

Register No.

UNIVERSITY OF CALICUT
Ph.D. ENTRANCE EXAMINATION, 2023
ZOOLOGY

Time: 2 hours

Maximum Marks: 100

SECTION A

Answer ALL questions by putting a tick (✓) mark against the most appropriate option.
Each question carries ONE mark

1. Which of the following is not a holoblastic cleavage
(a) Radial (b) Bilateral
(c) Discoidal (d) Rotational
2. Which of the following has the highest degree of developmental plasticity
(a) Multipotent (b) Pluripotent
(c) Totipotent (d) Unipotent
3. Link between 'reptiles and birds' is
(a) Crocodile (b) Dinosaur
(c) Archaeopteryx (d) Toad
4. Egg of birds are
(a) Alecithal (b) Isolecithal
(c) Homolecithel (d) Telolecithel
5. Which of the following birds is the state bird of three Indian states?
(a) Great Hornbill (b) Greater Flamingo
(c) Hill Mynah (d) Blue Jay (Indian Roller)
6. Corneal grafts are generally not rejected by the recipient because cornea is
(a) Non-living (b) Non-proteinaceous
(c) Non-cellular (d) Non-vascularized
7. Distinguish the transmembrane protein connected to the cytoskeleton of the cells
(a) G-protein (b) Integrin

- (c) Microtubule (d) Repressor protein
8. Volume of CSF is about
(a) 50ml (b) 100ml
(c) 150ml (d) 200ml
9. Dissymmetria is seen in
(a) Extra pyramidal lesions (b) Cerebellar lesions
(c) Pyramidal lesions (d) Cortical lesions
10. NMR spectroscopy is
(a) Diffraction (b) Absorption
(c) Radiation (d) Emission
11. The following is true about brain metabolism except
(a) Use fatty acid in starvation (b) In resting state 60% of total energy utilized
(c) Ketone bodies are used in starvation (d) Has no energy store
12. Satiety center in hypothalamus is regulated by
(a) Gastric dilatation (b) Blood glucose levels
(c) Blood insulin level (d) All of the above
13. Sella turcica is
(a) Covering of ovary (b) Covering of testis
(c) Depression in the skull (d) Part of temporal bone
14. Name the process that occurs due to the multiple reproductive barriers
(a) Heterozygote advantage (b) Genetic drift
(c) Allopatric speciation (d) Sympatric speciation
15. Which is the most efficient complement fixing class of antibody?
(a) IgA (b) IgG
(c) IgM (d) IgE
16. All membranes of free-living organisms have phospholipid bilayers, but exception is
(a) Bacteria (b) Archaea
(c) Fungi (d) Protozoa
17. Which of the following is/are not Gram-positive bacteria?

- (a) *Pseudomonas* (b) *Streptococcus*
 (c) *Mycobacteria* (d) None of these
18. The dengue fever virus is
 (a) Arbo virus (b) Echo virus
 (c) Entero virus (d) Orthomyxo virus
19. The first engineered plasmid vector
 (a) PBR 322 (b) PUC vector
 (c) PRB Vector (d) PRC 412
20. What is missing the early embryonic cell cycle when compared to somatic cell cycle
 (a) S and M phase (b) G1 and S Phase
 (c) G2 and M phase (d) G1 and G2 Phase
21. The envelope of which of the following viruses is derived from the host cell nucleus?
 (a) Paramyxoviruses (b) Retroviruses
 (c) Orthomyxoviruses (d) Herpesviruses
22. Which is the central component in complement activation pathways
 (a) C1s (b) C2a
 (c) C3b (d) C5b
22. The ratio of T cells to B cells is
 (a) 1:3 (b) 3:1
 (c) 2:1 (d) 1:1
23. The primary antibody of exocrine secretions is
 (a) IgA (b) IgG
 (c) IgM (d) IgE
24. Which one of the following chemicals is a DNA intercalator
 (a) 5-bromouracil (b) Ethyl methane sulphonate
 (c) Acridine Orange (d) UV
25. The natural habitat of Niligiri Tahr is
 (a) Shola grasslands (b) Nilgri forests
 (c) Shola grasslands and Nilgiri forests (d) At high altitude of South- western ghats

