

Paper -01: Basic Biology

1) BIOLOGICAL CLASSIFICATION AND DIVERSITY OF LIFE:

- a) Principles and Methods of Taxonomy: Species, Sub-species, Races, Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants and animals.
- b) Levels of structural organization: Unicellular and multicellular forms; levels of organization – tissues, organs and systems.
- c) Outline classification of plants and animals: Criteria used for classification, classification of plants and animals; evolutionary relationships among taxa.

2) STRUCTURAL ORGANIZATION AND FUNCTIONS OF THE CELL:

- a) Membrane structure and functions: Various models of membrane, Dynamics of cell membrane- Osmosis, active transport, ion channels and ion pumps, mechanism of intracellular transport.
- b) Cell Organelles: Cell wall, nucleus, mitochondria, golgibodies, lysosomes, endoplasmic reticulum, peroxisomes, Vacuoles, plastids and cytoskeleton.
- c) Organization of Chromosomes: Structure of chromatin, Nucleosome, Heterochromatin and Euchromatin.
- d) Cell Cycle and Cell Division: Phases of Cell cycles, regulation of cell cycle, Mitosis and Meiosis and their regulation, Endomitosis, Amitosis.

3) BIOMOLECULES:

- a) Chemical bonds: Non-covalent and covalent interactions.
- b) Structure, classification and functions of biomolecules: Carbohydrates, Lipids, Proteins, Nucleic acids.
- c) Principles of biophysical chemistry: p^H , buffer, thermodynamics, Molarity and Normality.
- d) Principles of catalysis: Enzymes Classification, enzyme kinetics, enzyme regulation, mechanism of enzyme action, isozymes.
- e) Models of DNA (A, B, Z) and types of RNA (t-RNA, m-RNA, r-RNA, microRNA) .

4) ECOLOGY AND ENVIRONMENTAL BIOLOGY:

- a) Abiotic and biotic factors, habitat and niche.
- b) Ecosystems: Structure and function; energy flow; primary production & decomposition. Food chains, Food web and ecological pyramids. Structure and function of Indian ecosystem: aquatic (fresh water, marine and estuarine) and terrestrial ecosystem (forest, grassland).

- c) Population Ecology: Characteristics of population, population growth curves, population regulation, concept of metapopulation, demes and dispersal and interdemec extinctions.
- d) Community Ecology: Nature of communities, Community structure and attributes, edges and ecotones.
- e) Species interactions: Levels of species diversity, types species interactions (symbiosis) Commensalism, Amensalism, Predation, Parasitism, and competition, pollination
- f) Ecological Succession: Types, mechanisms and concept of climax.
- g) Biogeochemical cycles: Definition, types- gaseous (Carbon, Nitrogen & Oxygen), Sedimentary (sulphur and phosphorous).
- h) Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

5) FUNDAMENTAL GENETICS:

- a) **Mendelian principles:** Laws of segregation and independent assortment, Dominance, Allele, multiple alleles, pseudoalleles.
- b) **Deviations to Mendelian principles:** Co-dominance, incomplete dominance, Epistasis, Pleiotropy, Penetrance and expressivity, phenocopy .
- c) **Linkage and Linkage maps:** Linkage, complete and incomplete linkage, sex linkage, sex limited and sex influenced characters, crossing over and construction of linkage maps. Mapping with molecular markers.
- d) **Extranuclear inheritance:** Maternal effects (Limnea), Organelle heredity (mitochondria and chloroplasts), infection heredity (Kappa in Paramecium)
- e) **Gene mutations:** Spontaneous and induced mutations, types of mutations, molecular mechanisms of mutations, methods of testing mutations.
- f) **Sex determination and Dosage compensation:** Sex determination (Drosophila and Man), Secondary Sex determination, Dosage compensation in Drosophila and Man.
- g) **Recombination:** Homologous and non-homologous recombination, transportation, molecular mechanism of recombination.
- h) **Fine structure of the gene:** Gene concept: One gene one enzyme, one gene one polypeptide concept, Bar and Lozenze eye in Drosophila, complementation test (rII locus) in E coli, Cistron, Muton and Recon concept, Split genes.

