PHYCOLOGY AND MICROBIOLOGY

UNIT I **Introduction to microbial world**

General account of the Darwin's theory of evolution; the evolution of populations, concepts of species, Mechanism of speciation; Microbial nutrition, growth and metabolism. Economic importance and scope of viruses and bacteria.

UNIT II **Viruses**

Discovery, general structure, physiochemical and biological characteristics; classification (Baltimore), viroids and prions; replication (general account), DNA virus (T-phage), lytic (*T4 phage*) and lysogenic cycle (*Lambda phage*); RNA types: RNA virus (TMV), Retro virus *(HIV),* DNA virus *(coliphage).*

UNIT III **Bacteria** Discovery, general characteristics; Bergey's classification of bacteria; Shapes of bacteria; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction), bacterial genome and plasmid, gram positive and gram negative bacteria.

UNIT IV **Algae** I

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch; Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith). Economic importance of algae.

UNIT V **Algae II**

General characteristics, occurrence, range of thallus organization, reproduction and life cycle of Cyanophyta (*Nostoc*), Xanthophyta (*Vaucheria*), Chlorophyta (*Oedogonium*), Charophyta (*Chara*), Phaeophyta (*Ectocarpus*) and Rhodophyta (*Polysiphonia*)

BIOMOLECULES AND CELL BIOLOGY

UNIT I **Biomolecules 1**

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Lipids: Definition and principle classes of lipids. Storage, metabolic and structural lipids; Fatty acids Types, structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

UNIT II **Biomolecules 2**

Proteins: Structure and classification of amino acids; Levels of protein structure primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, C and Z types of DNA; Types of RNA; Structure of tRNA.

UNIT III **Bio energetic & enzymes**

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

UNIT IV **The cell**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.

UNIT V **Cell organelles**

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure and function. Golgi Apparatus – structure and function. Lysosomes- structure and function.

MYCOLOGY AND PHYTOPATHOLOGY

UNIT I **Introduction to true fungi, Chytridiomycota and Zygomycota**

General characteristics; Ecology, Nutrition; Classification, economic importance of fungi, Mushroom Cultivation

Chytridiomycota and Zygomycota: Characteristic features; significance; Reproduction; Life cycle with reference to *Synchytrium, Rhizopus*.

UNIT II **Ascomycota & Basidiomycota**

Ascomycota: General characteristics (asexual and sexual fruiting bodies); Life cycle of Saccharomyces, Aspergillus, Penicillium and Alternaria

Basidiomycota: General characteristics; Life cycle of *Puccinia* (Physiological Specialization), Agaricus life cycle; Bioluminescence, Fairy Rings.

UNIT III **Allied Fungi, Oomycota & Symbiotic associations**

General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

UNIT V **Applied Mycology**

Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

UNIT V **Phytopathology**

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker Viral diseases – Tobacco Mosaic viruses.

Algal disease- tea rust

Fungal diseases – Early & late blight of potato, Black stem rust of wheat.

Loose and covered smut (symptoms only)

ARCHEGONIATE

UNIT I **Introduction to Bryophytes & Pteridophytes**

Unifying features of archegoniates; Transition to land habit; Alternation of generations. Bryophytes-General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Pteridophytes- General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

UNIT II **Type Studies- Bryophytes** Classification (up to family), morphology, anatomy, reproduction and evolutionary trends of *Marchantia, Anthoceros, Sphagnum and Funaria*; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

UNIT III **Type Studies- Pteridophytes**

Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory and seed habit, telome theory, Stelar evolution; Ecological and economic importance.

UNIT IV **Gymnosperms**

General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

UNIT V **Paleobotany**

Geological time scale, fossil types and their formation, general account of dominant fossil flora of different ages, paleobotany in relation to exploration of fossil fuels

ANATOMY OF ANGIOSPERMS

UNIT I **Introduction, Structure and Development of Plant Body**

Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cyto-differentiation and organogenesis during embryogenic development.

UNIT II **Tissues**

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

UNIT III **Apical meristems**

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap;
Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

UNIT IV **Vascular Cambium and Wood**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

UNIT V **Adaptive and Protective Systems**

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

ECONOMIC BOTANY

NIT I **Origin of Cultivated Plants; Sources of sugars and starches**

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.
sugars and starches -Morphology and processing of sugarcane, products and byproducts of sugarcane industry. Potato – morphology, propagation & uses.

UNIT II **Cereals & Legumes: Spices & Beverages**

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.
Legumes- Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.
Listing of important spices, their family and part used. Economic importance with special reference to black pepper, ginger, turmeric and chillies.
Beverages- Tea, Coffee (morphology, processing & uses)

UNIT III **Agro ecosystem**

Agro-ecosystem in Nagaland. Jhum cultivation, terrace cultivation, water harvesting methods, irrigation methods, types of crops grown, cropping system, land use pattern and its importance to ecosystem.

UNIT IV **Sources of oils and fats; Natural Rubber**

General description, classification, extraction, their uses and health implications of groundnut, linseed, soyabean, mustard and coconut (Botanical name, family & uses).
Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
Natural Rubber -Para-rubber: tapping, processing and uses.

UNIT V **Drug-yielding plants, Timber plants & Fibers**

Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).

Timber plants-General account with special reference to teak and pine.
Fibers-Classification based on the origin of fibers; Cotton, Nettle, Coir and Jute (morphology, extraction and uses).