26. Which of the following factor is least responsible for genetic drift
- (a) Migration
 - (b) Founder effect
 - (c) Bottle neck phenomenon
 - (d) Restriction of resources
27. NMR is based on
- (a) Nuclear fission
 - (b) Charge of nucleus
 - (c) Magnetic moment of the nucleus
 - (d) Electrical moment of the nucleus
28. Satiety center in hypothalamus is regulated by
- (a) Gastric dilatation
 - (b) Blood glucose levels
 - (c) Blood insulin level
 - (d) All of the above
29. Which of the following is not used for detection in GC
- (a) Infrared spectroscopy
 - (b) NMR
 - (c) Flame ionization
 - (d) Electrical Conductivity
30. In reverse phase HPLC there is a
- (a) Non polar solvent and polar column
 - (b) Polar solvent and non-polar column
 - (c) Both solvent and column non-polar
 - (d) All the above
31. For separation of DNA by electrophoresis, which of the following method is commonly used?
- (a) Agarose- vertical
 - (b) Agarose- horizontal
 - (c) PAGE- vertical
 - (d) PAGE-horizontal
32. The main advantage of discontinuous buffer system in SDS and Native PAGE is
- (a) Conformation of protein is conserved
 - (b) Constantly maintain the charge of proteins
 - (c) Assist in migration of protein
 - (d) Enhance resolution of separation
33. A chromosome aberration leads to change in the order of genes in a genetic map but does not alter its linkage group. This is due to
- (a) Translocation
 - (b) Recombination
 - (c) Transposition
 - (d) Inversion
34. How many types of t-RNA are found in eukaryotic cell?
- (a) 64-one each for genetic codon
 - (b) 20-one each for amino acids
 - (c) 03-related to protein synthesis
 - (d) 02-related to ribosomes and endoplasmic reticulum
35. Insertion or deletion of a nucleotide in a class of mutation resulting in sequence of codon that makes nonsensical polypeptide chain is called

- (a) Transversion (b) Inversion
(c) Frame shift mutation (d) Lethal mutation
36. RNA molecules, capable of catalyzing a chemical reaction such as self-splicing are known as:
(a) Isozymes (b) Ribozymes
(c) Ribosomes (d) Lysosomes
37. When a child with blood group 1A, 1B is born of a woman with genotype 1B 11B, the father of the child could not be a man of the genotype:
(a) IB / IB (b) IA / IA
(c) IA / IB (d) IA / I
38. The deletion or insertion of a base pair into the generic code causes a frame shift mutation unless the number of the base pairs deleted or inserted is:
(a) One base pair (b) Two base pairs
(c) Three base pairs (d) Four base pairs
39. Which of the following amino acids has single codon?
(a) Isoleucine (b) Tryptophan
(c) Valine (d) Arginine
40. Which one of the following functions are performed by the restriction enzyme?
(a) Removing exons from the RNA (b) Removing introns from the RNA transcript
(c) Cutting up foreign DNA (d) Removing methyl group from DNA
41. Pre messenger RNA (pre- m-RNA) must be modified before translation because
(a) Pre-m-RNA contained leader sequence
(b) Pre-m-RNA contained the non-coding sequences (intron) within the coding region
(c) Pre-m-RNA contained methylated G nucleotide
(d) Pre-m-RNA is longer than the gene
42. Which is the best management practice in soil conservation
(a) Mulching (b) Contour tillage
(c) Conservation tillage (d) Planting cover crops
43. Which of the following is essential for the development of ozone hole
(a) Formation of smog (b) Tropospheric temperature rise
(c) Atmospheric buildup of CO₂ (d) Polar stratospheric clouds

44. Alpha diversity (α -diversity) is the mean species diversity
- (a) In sites or habitats at a local scale
 - (b) Of the entire landscape
 - (c) Of the earth
 - (d) In the oceans
45. Choose the glycoprotein which has a structural function
- (a) Mucin
 - (b) Nectin
 - (c) Collagen
 - (d) Calnectin
46. In the territorial behavior of the stickleback fish, the red belly of one male elicits attack from another male by functioning as
- (a) A search image
 - (b) A fixed action pattern
 - (c) A sign stimulus
 - (d) A pheromone
47. The student's t-test is
- (a) Non-parametric test
 - (b) Test for comparing variances
 - (c) Used for Correlation analysis
 - (d) Parametric test
48. A table listing such items as age, observed number of organisms alive each year, and life expectancy is known as a (an)
- (a) Insurance table
 - (b) Life table
 - (c) Survivorship table
 - (d) Rate table
49. Chi-square test is used to
- (a) Measure the deviation between sample and population mean
 - (b) Test the closeness of observed and expected frequency
 - (c) Test inferential statistics
 - (d) Test the regression analysis
50. Which of the following test is parametric test
- (a) Chi-square test
 - (b) Sign test
 - (c) ANOVA
 - (d) WSR test

