kinds and sources of pollutants; Water & Air pollution, Global climate change, green house effect, ozone depletion- causes and effects. Bioremediation

UNIT-III (Evolution I)

Introduction to Paleozoology; Geological time scale; Origin of life; Major events in the evolutionary time scale; Stages in primate evolution including Homo sapiens; Theories of evolution (Lamarckism, Darwinism), Evidences of evolution (Morphology to molecular level), Formation and types of fossils, and their significance; modes of fossilization, dating of fossils

UNIT-IV (Evolution II)

Variation and selection as underlying mechanisms' of evolution (Isolation, speciation and Natural selection). Spontaneity of mutations; Evolutionary trends (micro, macro and mega patterns of evolution);Hardy-Weinberg equilibrium: principle, derivation, conditions and applications; Molecular basis of variation and inheritance; Genotype-environment interactions; Inbreeding and assortive mating; Depression and heterosis; Molecular and genomic evolution: Protein and nucleotide sequence analysis; Concepts of neutral evolution and molecular clocks

Recommended Books

1. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J.
2. The Physiological Clock (3rd edition), Erwin Bunning, The English Universities Press Ltd. London
Springer- Verlag New York, Berlin Heidelberg
3. Circadian Physiology: Roberto Refinetti, CRC Press (3rded) 2016
4. Introducing Biological Rhythms: Willard L. Koukkari, Robert B. Sothorn, 2006, Springer

5. Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed. 2017) Springer India Pvt Limited.
6. Evolution : Strickberger
7. Evolutionary analysis : Herron and freeman
8. Ecology, E.P. Odum, R. Holt, Winston Inc., USA,
9. C.S. Binoda, M.P. Nayar, River Pollution In India. APH Publ. Corpn., New Delhi.

Paper CC-204

Immunology and Cancer Biology

Credits 4

Marks 80+20

UNIT I (Immune System and its components)

Phylogeny of Immune system, Innate and acquired Immunity, Haematopoiesis and differentiation, Cells of the Immune system, Organization and Structure of Lymphoid Organs, MALT, CALT, NALT, BALT, Nature and Biology of antigens and super antigens, Structure and function of antibody molecule, Antigen – Antibody interaction

UNIT-II (Antigen Presentation, Cytokines and Immunoassay)

Major histocompatibility complex and MHC restriction, Antigen Processing and Presentation, Complement system(Classical, Alternate and Lectin pathway), Cytokines- Types and their role in immune regulation, Immunoassay (Radial and Double immuno-diffusion, Radioimmunoassay, ELISA- Indirect, Direct, Sandwich, ELISPOT, Competitive, Western blotting)

UNIT-III (Adaptive Immunity, Hypersensitivity and Antibody production)

Generation of humoral and cell mediated immune response, BCR and TCR, generation of diversity, Activation and regulation of B and T lymphocytes, Cell-mediated cytotoxicity and Antibody dependent cell mediated cytotoxicity, Hypersensitivity, Autoimmunity and Transplantation, vaccines, monoclonal antibodies: production and application

UNIT-IV (Cancer Biology)

Biology of cancer cell, Genetic basis of cancer-I: Proto-oncogenes, Viral and cellular oncogenes, Genetic basis of cancer-II: Tumor suppressor genes from humans: structure, function and mechanism of action of pRB and p53 tumor suppressor proteins, Role of carcinogens and DNA repair in cancer

Recommended Books

1. Kuby's Immunology, 5th edition, By R. A. Goldsby et al.
2. Clinical Immunology By Brostoff, Seaddin, Male and Roitt
3. Fundamentals of immunology By William Paul.
4. Immunology by Janeway
5. Principles of Immunology by N.V. Shastri, Himalaya Publishing House
6. Cellular and Molecular Immunology- Abul Abbas and Andrew Lichtman
7. Immunology-Weir