6) EVOLUTION:

- a) Emergence of evolutionary thoughts: Lamarckism, Darwinism Weismanism and Neo-Darwinism, Neo-Lamarckism, Neutral theory.
- b) Origin of Life, Cell and its evolution : Origin of basic biological molecules, concept of Oparin and Haldane, Experiments of Urey and Miller, Chemical evolution, biological evolution, evolution of adapter molecules, protocell, microspheres, evolution of prokaryotes and eukaryotes.
- c) Paleontology and evolutionary history: Evolutionary time scale, eras, periods and epochs, major events in the evolutionary time scale, stages in primate evolution including Homo.

- d) Molecular evolution: Concepts of neutral evolution, molecular divergence, molecular clocks, Molecular tools in Phylogeny. Proteins and nucleotide sequence analysis, origin of new genes and proteins.

7) DEVELOPMENTAL BIOLOGY:

- a) Introduction: Concepts of development, Intracellular synthesis and its regulation, cell surface, cell adhesion, restriction and determination, differentiation and development.
- b) Early development: Gametogenesis, fertilization, cleavage, blastulation and gastrulation in sea urchins, amphibians, birds and mammals.
- c) Competence and induction: Mesodermal, primary, secondary, regional specificity, totipotency and nuclear transfer experiments, cell differentiation and differential gene activity, genetic mechanism of determination and differentiation, ooplasmic determinants, Lens induction in amphibian, competence factor.
- d) Genes and development: Role of maternal genes in early embryonic development of drosophila, Gap genes, Pair rule genes, segment polarity genes, Homeotic genes.

8) BIOLOGY OF NON-CHORDATES:

- a) Principles of Animal classification. Taxonomic procedures- Taxonomic collections, preservation, curation and process of identification. International Code of Zoological Nomenclature (ICZN).
- b) General Characters and Classification, Body plans and Symmetry- :
Protozoa- Type study- Amoeba, Entamoeba, Trypanosoma, Euglena and Paramecium. Locomotion, Nutrition and Reproduction. Structure, life history and pathogenicity of Plasmodium vivax.
Porifera – Histology, Spicules, Canal System, Reproduction and larval forms.
Cnidaria- Type study Hydra, Obelia, Sea Anemone, Aurelia. Polymorphism in Cnidaria, Mesenteries in sea anemone. Structure of corallite, coral reefs, conditions necessary for coral growth, types and theories.
- c) Platyhelminthes- Structure and reproduction, Mode of infection, disease caused and control measures of Taenia solium, Fasciola hepatica, Schistosoma hematobium, Ascaris, Wauchereria bancrofti and Ancylostoma. Parasitic adaptations.
- d) Annelida - Type study earthworm, nereis and Leech- External, digestive system, respiratory system, circulatory system, excretory system and reproductive system. Tubicolous Annelida. Parasitic adaptations.
- e) Onychophora- Peripatus- Salient features and significance
Arthropoda- Type study - Cockroach, Prawn and Scorpion.
Respiration, Circulation and Excretion. Larval forms, Metamorphosis and Endocrine control. Economic importance of Insects- Silkworm, Honeybees and Lac insects.
Parasites – Bedbug, Head louse, Ticks, Mites, Mosquitoes.
Pests- Weevil, Beetles, Locusts, Cockroach and Biological control.
Trilobita

- f) Mollusca- Type study - Pila and Fresh water mussel. Types and structure of shells, Torsion in Gastropoda, Respiration in Mollusca, Foot in Mollusca. Neopalina.
- g) Echinodermata- Type study Star fish, Brittle star, Sea Urchin and Sea lilly. Water vascular system in star fish and corona of sea urchin. Larval forms and evolutionary significance.
- h) Hemichordata- Salient features and Phylogenetic significance.
- i) Minor Phyla- Organisation and general characters of Chaetognatha, Ctenophore, Phoronida, Pogonophora.

