NATURAL SCIENCE

PART A

Module I : Renaissance and freedom movement

Module II: General Knowledge and current affairs

Module III: Methodology of teaching the subject

♦ History/conceptual development. Need and Significance, Meaning Nature and Scope of the Subject.

♦ Correlation with other subjects and life situations.

♦ Aims, Objectives, and Values of Teaching - Taxonomy of Educational Objectives - Old and revised

♦ Pedagogic analysis- Need, Significance and Principles.

♦ Planning of instruction at Secondary level- Need and importance. Psychological bases of Teaching the subject - Implications of Piaget, Bruner, Gagne, Vygotsky, Ausubel and Gardener - Individual difference, Motivation, Maxims of teaching.

♦ Methods and Strategies of teaching the subject- Models of Teaching, Techniques of individualising instruction.

♦ Curriculum - Definition, Principles, Modern trends and organizational approaches, Curriculum reforms - NCF/KCF.

♦ Instructional resources- Laboratory, Library, Club, Museum- Visual and Audio-Visual aids - Community based resources - e-resources - Text book, Work book and Hand book.

♦ Assessment; Evaluation- Concepts, Purpose, Types, Principles, Modern techniques - CCE and Grading- Tools and techniques - Qualities of a good test - Types of test items- Evaluation of projects, Seminars and Assignments - Achievement test, Diagnostic test – Construction, Characteristics, interpretation and remediation.

♦ Teacher - Qualities and Competencies - different roles - Personal Qualities - Essential teaching skills - Microteaching - Action research.

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PART B

Module - I
ANIMAL DIVERSITY

I Whittaker's five Kingdom Classification:

Kingdom Protista - Salient features

Parasitic Protozoans

e.g. Entamoeba histolytica, Trypanosoma gambiense, Plasmodium vivax } Morphology, Life history, Pathogenicity, Prophylactic measures

Kingdom Animalia

Levels of organization - Cellular, Tissue, Organ, Coelom, Symmetry

Phylum Non-Chordata :

Phylum Coelenterata

General characters

Classes: (1) Hydrozoa e.g. Obelia
(2) Scyphozoa e.g. Aurelia
(3) Anthozoa e.g. Sea anemone

Polymorphism in Coelenterata

Phylum Platyhelminthes:-

General characters

Classes (1) Turbellaria e.g. Planaria
(2) Trematoda e.g. Fasciola
(3) Cestoda e.g. Taenia solium

Phylum Nematoda :

General characters

e.g. Ascaris, Ancylostoma, Enterobius, Wuchereria

Phylum Annelida

General characters

Classes (1) Polychaeta e.g. Arenicola
(2) Oligochaeta e.g. Nereis
(3) Hirudinea e.g. Hirudinaria

Vermiculture (brief account)

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Phylum Arthropoda

General characters

Classes (1) Crustacea e.g. Penaeus
(2) Insecta e.g. Honey bee
(3) Merostomata e.g. Limulus
(4) Myriapoda e.g. Centepede

Phylum Onychophora

Peripatus – Affinities, Distribution

Social Organization : Honey bee (mention caste system)
Economic Importance : Sericulture.

Phylum Mollusca

General characters

Classes (1) Amphineura e.g. Chiton
(2) Bivalvia e.g. Perna
(3) Scaphopoda e.g. Dentalium
(4) Gastropoda e.g. Pila
(5) Cephalopoda e.g. Sepia

Economic Importance : Pearl culture

Classes: (1) Asteroidea e.g. Asterias
(2) Ophiuroidea e.g. Ophiothrix
(3) Echinoidea e.g. Echinus
(4) Holothuroidea e.g. Sea cucumber
(5) Crinoidea eg. Sea lily (Antedon)

II PHYLUM CHORDATA

General characters

Sub phyla (1) Urochordata : e.g. Ascidia
(2) Cephalochordata e.g. Amphioxus
(3) Vertebrata . General characters.

Divisions (1) Agnatha – General character e.g. Petromyzon
(2) Gnathostomata - General characters.

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Superclass :

(1) Pisces . General characters, Classification

Class (1) **Chondrichthyes** e.g. Scoliodon

Class (2) **Osteichthyes** e.g. Sardinella

(2) Tetrapoda Salient features/ General characters.