Paper CC-205

Practical

Credits 6

Marks 100

1. Estimation of haemoglobin
2. Preparation of hemin crystals
3. Study of slides of endocrine glands and lymphoid organs
4. Study of evolution of horse and man (Pictorial evidences)
5. Preparation of karyotype and Pedigree analysis
6. Population genetics and Hardy-Weinberg Law (problems)
7. Comparative study of bones of axial and appendicular skeleton
8. Antigen-Antibody interaction: Blood grouping
9. Demonstration of Dot ELISA
10. Preparation of Blood smear for Differential count and type of leucocytes
11. Estimation of Dissolved oxygen content, alkalinity of water samples
12. Estimation of primary productivity
13. Measuring Species Richness(S), Evenness(E) , Simpson index(D), Shannon-Weiner Index (H') from data provided
14. Demonstration of Chromatography
15. Demonstration of Centrifugation
16. Demonstration of Spectrophotometer and Quantification of protein using Biuret method, lowry method
17. Tabular and Graphical presentation of Data using Excel
18. Hypothesis testing-student t-test, F-test, NOVA test, Chi-Square test
19. Demonstration on sequence searching (BLAST, FASTA), multiple sequence alignment (CLUSTALW/CLUSTALX)
20. Field work/study tour and project report submission on biological rhythm of any animal species

SEMESTER III

Paper CC-301

Development Biology and Animal Biotechnology

Credits 4

Marks 80+20

UNIT-I (Gametogenesis, Fertilization and Cleavage)

Early theories of Developmental biology Concepts of Developmental, Molecular mechanisms of Gametogenesis (Spermatogenesis, Oogenesis) and Fertilization, molecular strategy to avoid polyspermy in fertilization; Types of eggs & cleavage: Based on amount of distribution of yolk, Cleavage: types and significance.

UNIT-II (Gastrulation, Embryonic induction, Regeneration and Application)

Comparative study of Gastrulation in Amphioxus, Frog, Chick; Organizers: Spemann and Mangold: Primary embryonic induction, Functions of organizer, Molecular mechanisms of Amphibian axis formation; Regeneration: Limb regeneration: Salamander, Regeneration in Hydra; Apoptosis, aging and senescence. Application of developmental biology in medicine and animal husbandry: In vitro fertilization and embryo transfer

UNIT-III (Stem Cells, Teratogenesis)

Embryonic stem cells, stem cell niche, their role in development, Genetic errors of human development (Down's and Turner's syndrome) Nature of human syndromes- Pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; Teratogenesis: Environmental assaults on human development, teratogenic agents

UNIT – IV (Animal Cell culture)

Equipments and materials for animal cell culture; Sterilization and aseptic techniques, Culture media (Composition) : Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture, Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures, Growth curve, Culture of Cell lines, LSE culture, Scaling up of cultured cells: Anchorage dependent cell culture, Suspension culture and Cryopreservation; Cell characterization and Cell viability

Recommended books

1. Developmental Biology, S.F. Gilbert
2. Introduction to Embryology, B.L. Balinsky

Paper CC-302

Molecular Biology and Genetic Engineering

Credits 4

Marks 80+20

UNIT –I (DNA replication and repair)

DNA replication: Replication in prokaryotes, replication fork, initiation, elongation, termination, Replication in eukaryotes, D-loop model of DNA replication, DNA replication in single stranded DNA, rolling circle replication, DNA synthesis by reverse transcription DNA Repair: mismatch repair, base excision, nucleotide excision, direct repair, SOS repair

UNIT –II (Transcription and post transcriptional modification)

Prokaryotic transcription: Mechanism of transcription, Principle of gene regulation, The Operon concept, Processing of tRNA and rRNA Eukaryotic transcription and regulation: RNA polymerases structure and assembly, Eukaryotic promoters and enhancers, General and specific transcription factors, transcriptional repressors, mechanism of transcription regulation, Transcriptional and post-transcriptional gene silencing. Modifications in RNA: 5'-cap formation, transcription termination, 3'-end processing and polyadenylation, splicing, editing, synthesis and processing of non-coding RNAs. Diseases caused due to transcription error.