9) BIOLOGY OF CHORDATES:

- a) General characters and classification of protochordates:
Cephalochordata- Amphioxus- Detailed study.
Urochordata- Ascidia- Detailed study and retrogressive metamorphosis.
Cyclostomata-Salient features, Petromyzon and Myxine, ammocoete larva and its significance.
- b) Pisces- General characters, distinctive features between Chondrichthyes and Osteichthyes, Scoliodon- Detailed study. Scales in fishes, Parental care in fishes, Dipnoi.
- c) Amphibia- Origin of Amphibia. Type study- Frog: Externals, digestive, respiratory, skeletal, nervous system, circulatory, excretory and reproductive system. Metamorphosis. Parental care.
- d) Reptilia- General characters and classification. Evolution of Arcades and Fossae and its significance, Chelonia, Rhyncocephalia, Crocodilia and Squamata. Poisonous and Non-poisonous snakes, snake venom- types and composition and importance. Poison apparatus.
- e) Aves- General characters and classification. Salient features of Archaeornithes and Neornithes. Paleognathae, Neognathae and impennae. Palate in birds. Foot and beak in birds. Migration in birds.
- f) Mammals- General characters and classification. Prototheria, Metatheria, Eutheria-orders Cetacea, Chiroptera, Carnivora, Rodentia, Proboscidea, Artiodactyla. Perisodactyla and Primata. Dentition in Mammals
Type study- Rabbit: Externals, digestive, respiratory, circulatory and Urinogenital system.
- g) Comparative anatomy of Vertebrates.
Skeletal system- Skull, Vertebrae, Girdles and limb skeleton.
Circulatory system- heart and aortic arches.
Comparative anatomy of Vertebrates.
Nervous system- Brain, Cranial nerves, spinal nerves and Sense organs.
Urinogenital system- Evolution of Kidney and reproductive ducts.
- h) Adaptations- Aquatic, arboreal, Volant and desert adaptations. Coloration and mimicry.
- i) Zoogeography- Zoogeographical realms- Major fauna and flora.
- j) Economic Zoology – Vermiculture, Apiculture, Sericulture, Aquaculture, Dairy and Poultry.

10) SYSTEM PHYSIOLOGY OF ANIMALS:

- a) Blood and Circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, haemostasin.
- b) Cardiovascular System: Comparative anatomy of heart structure, types of heart, ECG-its principle and significance, Cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of heart.
- c) Respiratory System: Comparison of respiration in different species, anatomical consideration, transport and exchange of gases, water elimination, regulation of respiration.
- d) Nervous System: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.
- e) Sense Organs: Vision and hearing
- f) Excretory System: Comparative physiology of excretion, kidney, urine formation and concentration, regulation of water balance, electrolyte balance and acid-base balance
- g) Digestive system: Digestion and absorption of nutrients, energy balance. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

11) CLASSIFICATION AND MORPHOLOGY OF PLANT GROUPS:

a) Fungi :

- Introduction: History and present status of Mycology with special reference to India. Cell Structure, organization
- Lower Fungi: General Characteristics
- Plasmodiophoromycetes: Plasmodiophora, Chytridiomycetes and Synchronium.
- Oomycetes / water moulds: Saprolegnia, Pythium
- Zygomycetes: Mycorales – general account,
- Higher Fungi: General characteristics, Ascomycetes, Basidiomycetes and Deuteromycetes.

b) Algae :

- Habitat, Thallus organization, cell structure, patterns of life cycles with reference to Cyanobacteria, Chlorophyceae, Charophyceae, Bacillariophyceae, Xanthophyceae, Euglenophyceae, Chrysophyceae, Pyrrophyceae, Cryptophyceae, Phaeophyceae, and Rhodophyceae.

c) Bryophytes:

- Hepaticae – Marchantiales, Jungermanniales, Calogryales and Sphaerocarpaceae.
- Anthocerotae- Anthocerotales.
- Musci- Sphagnales, Andraeales, Funariales, Polytrichales, Buxbaumiales.

d) Pteridophytes:

- Introduction: Origin, Evolution, Distribution life cycle
- Fossil Pteridophytes: Psilophytales, Lepidodendrales and Calamitales
- Diversity in morphology

- Eusporangiate : Ophioglossales, Marattiales,
 - Leptosporangiate: Osmundales, Filicales (Saxifragaceae, Polypodiaceae, Adiantaceae, Gleicheniaceae, Cyatheaceae, Hymenophyllaceae, Aspleniaceae and Dryopteridaceae), Marsileales and Salviniaceae.
- e) **Gymnosperms :**
- Introduction: Distribution and System of Classification,
 - Fossil Gymnosperms: Types of Fossils, techniques to study fossils
 - Pteridospermales, Bennettitales, Pentoxylales, Caytoniales, Ginkgoales, and Cordaitales.
 - Diversity in morphology and anatomy Coniferales, Ginkgoales, Taxales and Gnetales.
- f) **Angiosperms:**
- Taxonomy, Taxonomic evidences, Chemotaxonomy, Cytotaxonomy and numerical taxonomy.
 - Study of some families with their phylogeny as per Bentham-Hookers system.