Classes : (1) Amphibia : General characters

Orders (1) Urodela : e.g. Ambystoma
(2) Aneura : e.g. Hyla, Bufo
(3) Apoda : e.g. Ichthyophis

(2) Reptilia : General characters,
Common examples: Calotes

Identification of venomous and non-venomous snakes.

(3) Aves : General Characters

Common examples: Emu, Pavo

Migration of Birds

(4) Mammalia : General characters

Common examples: Rattus

Dentition in Mammals.

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Module II

I. PHYSIOLOGY, BIOCHEMISTRY & DEVELOPMENTAL BIOLOGY

1) Physiology :

- **Nutrition :**

Types, Balanced diet, Nutritional disorders – Vitamin deficiency diseases, life style diseases, role of fibres, nervous & neuronal control of digestion.

- **Circulation :**

Blood and its composition, blood group, blood clotting mechanisms, anticoagulants, heart beat, pacemaker and conducting system of heart, blood pressure, pulse, common cardiovascular diseases – ECG, angiogram, angioplasty.

- **Respiration :**

Gas exchange, respiratory pigments, Haemoglobin, Transport of respiratory gases – Regulation of respiration - Respiratory disturbances – Apnoea, dyspnoea, hypoxia, hyper and hypo capnia, asphyxia, CO poisoning, asthma

- **Excretion :**

Nephron – Structure, Urine formation, role of kidney in osmoregulation, composition of urine, abnormal constituents of urine, renal disorders – nephritis, haematuria, renal calculi, acidosis and alkalosis, Dialysis.

- **Muscle Physiology :**

Types of muscles, Ultrastructure of striated muscle fibre, Muscle proteins, Muscle twitch, All or none law, Rigor mortis, Physiological and biochemical changes in muscle contraction.

- **Nerve Physiology :**

Structure of neuron, types; Synapse – types, nerve impulse propagation, Synaptic transmission, Reflex action, Neurotransmitters, EEG. Nerve disorders – epilepsy, Parkinson's diseases, Alzheimer's.

- **Endocrinology :**

Endocrine glands in man, hormones and disorders, mechanism of hormonal activity.

2 **Biochemistry:**

Biomolecules – Carbohydrates, Proteins, lipids and nucleic acids – structure and classification with examples.

- **Metabolism :**

Carbohydrate– glycogenesis, glycogenolysis, glycolysis, Kreb's cycle Electron Transport Chain.

- **Lipid:**

Beta Oxidation – Protein – deamination, transamination, Urea formation -

- **Enzymes:**

Mechanism of enzyme action, factors affecting enzyme action, Isoenzyme, Coenzyme, enzyme inhibition and activation.

3. Developmental Biology

Theories :

Preformation, Epigenesis, Recapitulation and Germplasm.

- Spermatogenesis, Oogenesis, Typical egg and Sperm.
- Types of eggs.

Fertilization :

Agglutination, Amphimixis, Physiological and biochemical changes during and after fertilization, Parthenogenesis, Artificial Parthenogenesis – Arrhenotoky, Thelytoky, Obligatory and facultative; Significance of fertilization and Partheogenesis.

Cleavage :

Types, Morula, blastula (different types), fate maps. Gastrula – Morphogenetic movements – concept of germ layers.

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Cell differentiation :

Unipotency, Pleuri and totipotency, Gene action – Homeotic genes, Hox genes.

Development:

- Man – Implantation, Pregnancy, Placentation – Different types, function.

Teratology:

Definition, Causes of infection, drug and chemicals, metabolic imbalance, ionizing radiation, malnutrition, auto immunization.

Experimental Embryology:

Spemann's constrtiction experiment, Organizer and embryonic Induction, IVF and embryo transfer in man, cloning experiment in animals – Prenatal diagnosis – Amniocentesis, Chorionic villus sampling, ultrasound scanning, stem cells – embryonic and adult – Stem cell therapy.

Module – III

CELL AND MOLECULAR BIOLOGY, GENETICS, BIOTECHNOLOGY AND BIOINFORMATICS

CELL BIOLOGY :

Development and Scope, Cell theory and its Modern version.