CORE 7 (BOC 3.31) GENETICS

UNIT I **Mendelian genetics and its extension**

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

UNIT II **Extrachromosomal Inheritance**

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects- shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

UNIT III **Linkage, crossing over and chromosome mapping**

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

UNIT IV **Variation in chromosome number and structure; Gene mutations**

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy *Gene mutations* -Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Baseanalogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms.

UNIT V **Fine structure of gene; Population and Evolutionary Genetics**

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.
Population and Evolutionary Genetics - Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

MOLECULAR BIOLOGY

UNIT I **Nucleic acids: Structures of DNA and RNA**

Historical perspective; DNA as the carrier of genetic information DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure_Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome_Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Central dogma, Genetic code (deciphering & salient features**)**

UNIT II **The replication of DNA**

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

UNIT III **Transcription**

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

UNIT IV **Processing and modification of RNA**

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport.

UNIT V **Translation** Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

PLANT ECOLOGY AND PHYTOGEOGRAPHY

UNIT I **Introduction; soil & water**

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. Soil- Importance; Origin; Formation, Composition; Physical, Chemical and Biological components. Soil profile; Role of climate in soil development. Water- Importance: States of water in the environment, Atmospheric moisture, Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle, Water in soil, Water table.

UNIT II **Light, temperature, wind and fire. Biotic interactions**

Light, temperature, wind and fire- adaptations of plants to their variation. *Biotic interactions*- Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism.

UNIT III **Population ecology and plant communities**

Characteristics and Dynamics. Ecological Speciation *Plant communities*-Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

UNIT IV **Ecosystems & Functional aspects of ecosystem**

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. *Functional aspects of ecosystem*- Principles and models of energy flow, Productivity, biomass, standing crop. Ecological efficiencies, Biogeochemical cycles-Cycling of Carbon, Nitrogen and Phosphorus.

UNIT V **Phytogeography**

Principles of Continental drift, Theory of tolerance, Endemism. Brief description of major terrestrial biomes (one each from tropical, temperate & tundra). Phytogeographical division of India with special reference to North East region of India.

PLANT SYSTEMATICS

UNIT I **Significance of Plant systematics**

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

UNIT II **Angiosperm taxonomy**

Critical study of the following families with emphasis on identification of local members using flora, economic importance, interrelationship and evolutionary trends- *Dicots*; Magnoliaceae, Brassicaceae, Ranunculaceae, Rutaceae, Fabaceae, Meliaceae, Lamiaceae, Euphorbiaceae, Solanaceae, Cucurbitaceae, Asteraceae.
Monocots; Orchidaceae, Poaceae, Zingiberaceae

UNIT III **Taxonomic hierarchy & Taxonomical nomenclature**

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). *Botanical nomenclature*- Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

UNIT IV **Systems of classification**

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

UNIT V **Phylogeny of Angiosperms & Biometrics, numerical taxonomy and cladistics**

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals. Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

UNIT I **Introduction; reproductive biology**

History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope. *Reproductive development*-Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

UNIT II **Anther and pollen biology**

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

UNIT III **Ovule**

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

UNIT IV **Pollination and fertilization; self incompatibility**

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. *Self incompatibility* -Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

UNIT V **Embryo, Endosperm, Seed, Polyembryony and apomixis**

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Endosperm haustoria, Suspensor: structure and functions; Embryoendosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia.* Seed structure, importance and dispersal mechanisms *Polyembryony and apomixis* -Introduction; Classification; Causes and applications.

PLANT PHYSIOLOGY

UNIT I **Plant-water relations**

Water Potential and its components, water absorption by roots, pathway of water movement- symplast, apoplast, transmembrane pathways, aquaporins. Ascent of sap–cohesion-tension transpirational pull theory, Root pressure. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement, guttation.

UNIT II **Mineral nutrition**

Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

UNIT III **Nutrient Uptake & translocation in the phloem**

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport. *Translocation in the phloem* -Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

UNIT IV **Plant growth regulators**

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

UNIT V **Physiology of flowering: Phytochrome, cryptochromes and phototropins**

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. *Phytochrome, cryptochromes and phototropins* - Discovery, chemical nature, role in photomorphogenesis, Low Energy Responses (LER) and High Irradiance Responses (HIR), mode of action.

CORE 13 (BOC 6.11) PLANT METABOLISM

UNIT I **Concept of metabolism: Carbohydrate metabolism**

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).
Carbohydrate metabolism- Synthesis and catabolism of sucrose and starch.

UNIT II **Carbon assimilation**

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C_3 & C4 pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.

UNIT III **Carbon Oxidation**

Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

UNIT IV **ATP-Synthesis & Mechanisms of signal transduction**

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.
Mechanisms of signal transduction- Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

UNIT V **Lipid & nitrogen metabolism**

Synthesis and breakdown of triglycerides, β-oxidation, α-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination.

Nitrogen metabolism- Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

PLANT BIOTECHNOLOGY

UNIT I **Plant Tissue Culture**

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

UNIT II **Recombinant DNA technology**

Restriction Endonucleases (History, Types, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic; Eukaryotic Vectors (YAC).

UNIT III **Gene Cloning**

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

UNIT IV **Methods of gene transfer**

Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

UNIT V **Applications of Biotechnology**

Pest resistant (Bt-cotton); herbicide resistant plants (Round-Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.