UNIT –III (Translation)

Prokaryotic and eukaryotic translation: The translation machinery, mechanism of initiation, elongation and termination Co- and post-translational modifications of proteins Cell Signaling: Signaling molecules and signal receptors, second messengers, G protein coupled receptors, activation of gene transcription by G protein coupled receptors. Diseases caused due to translation error.

UNIT –IV (Genetic Engineering)

Scope of Genetic engineering, Milestones in genetic engineering Molecular tools: Enzymes (Nucleases, Restriction endonucleases, Phosphomonoesterase, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase), Hosts (E. coli, yeast, animal cells and Plant cells) and Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and artificial chromosomes). Basics of DNA cloning: Various ways of cloning. Cloning into different vectors – plasmids, phages, and phage-derived PACs, BACs and YACs, Selection and screening of clones.

Recommended books

1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin
2. Cell Biology, G. Karp
3. Cell and Molecular Biology, De Robertis
4. Molecular Biology of the Cell, Alberts et al., Garland Science, NewYork, USA

Paper CC-303

Practical

Credits 6

Marks 100

1. Study of developmental stages of frog (cleavage, blastula, gastrula, tail and limb bud stage)
2. Study of developmental stages of chick (primitive streak, 24hrs, 36hrs, 48hrs, 72hrs and 96hr)
3. Calculation of transformation efficiency from the data provided
4. Estimation of DNA
5. Estimation of RNA
6. Isolation of genomic DNA/ plasmid DNA
7. Demonstration of Agarose gel electrophoresis of DNA
8. Demonstration of SDS PAGE
9. Seminar and seminar report submission (30 marks)

Paper CC-304

Research Methodology

Credits 4

Marks 100

UNIT- I (Concept and Problem identification)

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process; Problem Identification & Formulation: Research Question, Investigation Question, Measurement Issues, Hypothesis – Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

UNIT- II (Research Design)

Research Design: Concept and Importance in Research, Features of a good research design; Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Qualitative and Quantitative Research: Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement, Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

UNIT- III (Sampling and Data analysis)

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Characteristics of a good sample, Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

UNIT- IV (Research Writing and Tools)

Interpretation of Data and Paper Writing – Layout of a Research Paper, Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook, Academic Databases, Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Recommended Books:

1. Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th editions.
2. Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology- C. R. Kothari

Paper CC-305

Open Elective

Credits 6

Marks 80+20

UNIT- I

Classification of animal Kingdom, protozoan (malaria) and parasitic diseases of humans (helminth parasites), diseases related to fungal (ringworm), bacterial (Cholera) and viral (HIV) infections

UNIT- II

Cell: Structure and function of Mitochondria, Cell division, Structure of DNA and RNA, Genetic code, Basic features of DNA replication, transcription and translation,

UNIT- III

Ecosystem- structure and components, Food chain and Food Web, Species interaction and competition

Mendelism and its deviation, Linkage and crossing over, Extra chromosomal inheritance and maternal inheritance

UNIT- IV

Origin of life, Lamarkism, Darwinism, Variation, Speciation, Fossils, Gene pool, Gene Frequency, Hardy-Weinberg's Law

Semester IV

Paper DEC-401A

Environment Toxicology

Credits 4

Marks 80+20

UNIT-I

Introduction of toxicology, history of toxicology, definition of toxicology, definition of poison, definition of toxicity and classification of toxicants. Mode of action of toxic agents; Toxicology: Classification- Acute, sub-acute, chronic, dose- response relationship and effect, LD 50, LC 50, Bioassay- Types and significance of bioassay

UNIT- II

Classification of pesticides and Metals, Toxicity of Aluminium, arsenic, cadmium, chromium, lead and mercury, Bio-concentration, Bio-accumulation, Bio-magnification of pesticides and metals, biotransformation (Phase I and II)

UNIT-III

Environmental Impact Assessment, Principle, Characteristics and Components of EIA, EIA Wing, EIA Documentation and processes, Environmental management techniques, Risk characterization, EIA monitoring and auditing

UNIT-IV

Environmental Pollution – Classification, major sources, types and nature of pollutants, Air Pollution: Formation of Photochemical Smog and Acid Rain, General methods of Air pollution control, Water pollution: BOD and methods of water pollution control, Wastewater treatment processes: Biological treatment of wastewater (oxidation, nitrification, denitrification, role of biofilm), biofilters, activated sludge, nutrient removal through biomass production

Recommended books

1. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, Inc.
2. Klaassen, C. (2007) Casarett and Doull's Toxicology The basic science of poisons – McGraw-Hill.
3. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publishing.