12) PLANT ANATOMY AND PALYNOLOGY:

PLANT ANATOMY:

- a) Plant Cell Wall : Structure and Organisation
- b) Root Anatomy: Primary structure of root, variations in number of vascular strands, Velamen and Tricoblast.
- c) Leaf anatomy: Dicot, Monocot and Variations, Venation pattern stomatal types and distribution
- d) Nodal anatomy: Types of nodes and origin of Bud traces.
- e) Internodal Anatomy: Herbaceous dicot woody and monocot stem, medullary bundles, bicollateral bundles and internal phloem.
- f) Floral Anatomy: Ontogeny and vascularisation.
- g) Primary Xylem: Concepts of Protoxylem and metaxylem, vascular differentiation in shoot apex and leaf primordial.
- h) Diversity in structure of wood: Heart and sapwood, growth rings, ring porous wood porous wood diversity in axial parenchyma distribution and diversity in ray system.
- i) Anatomical variations: Ecological and anatomical adaptations in hydrophytes, xerophytes, Halophytes and Epiphytes.
- j) Phloem Tissue: Ultra structure and development of sieve tube element
- k) Vascular cambium, Structure and activity Uniseriate/Multiseriate nature fusiform ray initials and cambium zone
- l) Variations in Vascular Cambium: Gnetum and Magnoliales
- m) Unusual Secondary Growth: *Serjania clamatidifolia* and *Passiflora* sps.

PALYNOLOGY:

- a) Introduction: Scope and development
- b) Branches and palynology: Aerobiology, Forensic Palynology, Paleo Palynology and Palynostratigraphy.
- c) General account and pollen / Spore morphology; dicot, Monocot, Gymnosperms and Pteridophytes, Chemical Composition of pollen wall and ornamentation palynological techniques.
- d) **Melitto palynology:** - Role of bees in crop productivity, bee pollen in health care.
- e) **Acrobiology:** General account and its applications, Methods used in atmospheric pollen monitoring.

13) SYSTEM PHYSIOLOGY OF PLANTS:

- a) Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO₂ fixation-C₃, C₄ and CAM pathways.
- b) Respiration and Photorespiration: Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.
- c) Nitrogen Metabolism: Nitrate and ammonium assimilation; amino acid biosynthesis.
- d) Plant hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.
- e) Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cytochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
- f) Solute transport and photoassimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.
- g) Secondary metabolites: Biosynthesis of terpenes , phenols and nitrogenous compounds and their roles.
- h) Stress physiology: Responses of plants of biotic (pathogen and insects) and abiotic (water temperature and salt) stresses; mechanisms of resistance of biotic stress and tolerance to abiotic stress.

Paper – 02: Advanced Biology

1) FUNDAMENTAL PROCESSES OF DNA:

- a) DNA replication: semi conservative replication in E. coli and Eukaryotes, control of replication, replication in phage, plasmid and mitochondria.
- b) RNA biosynthesis : DNA dependent RNA biosynthesis in prokaryotes and eukaryotes, Initiation elongation and termination, RNA polymerase I , II and III processing of RNA, RNA editing, RNA stability RNA transport, Antisense RNA.
- c) Genetic code: Triplet codon, Assignment of codons, degeneracy, variation in codon usage, universality.
- d) Protein synthesis: Ribosome structure, Bacterial, Eukaryotic protein synthesis, initiation, elongation and termination.
- e) Post translation Modifications : protein folding role of chaperons, O and N glycosylation fatty acylation, attachment of glycosyl anchor phosphorylation , other modifications.