(50 x 1 = 50 marks)

SECTION B

Answer any TEN of the following. Each question carries FIVE marks

51. What is the working principle GCMS? Specify the applications.
52. Briefly describe (a) Isoelectric focusing and (b) Flow cytometry
53. Give an account on different DNA repair mechanisms existing in a cell.
54. Write a brief note on MHC molecules and their role in immune response
55. Describe mathematical methods for correlation analysis
56. Give an account of enzyme inhibition and its applications
57. Evaluate various parametric and non-parametric tests with suitable examples
58. Demonstrate consequences of habitat fragmentation
59. Explain the impact of genes and environment on animal behaviour
60. Describe the molecular tools employed for gene mapping
61. Explain the different mechanisms of speciation, with suitable examples
62. Summarize the complement activation pathways of human immune system
63. What are endocrine disruptors? Briefly discuss their environmental impacts
64. Explain the mechanism of excitatory and inhibitory synaptic transmission
65. Describe the role of vitellogenesis in the development of insect and amphibian development

(10 x 5 = 50 marks)

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SYLLABUS

I. METHODS IN BIOLOGICAL STUDIES

1. **Biophysical methods:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. Relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure, Fick's law and diffusion coefficient, Stoke- Einstein's law, Gibb's Donnan equilibrium. Application of diffusion processes in biology: hemolysis, cyclosis, plasmolysis, Vant Hoff's laws, Osmotic concentration, osmotic gradient, Electro-osmosis, Electrolytic and ionic balance in biological fluid, Viscosity and factors affecting viscosity, Determination of viscosity of liquids, significance.
2. **Microscopic techniques:** Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, Phase contrast, fluorescent and confocal microscopy, Electron microscopy: Scanning and transmission (SEM and TEM), Freeze-etch and freeze-fracture methods for Electron Microscope, Cytophotometry, Micrometry, Different fixation and staining techniques, Cryotechnique, Image processing methods in microscopy
3. **Chromatographic techniques:** Principle and applications, Types of chromatography – Adsorption, Partition, Column, Paper, Thin layer, Gel-filtration, Ion-exchange, Gas, Affinity and HPLC.
4. **Radiolabeling techniques:** Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
5. **Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.
6. **Statistical methods:** Measures of central tendency and dispersal, Probability distributions (Binomial, Poisson and normal), Sampling distribution, Difference between parametric and non-parametric statistics, Confidence Interval, Errors, Levels of

significance, Assumptions and techniques of ANOVA, One-way and Two-way classification, Basic introduction to Multivariate statistics, Correlation – graphic and mathematical methods, Karl Pearson's co-efficient of correlation, Spearman's Rank correlation co-efficient, Tied ranks and Repeated ranks, Co-efficient of concordance, Types of Regression, t-test, Chi-square test, Parametric and Non-parametric test

7. **Methods in field biology:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect, and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.

II. BIOMOLECULES

1. **Structural composition:** Atoms, molecules and chemical bonds, Composition, structure, and function of different biomolecules – carbohydrates, lipids, amino acids, proteins, enzymes, nucleic acids and vitamins, Stabilizing interactions – Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds), Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
2. **Acids Bases and Buffers:** Weak acids and weak bases, Equilibrium constant, pH and pKa scale and pKa. Working out problems related to determination of pH and pKa, Buffers and buffering action. Henderson-Hasselbalch equation, Phosphate and bicarbonate buffer system in biological system
3. **Bioenergetics:** Laws of thermodynamics and biological system, Entropy, Enthalpy, Concept of free energy. Standard Free energy change and equilibrium constant. Coupled reactions. Glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
4. **Metabolism:** Carbohydrates, lipids, amino acids nucleotides and vitamins, Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes,

III. CELL AND MOLECULAR BIOLOGY

1. **Cellular organization:** Structure of model plasma membrane, mechanism of intracellular and intracellular transport, electrical properties of membranes, Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.
2. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, regulation, and control of cell cycle), Programmed cell death, aging and senescence