Types of Cells: Prokaryotic and Eukaryotic. Ultra structure and functions of Plasma membrane, Plasma membrane model – fluid mosaic, Functions, Membrane transport, Cell communication - Modifications of Plasma membrane.

Cell organelles :

Nucleus - Structure, Interphase, nuclear envelope – functions.

Nucleolus - Structure, nucleolar organizer and functions.

Mitochondria - Structure and function, Oxidative phosphorylation.

Endoplasmic reticulum - Structure and function , types.

Lysosomes - Morphology, Polymorphism and functions.

Ribosomes - Different types – sub units, functions.

Centrioles and basal bodies – Structure and function.

Microbodies – Peroxisomes, glyoxisomes, funcions.

Cell division

MOLECULAR BIOLOGY :

Gene expression : Central dogma in Molecular Biology, One gene – one enzyme, one gene – one polypeptide hypotheses.

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Genetic code - Wobble hypothesis.

Contributions of Khorana, Nirenberg and associates, RNA polymerase, chaperones, protein synthesis.

Gene regulation: Operon concept – Lac and Trp operon.

Bacterial Recombination : - Transformation, Conjugation and Transduction.

GENETICS AND BIOTECHNOLOGY :

Human Genetics: Karyotyping, pedigree analysis, chromosomal anomalies in man

a) Autosomal (e.g. Down syndrome, Edwards syndrome)

b) Allosomal (e.g. Turners and Klinefelters syndrome)

Biochemical genetics:

Disorders Phenylketonuria, alkaptonuria, albinism, tyrosinosis.

Biotechnology: -

Scope of Biotechnology, Recombinant DNA Technology, Techniques in gene cloning, restriction endonucleases, ligases, major steps in cutting and joining of DNA, Probes, linkers.

Blotting Techniques

Southern, Northern and Western, DNA finger printing.

Genomic library

cDNA library, PCR, DNA sequencing

Human Genome Project

Hybridoma and monoclonal antibodies, transgenic organisms.

Practical applications

Medicine, agriculture, industry, pollution control, forensic & judiciary.

Potential hazards of Biotechnology.

IMMUNOLOGY AND MICROBIOLOGY

Immunology:

Immunity : Definition, Types.

Immune System :

Primary and Secondary.

Immunogens:

Antigens – Definition, types.
Antigen – antibody reactions.

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Immune responses :

Allergy – Classification.
AIDS, Autoimmunity, Vaccines.

MICROBIOLOGY:

Survey of microbes – Viruses – Prions, Viroids, Bacteria, Protozoa.

- Applied microbiology in various fields.
  Microbial diseases in man.

Module IV

ECOLOGY, ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY

ECOLOGY

Population ecology :- Properties of Population, emigration, immigration and migration, population fluctuation.

Community ecology :- Definition, Species diversity.

Wildlife conservation and Management

Threatened Species, Red data book, IUCN, WWF, CITES, Green Peace, Biosphere reserve, National Park, Sanctuaries, forests in India, importance of mangroves, hotspots. Ecosystem – Conservation and management.

Ethology

Motivation, Learning – types, socio biology, pheromones, human pheromone.

Evolution

- Geological time scale, fossils, fossil dating and significance of fossils.
- Genetic drift, genetic equilibrium, Hardy-Weinberg law, punctuated equilibrium.
- Speciation – Sympatric and allopatric; adaptive radiation.

Zoogeography

Animal distribution – Different types, factors affecting distribution.
Zoogeographical realms – Brief account of each realm
Biogeographical classification of India – Eastern and Western Ghats.

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Module V

MICROBIOLOGY

Bacteria: Ultra structure, reproduction, genetic recombination, economic importances (Industrial uses, food preservation and spoilage, biopesticides, biofertilizers, sewage treatment, nitrogen fixation and symbiosis), staining techniques

Viruses: structure and reproduction – RNA and DNA viruses, bacteriophages, TMV and HIV

MYCOLOGY AND LICHENOLOGY

Fungi: General characteristics, reproduction and life cycle, heterothallism and parasexuality

Distinguishing characters of different classes of fungi representing the following genera: Mastigomycotina (Pythium), Zygomycotina (Rhizopus), Ascomycotina (yeast), Basidiomycotina (Agaricus) and Deuteromycotina (Cercospora)

Economic importances of fungi: industrial, medicinal, food and agriculture (Biofertilizers and Biocontrols)

Lichens: Economic and ecological importances, habit of crustose, foliose and fruticose lichens – homomerous and heteromerous

General account and economic importance, structure, reproduction and lifecycle of Usnea.