2) MOLECULAR BIOLOGY:

- a) Central dogma of molecular biology, C-Value paradox, genome size.
- b) Regulation of Gene Expression: Promoters, enhancers, silencers regulatory sequences DNA binding proteins, Operon concept, Lac operon, catabolite repression Negative and positive control, Trp operon, attenuation, antitermination.
- c) **Gene silencing technology (RNA Interference):** Principle of gene silencing, siRNA, siRNA technology, MicroRNA. Applications of RNA interference. Ribozymes.
- d) **Mutations:**
Chromosomal mutations: Deletion, Duplication, Inversion, Translocation and their genetic implications.
Genes mutations: Types of mutations, and Molecular mechanisms of mutations.
Structural mutations: Point mutations – Silent, missense, and nonsense mutations.
Functional mutations: Loss-of-function and Gain-of-function mutations. Causes of mutations. Mutational analysis in vitro and in vivo.
- e) **Genetic Repair mechanisms:** Types of DNA damage; Types of DNA repair mechanisms: Photoreactivation, excision repair, SOS repair, adaptive response, post-replication repair.

3) RECOMBINANT DNA TECHNOLOGY:

- a) Enzymes recombinant DNA technology: Restriction enzymes, DNase, RNase, DNA polymerase, T4 polynucleotide kinase, Phosphatase, reverse transcriptase, DNA ligase, Terminal deoxyribonucleotide transferase.
- b) Cloning vectors: Plasmids, phages, cosmids and phagemids artificial chromosomes (BAC, YAC, HAC) , animal viruses as expression vectors (SV40, Retroviruses , vaccinia virus , Baculoviruses).
- c) DNA libraries: Genomic and DNA libraries, identification of recombinants, genetic selection, insertional inactivation, blue/white selection, colony/plaque hybridization,

electrophoresis, southern blotting, western blotting, polymerase chain reaction (PCR), DNA sequencing.

4) MICROBIOLOGY AND BIOTECHNOLOGY:

Microbiology:

- a) Viruses : Classification, Occurrence, DNA and RNA viruses.
- b) Bacteria: Occurrence , general structure of bacteria classification ,ultra structure of E coli. Recombination in bacteria (conjugation, transduction , sexduction) , cyanobacteria : occurrence , salient features structural organization importance of cyanobacteria.
- c) Microbial metabolism : Bacterial photosynthesis , light and dark reactions, EMP pathway, electron transport chain, anaerobic pathways , mechanism of nitrogen fixation.
- d) Microbial pathogenesis: Viral pathogenesis (influenza) protozoan parasites (plasmodium mechanism infection),Medically important bacteria , mode of infection and pathogenesis of staphylococcus clostridium. Streptococcus, enteropathogenic bacteria , salmonella and mycobacterium.

Biotechnology:

- a) Basic principles of bioprocess, isolation and improvement of industrial important strains fermentation process, types of fermentation, bioreactors.
- b) Plant biotechnology: Genetic manipulation of plants, GM plants (BT cotton, BT brinjal, Golden rice, Flavr savr tomato), GM foods , plant tissue culture, Plant health and diseases, *Arabidopsis thaliana* as a model system.
- c) Animal Biotechnology: Transgenic animals (Drosophila, mouse, fish, and sheep), gene knock out, *invitro* fertilization (IVF) and embryo transfer (ET), somatic cell fusion, Monoclonal antibodies production. Animal cell culture and organ culture, Animal cells as source of Biochemicals (vaccines, Hormones), Stem cells, Gene therapy.
- d) Bio-remediation, Bio-pesticides, Bio-fertilizers, Intellectual Property rights, ethical issues (human and animal rights).

5) BIODIVERSITY AND CONSERVATION:

- a) Concepts of biodiversity : Ecosystem diversity, Genetic diversity, species diversity, types of biodiversity, Modern tools of Taxonomy (alpha beta and gamma level taxonomy), Assessment of biodiversity: Inventorying and monitoring biodiversity, biodiversity indices, hotspots of biodiversity.
- b). Major threats of biodiversity change: Habitat destruction and fragmentation, Overexploitation of natural resources, Population growth, Hunting, Land use, Degradation of aquatic system, Environmental pollution and biodiversity loss. Endemic and extinct species, IUCN red list.

c). Application of molecular and computational tools for phylogeny, DNA bar-coding, Effects of man made alteration on biosphere.

d). Conservation of Biodiversity: principles of conservation approaches of management,

Indian case studies on conservation strategies (project tiger, biosphere reserve), in-situ methods (national parks and sanctuaries), ex-situ methods (captive breeding program, role of zoos and botanical gardens, Gene banks- NBPGR, IPGR, Sperm and egg bank), Indian biodiversity acts, Earth summit, Ramsar conventions.