Paper DEC-401B

Advanced Cytogenetics

Credits 4

Marks 80+20

UNIT-II

Human cytogenetics- Human karyotype, banding and nomenclature, Numerical and structural abnormalities of chromosomes, Meiotic abnormalities- Non-disjunction of chromosomes, mis-division of centromere, Repetitive and Non-repetitive DNA sequence, Monogenic disorders: Autosomal dominant (Huntington's diseases), Autosomal recessive (Cystic fibrosis), Sex linked (Color blindness and Hemophilia), In situ- hybridization and its applications: FISH and GISH, Transposons and associated disorders

UNIT-II

Molecular markers, Mapping of genome: Genetic and physical maps (tools and techniques), physical mapping (restriction mapping, fluorescence in situ hybridization, sequence tagged site mapping), map based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, molecular markers in genome analysis (RFLP, RAPD, STRs and SNPs), Genome sequencing: Construction of libraries (genomic and cDNA)

UNIT-III

DNA transfection: Physical methods (microinjection, electroporation, biolistics, somatic cell fusion, Gene transfer by pronuclear microinjection), Chemical method (liposomes), Virus mediated transfection. Expression Strategies for Heterologous genes: Bacterial expression systems, *Saccharomyces cerevisiae* expression system, Baculovirus-insect cell expression systems, mammalian cell expression systems

UNIT-IV

Mapping and quantifying transcripts: Northern blot, S1 mapping, RNase protection assay, Primer extension; DNA-protein interactions: EMSA, DNase foot printing, Methyl interference assay, CHIP; Protein-protein interaction: Yeast two hybrid system, Phage display; Gene therapy, Knockout and transgenic technologies

Recommended books

1. Russell, P.J. (2010) Genetics (Benjamin Cummings).
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
3. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
4. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings.
5. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co. Ltd.

6. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th edition) Blackwell Publishing.
7. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
8. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.
9. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.

Paper DEC-402A

Taxonomy and Biosystematics

Credits 4

Marks 80+20

UNIT-I

Definition and basic concepts of Biosystematics and Taxonomy, Historical resume of Systematics, Importance & Applications of biosystematics in biology, Different attributes of biosystematics, Dimensions of speciation and taxonomic characters, Species concept (species category-Polytypic species, Population systematics and other Intraspecific categories), Theories of biological classification and Hierarchy categories

UNIT-II

Procedure keys in taxonomy, Taxonomic procedures: Taxonomic collections, preservation, curation, process of identification, International code of Zoological Nomenclature (ICZN): Its operative principles, interpretation and application of important rules, Zoological nomenclature, Formation of scientific names of various taxa, Taxonomic publications: Strategy, Documentation, Kinds of Publication, Major features and Preparation of manuscript for publication

UNIT III

Evaluation of biodiversity indices: Shannon-Winner Index, Dominance Index, Similarity & Dissimilarity Index; Traditional taxonomy and newer trends in systematic; Chemo and sero taxonomy, Cytotaxonomy, Numerical taxonomy, Cladistics, Molecular systematic and DNA bar coding

UNIT-IV

Study of morphology, range and broad classification of major invertebrate phyla viz. coelenterata, brachiopoda, mollusca, arthropoda (trilobite) and echinodermata (echinoidea), brief features of micro fossils, brief features of Paleobotany, Evolution and classification of vertebrates, Origin of Jaws (Class Placodermi: Armour-Plated Monsters, Class Chondrichthyes: The First Sharks, Class Acanthodii The Spiny Skins), Archaeopteryx, Flightless birds: Division Palaeognathae, Ice Age Extinction of Large Mammals