PLANT PATHOLOGY

Principles of plant pathology – biotic and abiotic causes of plant diseases

Classification of plant diseases on the basis of causative organisms and symptoms:

Transmission and spread of diseases – quarantine regulations – disease control measures

Study of the following diseases – causal agent, symptoms, etiology and control measures : Tapioca mosaic disease, Citrus canker, Blast of paddy

BRYOLOGY

Structure, reproduction and life cycle of the following types: Hepaticopsida (Riccia), Anthoceratopsida (Anthoceros), Bryopsida (Fuaria)

Economical importances of bryophytes

PTERIDOLOGY

Structure, reproduction, life cycle and affinities of following types: Psilotum (Psilopsida), Selaginella (Lycopsida), Equisetum (Sphenopsida) and Marsilea (Pteropsida)

Heterospory and seed habit

Affinities of pteridophytes with bryophytes and gymnosperms

Economic importances of pteridophytes - Biofertilizer

GYMNOSPERMS

General characters, structure (external and internal), reproduction and life cycle of following gymnosperms – Cycas, Pinus, Gnetum

Origin and evolution of gymnosperms and their affinities with pteridophytes and angiosperms

Economic importances of gymnosperms

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PALAEOBOTANY

Objectives of palaeobotany, geological time scale, methods of fossilization, fossil pteridophyte (Rhynia)

Module VI

MORPHOLOGY

Description of various types of leaves, stem, inflorescence (racemose, cymose and mixed type), fruit (simple, multiple and aggregate) placentations (axile, marginal, free-central)

Seeds and seed dispersal

SYSTEMATICS

Objectives and importances of systematic

Systems of classification: Artificial (Linnaeus), Natural (Benthem and Hooker), and Phylogenetic (Engler and Prantl)

Detailed study of Benthem and Hooker Classification

Principles and rules of plant nomenclature, ICBN

Taxonomic structure – hierarchial concept (Type, species, genus, family)

Recent trends in taxonomy: cytotaxonomy, chemotaxonomy, numerical taxonomy, molecular taxonomy

Taxonomic information resources: herbaria, botanical gardens, BSI, taxonomic literature: floras, manuals and monographs

Study the following families: Annonaceae, Malvaceae, Rutaceae, Leguminosae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Orchidaceae, Poaceae

ECONOMIC BOTANY

Botanical name, family, morphology of useful part of the following:

Cereals: Wheat, ragi

Pulses: Black gram, Bengal gram

Sugar: Sugar cane

Spices: Cardamom, black pepper, nutmeg

Tubers: Tapioca

Fibre: Coir, cotton, jute

Latex: Rubber

Beverages: Coffee

Medicinal: Adhatoda, Catheranthus, Rauvolfia, Phyllanthus, Neem

ANATOMY

Typical structure of a plant cell

Non-living inclusions of plant cells – cystolith, raphides, aleuron grains, starch grains

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Tissues: Meristematic, permanent and complex tissues

Roots and shoot apex organization

Primary and secondary structure of root, stem (monocot and dicot)

Anatomy of monocot and dicot leaf

Stomata – structure – dicot and monocot

Nodal anatomy

Structure of secondary wood – phellem, phellogen and phelloderm, lenticels and annual rings

Anomalous secondary growth – Boerhaavia, Bignonia and Dracaena

EMBRYOLOGY

Microsporogenesis: Development of microsporangia, and male gametophyte

Megasporogenesis: Development of megasporangia and female gametophyte

Types of ovules: orthotropous, anatropous, campilotropous

Fertilization and endosperm formation

Endosperm formation: nuclear, cellular and helobial

Embryo – dicot and monocot embryo, polyembryony, apomixes, apospory and parthenocarpy