6) TECHNIQUES IN BIOLOGY:

a) Molecular biology and recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and Plasmid) and proteins separation methods electrophoresis centrifugation, chromatography analysis of RNA DNA and proteins by one and two dimensional gel electrophoresis. Micro array based techniques, isolation separation and analysis of carbohydrate and lipid molecules, RFLP, RAPD and AFLP techniques.

b) Histochemical and immunotechniques: Principals and applications :Antibody generation , detection of molecules using ELISA, RIA ,western blot , immunoprecipitation, Flowcytometry and immunofluorescence, in situ localization by techniques such as FISH and GISH.

c) Biophysical methods : principal analysis of biomolecules using UV/ Visible spectrophotometry, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; different types of mass spectrometry and surface plasma resonance methods, calorimetry.

d) Statistical Methods: Mean, Mode, standard deviation, levels of significance; students t-test, analysis of variance, Chi –square (χ^2) test.

e) Radiolabeling techniques: Properties of different types of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

f) Microscopic Techniques : Principal of different microscopy, Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, Phase contrast microscopy, electron microscopes, fluorescence microscopy.

7) HUMAN HEALTH AND DISEASES:

a) Nutritional basis of health, BMR.

b) Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal cells, alteration of host cell behavior by pathogens. Immune responses during bacterial (tuberculosis) and parasitic (malarial) infections.

c) Cancer: properties of cancer cells, causes of cancer, Protooncogenes and Oncogenes, tumor suppressor genes, multistep process of carcinogenesis. Cancer and cell cycle, Virus induced cancer, apoptosis, therapeutic interventions of uncontrolled cell growth. Genetic rearrangements in progenitor Cells, free radicals, antioxidants and cancer and proteomics and their strategies of anticancer.

- d) Transgenic technology, transgenic animals, molecular approaches to diagnosis and strain identification.
- e) Vaccines, production and applications.
- f) Human genetics: Pedigree analysis, linkage testing, karyotyping, chromosomal disorders, Genetic disorders, Molecular techniques to diagnose genetic defects; Genomics application to health, Gene therapy and genetic counseling.
- g) Addiction: Drug and alcohol, addiction implications and control.

8). ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY:

- a) Basic Concepts of Endocrinology:
 Chemical messengers: Autocrine, Paracrine and endocrine secretions, Types of hormones, an overview of human endocrine system.
 Hormone synthesis: Peptide and steroid hormones. Role of Hormones in homeostasis- Glucose and Water balance.
- b). Physiology of Endocrine glands: Structure and function of endocrine hypothalamus, pituitary gland, chemical structure and control of hypothalamic hormones. Pituitary hormones and their physiological actions. Feedback regulation. Hypothalamo - hypophysial portal system.
 Structure and biosynthesis and actions of hormones of Thyroid and adrenal gland.
 Endocrine pancreas- structure and secretions of hormones and Diabetes mellitus, Gastro intestinal hormones.
- c). Gametogenesis, fertilization and early development: Production of gametes, cells surface molecules in sperm egg recognition, zygote formation, cleavage, blastula formation, gastrulation and formation of germ layer and embryogenesis in sea urchins, amphibians, birds and mammals.
- d). Reproductive system: Functional morphology of mammalian testis, Kinetics of spermatogenesis – wave and cycle, Hormonal control of spermatogenesis, Sperm maturation, morphological and biochemical events, Ultrastructure of spermatozoa, abnormalities of sperm, Biochemistry of semen and capacitation, Structure of mammalian ovary- folliculogenesis and its hormonal control, atresia, ovulation and regulation of corpus luteum. Hormonal control of female reproductive organs. Reproductive cycles- estrous and Menstrous hormonal control of menstrual cycle. hormonal regulation of Pregnancy, Parturition, and Lactation.
- e). Reproductive Health Problems and Strategies: Infertility, Birth control measures, contraception and medical termination of pregnancy, sexually transmitted disease.

9). IMMUNOLOGY:

- a. Types of Immunity: Innate, Acquired and passive immunity.
- b. Cell and Molecules involved in immune system
- c. Complement system, components, pathways and regulation

- d. Antigen, immunogens, antigenicity, immunogenicity, epitopes and their properties.
- e. Structure, Diversity and function of immunoglobulins.
- f. MHC molecules, structure, functions, antigen processing.
- g. Humoral and cell mediated responses
- h. Inflammation and Hypersensitivity
- i. Autoimmunity and immunodeficiencies, AIDS.