Recommended books

1. Goto H.E., Animal Taxonomy, Hodder Arnold H&S.
2. Gregg J.R., The Language of Taxonomy - An Application of Symbolic Logic to the Study of Classificatory System, Columbia University Press, New York.
3. Kapoor V.C., Principles and Practices of Animal Taxonomy, Science Publishers, New Delhi.
4. Mayr E. and Ashlock P.D., Principles of Systematic Zoology, Mac Graw-Hill, Inc, New Delhi.
5. Minelli A., Biological Systematics - The State of Art, Chapman and Hall, London.
6. Narendran T.C., An Introduction to Taxonomy, Zoological Survey of India, Kolkata.

Paper DEC-402B

Entomology and Applied Zoology

Credits 4

Marks 80+20

UNIT-I (Apiculture)

Classification and Biology of Honey Bees, Social Organization of Bee Colony (Queen, Drone, Worker). Economic Importance, Scope in Apiculture, Diseases & its control, Rearing of Bees, Bee Keeping Equipment. Bee Economy & Entrepreneurship in Apiculture.

UNIT-II (Aquaculture)

Introduction to fresh water aquaculture, species for aquaculture, composite fish culture, Integrated farming Systems; Paddy cum fish culture, poultry cum fish culture, poultry-piggery cum fish culture, Waste water fed aquaculture. Physico-chemical properties of soil and water, Productivity & nutrient quality & quantity of soil and water, Soil and water quality monitoring and management. Preparation and maintenance of aquarium

UNIT III (Sericulture)

Introduction to Sericulture, Types of mulberry and non-mulberry silkworms, Food plants of Silkworms. Rearing of different species of silkworm, Diseases of silkworm and their control, Reeling methods. Economic income of Silk Industry.

UNIT-IV (Vermicomposting)

Different species of Earthworms, Ecological role and economic importance of earthworms. Vermiculture – definition, scope and importance; Environmental requirements; Culture methods, Vermicomposting – applications, Future perspectives, Potentials and constraints for vermiculture in India.

Recommended books

1. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
2. Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.
3. Edwards CA, Hendrix P and Arancon N (2014) Biology and Ecology of Earthworms, Springer Publishers.
4. Edwards CA, Arancon NQ and Sherman RL (2011) Vermiculture Technology:
5. Earthworms, Organic Wastes, and Environmental Management, CRC Press, USA.
6. Ismail SA (2005) The Earthworm Book. Edition, Other India Press, Apusa, Goa, India

Paper DEC-403

Practical

Credits 6

Marks 100

Paper DEC 401A

1. Study the different physico-chemical parameters of water sample
2. Study the different physico-chemical parameters of soil sample
3. Calculate BOD of given water samples
4. Calculate COD of given water samples

Paper DEC 401B

5. Isolation of genomic DNA/plasmid DNA
6. Human karyotyping (normal and diseased)
7. Demonstration of Southern blotting, Northern blotting, Western blotting, PCR and DNA fingerprinting
8. Preparation of circular and linear restriction map from the data provided
9. Calculation of transformation efficiency from the data provided

Paper DEC 402 A

10. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys
11. Evaluation of diversity indices: Species Richness(S), Evenness (E), Simpson index (D), Shannon-Weiner Index (H')
12. Construction of phylogenetic tree using basic morphological features
13. Construction of phylogenetic tree using 16s rRNA gene sequences retrieved from NCBI database

Paper DEC 402B

14. External features of available field collected insects
15. Methods of collection and preservation of insects (sample submission)
16. Wing venation, types of wings and wing coupling apparatus
17. Specimen of commercially important freshwater fish species
18. Study of different types of bees, silk moths, vermin, fins and scales of fish

Paper DEC-404

Dissertation/Project Work

Credits 8

Marks 200

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| 1. Dissertation/ Project work and thesis submission | 150 marks |
| 2. Seminar and Viva-voce | 50 marks |