CROP IMPROVEMENT

Objectives of plant breeding

Breeding techniques and achievements

Introduction and acclimatization

Selection - pure line selection, mass selection and clonal selection

Hybridization

Heterosis and inbreeding depression

Polyploidy breeding

Mutation breeding

Plant Propagation methods: Cutting, Budding, Grafting and Layering

Module VII

PLANT PHYSIOLOGY

Water in relation to plants: Water potential, diffusion, osmosis, DPD, turgor pressure, osmotic pressure, exosmosis, endosmosis, plasmolysis

Transpiration: Mechanism of guard cell movement, role of K ions, anti-transpirants

Mechanisms of water absorption, passive and active

Translocation of water: transpiration pull

Water stress and physiological consequences

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Mineral nutrition – essential and non-essential elements and their role in growth and development

Mechanism of mineral absorption- active, passive and fecilitated

Photosynthesis: chloroplast as photosynthetic apparatus, light phase, cyclic and non-cyclic photophosphorylation, dark reaction, C3, C4 and CAM path ways, photorespiration

Translocation of photosynthates: phloem transport, phloem loading and un-loading

Growth and Development : Concept of hormone and growth regulators on plant, hormones and their action: auxins, GA, cytokinines, ABA, ethylene

Photoperiodism, and vernalization

Photomorphogenesis, phototropism, gavitropism,

Nyctinastic, Seismonastic movement

METABOLISM AND BIOCHEMISTRY

Biological nitrogen fixation, symbiotic nitrogen fixation, biochemistry of nitrogen fixation and genetics of nitrogen fixation

Biosynthesis of amino acids, reductive amination and transammination, GS/GOGAT pathways

Oxidation of fatty acids, alpha and beta oxidation of fatty acids, cellular respiration of proteins

CELL BIOLOGY

Chromosomes, morphology, telomere, satellite, primary and secondary constrictions, nuclear organizer, chromosome banding, heterochromatic and euchromatic, nucleosomes, polytene and lampbrush chromosomes, chromosomal aberrations – deletion, duplication, inversion and translocation

Numerical aberrations: anueploidy and euploidy

Cell cycle: mitosis and meiosis, significances of meiosis

GENTICS AND MOLECULAR BIOLOGY

Mendel's experiments, symbols, terminology, Mendalian laws, Monohybrid cross, Dihybrid cross, backcross, Test cross, Modified Mendelian ratios inter actions of genes, epistasis, Complementary genes, Inhibitary genes, quantitative inheritance

Multiple alleles- Self sterility in nicotiana

Linkage and crossing over- 2 point and 3 point crosses, Linkage maps, Interference and co-incidence

Sex determination and Sex linked inheritance

XX-XY type, XX- XO type, Sex determination plants, criss cross inheritance, Sex limited and sex influenced traits

Extra nuclear inheritance plastid inheritance in mirabilis, coiling of shells in snails

Mutation- Types, Mutagens, Physical and Chemical, Molecular basis of Mutations, transitions, transversion, frameshift

Nucleic acids- DNA, RNA – Evidence of DNA as genetic material DNA structure Watson and Cricks model, types of DNA, A,B,Z, RNA structure types (mRNA, tRNA, rRNA)

DNA replication, enzymology of DNA replication, semi conservative mode, Meselon and Stahls

experiments, molecular mechanism of replication

Gene Expression- Genetic Code, transcription in Prokaryote and Eykaryote

Post transcriptional modifications, translation, teminism

EVOLUTION

Molecules and origin of lives, evolution of Prokaryotic and Eukaryotic cells, Mitochondrial and endosymbiotic theory, Chloroplast and endosymbiotic theory.

Theories on origin and evolution of species, Lamarkism, Darwinism, Weismann, Devries, Neo Darwinism

Module VIII : ENVIRONMENTAL BIOLOGY

Ecosystem

Intorduction- Basic principles and concepts of ecology and environment – Interdisciplinary approach-Scope and relevance ot society and human environment. Need for public awareness- Ecosystem-Definition, ecosystems- concept of an ecosystem – structure and function of an ecosystem. A) Abiotic factors: Climate shapes the character of ecosystem- Edaphic factors- B) Biotic factors-, food chain Food web and ecological pyramids. Biogeochemical cycle: Gaseous-Carbon, Oxygen & Nitrogen. Hydrological- Water-Ecological succession- definition, types, causes of succession, process of succession. Hydrosere and Lithosere. Ecological groups of plants: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites (brief account only)

Natural resources

Renewable and non-renewable resources. Natural resources and associated problem. Forest resources-deforestation, aforestation, - conservation- protection forestry-chipko movement- production-commercial forestry-social forestry, Agroforestry- timber extraction, mining, dams and their effects on forest, and tribal people-mineral resources- Environmental effects of extracting and using mineral resources- Water resources-use and overuse of surface water and ground water-floods, droughts- Food resources –World food problems- Energy resources.