3. **Cell communication and signaling:** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two- component systems, light signaling in plants, bacterial chemotaxis and quorum sensing, Toll-like receptors, Ligand-gated ion channel receptors and integrins, Signaling through Intracellular receptors, Receptor desensitization, Cell Signaling network, Impairment of signaling mechanism.
4. **DNA replication, repair, and recombination:** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination,
5. **RNA synthesis and processing:** Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure, and function of different types of RNA, RNA transport.
6. **Protein synthesis and processing:** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, post-translational modification of proteins.
7. **Control of gene expression at transcription and translation level** (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).
8. **Recombinant DNA methods:** Isolation and purification of RNA, DNA and proteins, Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors, Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors, Mutagenesis and deletion techniques, Gene knock out, DNA and Protein sequencing methods, Metagenome and whole genome sequencing, Gene expression at RNA and protein level.

IV. INHERITANCE BIOLOGY

1. **Organization of genes and chromosomes:** Concept of gene, Alleles (multiple alleles, pseudoalleles, complementation tests), Structure of chromatin and chromosomes, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons, Inheritance of mitochondrial and chloroplast genes, maternal inheritance.
2. **Mendelian principles and its extension:** Dominance, segregation, independent assortment, Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance, and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
3. **Gene mapping methods:** Physical and genetic mapping, Low resolution mapping (Linkage maps, LOD score for linkage testing, Cytogenetic maps, Banding of chromosomes, Restriction mapping, Chromosome walking, Cosmid, BAC/YAC, cDNA mapping), High resolution mapping (Mapping using molecular markers: RFLP, AFLP, RAPD, SNP, STS/EST based mapping, PFGE, FISH)
4. **Human genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping, Pedigree analysis, Karyotyping, Genetic disorders (Down's, Klinefelter's and Turner's syndromes).
5. **Chromosomal aberrations and Mutation:** Deletion, duplication, inversion, translocation, ploidy and their genetic implications, Homologous and non-homologous recombination including transposition Types, causes and detection of mutation, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
6. **Transposable genetic elements:** Transposition and transposons, Class I and Class II transposable elements (LTR and Non-LTR Retrotransposons, P elements in *Drosophila*, IS elements in bacteria, Composite transposons), Tn family, medical significance

V. IMMUNE BIOLOGY

1. **Cells and organs of immune system:** Haematopoiesis – Lymphoid and myeloid lineages, Regulation of hematopoiesis, Development of T cells and B cells, Primary, secondary, and tertiary lymphoid organs, Activation and differentiation of B and T cells, B and T cell receptors
2. **Innate and adaptive immune system:** Antigens, antigenicity and immunogenicity. B and T cell epitopes, Structure and function of antibody molecules. Organization and expression

of lymphocyte receptor genes, Generation of antibody diversity, Monoclonal antibodies, Antibody engineering, antigen-antibody interactions.

3. **Immune effector mechanisms:** Humoral and cell- mediated immune responses, MHC molecules, antigen processing and presentation, Cytokines and chemokines, Primary and secondary immune modulation, Complement system, Toll-like receptors, cell-mediated effector functions, inflammation, vaccines, and vaccination.
4. **Immune disorders:** Hypersensitivity, Tolerance and autoimmunity, Primary and secondary immunodeficiency diseases, Transplantation antigens, Immunosuppressive therapies.
5. **Immunological techniques:** Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, Immunoelectrophoresis.
6. **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

VI. ANIMAL PHYSIOLOGY

1. **Digestive system** - Digestion, absorption, energy balance, BMR.
2. **Blood and circulation:** Blood corpuscles and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, homeostasis, Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
3. **Respiratory system:** Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
4. **Nervous system and sense organs:** Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture, Vision, hearing and tactile response.
5. **Excretory system:** Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
6. **Adaptation:** Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization, Stress and adaptation

7. **Endocrinology:** Endocrine glands, basic mechanism of hormone action, hormones and diseases, Hormones as signal transducers, Hormones and behavior, Control of chromatophores (Pituitary, pineal), Role of hormones in reproduction, Hormone therapy in reproductive impairments, Endocrine disruptors in the environment.