10). REPRODUCTION AND DEVELOPMENT IN PLANTS:

- a) Reproduction in Fungi, Algae, Bryophytes, Pteridophytes and Gymnosperms
- b) Asexual reproduction- Zoospore (Chlamydomonas), Conidia (Pencilium).
- c) Vegetative propagation – Definition, methods of propagation: stem and root cutting, runner, sucker, rhizome, offset, bulbil and leafbuds.
- d) Sexual reproduction in flowering plants:-L.S. of flower, Pre fertilization, structure and events, stamen – microsporangium and pollen grain, pistal-megasporangium (ovule) embryosac.
- e) Pollination-kinds of pollinations agents of pollination, Outbreeding device; pollen pistil interaction, artificial hybridization. Double fertilization, post fertilization-structure and events. Endosperm, embryo (monocot and dicot), Apomixis and polyembryony, Parthenocarpy.

11). PLANT BREEDING AND ECONOMIC BOTANY:

- a) History, objectives, Present status and future prospects of plant breeding; Plant breeding as both an art and science. Modes of Reproduction- asexual and sexual. Determination of mode of reproduction and pollination in a species. Mechanism of pollination control. Morphological contrivances promoting allogamy and autogamy, self-incompatibility and male sterility.
- b) Centres of Origin; Domestication- Plant introduction- history and procedure; Germplasm Collection- types, purpose, maintenance, evaluation, achievements, merits and demerits. Continuous variation and its significance- qualitative traits and discrete variation, quantitative traits and continuous variation, polygenes and polygenic inheritance.
- c) Nature of gene action and components of genetic variation: Genotype and environment interaction and adaptation. Methods of selection, population improvement, hybrids and synthetic varieties.
- d) Breeding in self-pollinated crops- hybridization- History, objectives, types procedures, consequences and achievements. Pure lines-origin of variation, Pure line theory, effect of self-pollination on the genotype and achievements in breeding self-pollinated crops; Heterosis-homozygous and heterozygous balance.
Breeding for disease resistance- History, mechanism of variability in pathogens, methods of breeding for disease resistance; polyploidy-types, applications and its limitations.

Economic Botany:

- a) Economic importance of Algae
- b) Cereals and pulses.

- c) Fibre yielding plants.
- d) Oil yielding plants.
- e) Perfume and essential oil yielding plants
- f) Medicinal Plants.
- g) Spices and Beverages.
- h) Timber and wood yielding trees.
- i) Vegetables.

12). APPLIED BIOLOGY:

- a) **Apiculture:** Scope and Importance, Classification of honey bees, species and races of honey bees. Morphology and Structural adaptations of bees, Bee plants, pollen and nectar composition, Pollen calendar, Relationship between floral design and mouth parts of honey bees. Food collection. Social life in bees, Honey and it's chemical composition, properties and medicinal importance, Honey bee pests and Predators, Bee keeping and management, Economics of apiculture.
- b) **Sericulture:** Origin and development of the science of sericulture. Global silk production, silk production in India, economics of silk production, foreign exchange. Morphology and life cycle of *Bombyx mori*. Structure and functions of Silk glands, Silkworm rearing technology: Building, equipments, disinfection, environmental factors, Seed cocoons, preservation, grainage activity, LSPs, egg production, incubation, artificial hatching, seed organization, seed area spacing, feeding, bed cleaning and bivoltine rearing. Silkworm pests and Predators: Uzi fly, Dermestid beetle, ants, lizard, birds and monkey. Silkworm diseases: Protozoan, Fungal, Viral and Bacterial diseases and their control measures. Non-mulberry silkworms: Types, morphology and life cycle, rearing and tribal welfare, spinning, harvesting, transportation, testing and marketing of cocoons and silk reeling.
- c) **Aquaculture:** Scope and status of Aquaculture, Techniques of culturing fishes Carps (Indian major & minor carps), trouts, catfishes, ornamental fishes, shell fishes (prawns, pearl oysters). Breeding and seed production of important fishes, Aquaculture systems: Inland farms, tanks, pens and cages, Nutrition and feeds, Fish diseases and their control, Fish Farm management and economics.

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