Social issues and the environment

Environmental pollution a) Definition, causes-effects and control measures. Types of pollution- Soil, Air, Water, Solid wastes-management- radioactive, noise & thermal pollution. Role of an individual in prevention of pollution. Pollution case studies. Role of pollution control board- Urban problems related to energy. Water conservation- Rain water harvesting and water shed management. Resettlement and rehabilitation of people- its problems and concerns. Environmental ethics: issues and possible solutions- Climate change and Global warming, acid rain, ozone layer depletion, nuclear accidents-Wasteland reclamation, Issues involved in enforcement of environmental legislation- Public awareness-Human population and environment- Population growth, variation among nations. Population explosion- Family welfare program. Environment and human health: Human rights- The Ecological crisis- industrialization- the human transformation of the earth- human activity is placing the biosphere under increasing stress growth of the world economy- urbanization- the vulnerable planet. World Earth summits and protocols- Rio, Kyoto. Johannesberg. The failure of ecological reforms-

Biodiversity and Conservation

Biodiversity-Concepts of biodiversity- Types of biodiversity- biodiversity in India. India as mega diversity nation- hotsposts of biodiversity, threats to biodiversity- Conservation of biodiversity- The conservation strategies are multidimensional- National parks, wildlife sanctuaries.

TISSUE CULTURE AND BIOTECHNOLGY

Plant Tissue culture

Plant Tissue Culture- History, Principle – Totipotency, differentiation, dedifferentiation, redifferentiation. Tissue culture laboratory, Media- MS medium composition, Preparation, Sterilization techniques, Ex-plant selection, sterilization and Inoculation. Types of culture- Meristem culture, Organ culture; Sterilization and Inoculation.

Recombinant DNA and Molecular cloning-

Cloning vectors – Plasmids-Bacteriophages PBR322, PUC, phage. Artificail chromosome vectors-BAC, YAC, Shuttle vectors. Consruction of recombinant DNA methods.

Gene transfer technique- Vector method. Agrobacterium mediated gene transfer- Ti and Ri Plasmids; Direct DNA uptake- Electroporation – shot gun method-microinjection, lipofection.. Herbicide Resistance- drought resistance- enrichment of storage protein , Improvement of the nutritional quality of seeds.

Biotechnology and Bio ethics- Gene therapy

GMOs food safety, environmental and Biosafety issues, Concerns, Role of multi national companies in biotechnology- Agribusiness- Golden Rice, Terminator Genes. Economical and Legal issue. Bio Ethics-Patenting

Bioinformatics

Bioinformatics- Introduction, scope and fields of application.

Major databases in Bioinformatics:

Nucleotide sequence databases-EMBL, DDBJ, Genbank; Protein sequence databases swiss Prot, PIR,

Database Search Engines- Entrez at NCBI of USA, SRS at EBI of England. Sequence Similarity Search:

Pair wise sequence alignment- BLAST, FASTA; Multiple sequence alignment-CLUSTALW, CLUSTAL X

Homology modeling of protein, structure prediction- Protein Data Bank. Similarity search.

Microarrays, Proteomics, Genomics and Application of bioinformatics.

Microtechnique- Principles of Microscopy, micrometry, Killing and fixing, Dehydration, Embedding, Staining, Clearing, Mounting media, wholemount, maceration.

Biostatistics- Measures of Central tendency- Arithmetic Mean, Median, Mode; Measures of Dispersion- Range, Standard Deviation, Standard Error; Correlation and Regression, Analysis of variance ANOVA; Application of Biostatistics.

Design of Experiment- Data collection, representation and interpretation, observation direct and indirect observations, controlled and uncontrolled observations, Human and machine observations.

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