VII. DEVELOPMENTAL BIOLOGY

1. **Basic concepts of development:** Potency, commitment, specification, induction, competence, determination, and differentiation, morphogenetic gradients, cell fate and cell lineages, stem cells, genomic equivalence and the cytoplasmic determinants, imprinting, mutants and transgenics in analysis of development
2. **Gametogenesis, fertilization, and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals, embryo sac development and double fertilization in plants, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis, establishment of symmetry in plants, seed formation and germination.
3. **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in *Dictyostelium*, axes and pattern formation in *Drosophila*, amphibia and chick, organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates, differentiation of neurons, post embryonic development- larval formation, metamorphosis, environmental regulation of normal development, sex determination.

VIII. ECOLOGY

1. **Environment:** Physical environment, biotic environment, biotic and abiotic interactions, Ecosystem structure, ecosystem function, energy flow and mineral cycling, primary production and decomposition, structure and function of some ecosystems – terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
2. **Habitat and Niche:** Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.
3. **Population Ecology:** Characteristics of a population, population growth curves, population regulation, life history strategies (r and K selection), concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations.
4. **Species Interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
5. **Community Ecology:** Nature of communities, community structure and attributes, levels

of species diversity and its measurement, edges and ecotones.

6. **Ecological Succession:** Types, mechanisms, changes involved in succession, concept of climax.
7. **Biogeography:** Major terrestrial biomes, theory of island biogeography, biogeographical zones of India.
8. **Conservation Biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy.

IX. EVOLUTION AND BEHAVIOUR

1. **Emergence of Evolutionary thoughts:** Lamarck, Darwin—concepts of variation, adaptation, struggle, fitness, and natural selection, Mendelism, Spontaneity of mutations, The evolutionary synthesis, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane, Experiment of Miller, Evolution of prokaryotes, Origin of eukaryotic cells, Evolution of unicellular eukaryotes, Anaerobic metabolism, photosynthesis and aerobic metabolism, Adaptive radiation and modifications,
2. **Paleontology and Evolutionary History:** The evolutionary time scale, Eras, periods and epoch, Major events in the evolutionary time scale, Origins of unicellular and multi cellular organisms, Major groups of plants and animals, Stages in primate evolution including Homo.
3. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks, Molecular tools in phylogeny, classification and identification, Protein and nucleotide sequence analysis, origin of new genes and proteins, Gene duplication and divergence.
4. **Population genetics:** Populations, Gene pool, Gene frequency, Hardy-Weinberg Law, concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, Adaptive radiation, Isolating mechanisms, Speciation (Allopatric and Sympatric), Convergent evolution, Sexual selection, Co-evolution.
5. **Brain, Behavior and Evolution:** Approaches and methods in study of behavior, Proximate and ultimate causation, Altruism and evolution-Group selection, Kin selection, Reciprocal altruism, Neural basis of learning, memory, cognition, sleep and arousal, Biological clocks, Development of behavior, Social communication and dominance, Territoriality, Mating systems, Parental care and reproductive success, Aggressive behavior, Habitat selection and optimality in foraging, Migration, orientation and navigation, Domestication and behavioral changes.

X. APPLIED BIOLOGY

1. **Applications of biotechnology:** PCR and its applications, Genetic engineering, Next generation sequencing and direct sequencing of genomes, Gene editing, Gene Silencing, Transgenic animals and plants, Molecular approaches to diagnosis and strain identification, Tissue and cell culture methods.
2. **Microbes in industry and agriculture:** Production of organic compounds and antibiotics by microbes, Bioreactors, Microbial transformations, Single cell proteins (SCP) from microorganisms, Biofertilizers and Bioinsecticides, Genetically Engineered Microbes, Bioremediation and Biosensors.
3. **Applied Ecology:** Environmental pollution, global environmental change, biodiversity: status monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches.
4. **Intellectual property rights and intellectual property protection:** Patents, Copyright, Trade secrets, Trademarks, PGR, GATT and TRIPs, Patenting of biological materials, Patenting plants, animals, transgenic organisms, genes, and DNA sequences
5. **Bioethical principles:** Beneficence, Least Harm, Respect for Autonomy, Theories on animal ethics (Deontology, Utilitarianism, Casuist ethical theory, Virtue ethical theory, Rights Theory), Animals in Research (Experimenting on animals, Specism, Methods to reduce animal numbers in research), Animal protection (Laws and Rules, IAEC – Rules and Regulation), Ethics on cloning and stem cell research.
