DAVANGERE UNIVERSITY

DAVANGERE-577007

COURSE SCHEME
AND
SYLLABUS FOR

MASTER OF SCIENCE
DEPARTMENT OF STUDIES IN BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM
(2017-18 onwards)

SHIVAGANGOTRI

DAVANGERE UNIVERSITY

DAVANGERE-577007

DAVANGERE UNIVERSITY
DEPARTMENT OF BIOTECHNOLOGY
Shivagangothri, Davangere - 577 007

M.Sc. in Biotechnology

Semester scheme with Choice –Based Credit System

(CBCS) Course Structure

I Semester

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-1.1	Cell Biology	4	4	75	25	**100**
	Theory BT-1.2	Genetics	4	4	75	25	**100**
	Theory BT-1.3	Microbiology	4	4	75	25	**100**
Supportive	Theory BT-1.4	Biochemistry	4	4	75	25	**100**
Core	Practical BT-1.5	Cell Biology	4	2	50	-	**50**
	Practical BT-1.6	Genetics	4	2	50	-	**50**
	Practical BT-1.7	Microbiology	4	2	50	-	**50**
Supportive	Practical BT-1.8	Biochemistry	4	2	50	-	**50**
		Total		24	Marks		**600**

Internal Assessment for papers:

1) Two sessional tests of 05 marks each : 10 Marks
2) Seminar/Tutorial /Group discussion : 05 marks
3) Assignment/Field work/Submission of specimen : 05 marks
4) Attendance : 05 Marks

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Total: 25 Marks

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M.Sc. Biotechnology II Semester

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-2.1	Molecular Biology	4	4	75	25	**100**
	Theory BT-2.2	Immunology	4	4	75	25	**100**
	Theory BT-2.3	Metabolism	4	4	75	25	**100**
Supportive	Theory BT-2.4	Biophysics, Bioinformatics and Biostatistics	4	4	75	25	**100**
Core	Practical BT-2.5	Molecular Biology	4	2	50	-	**50**
	Practical BT-2.6	Immunology	4	2	50	-	**50**
	Practical BT-2.7	Metabolism	4	2	50	-	**50**
Supportive	Practical BT-2.8	Biophysics, Bioinformatics and Biostatistics	4	2	50	-	**50**
		Total		24	Marks		**600**

M.Sc. Biotechnology III Semester

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-3.1	Genetic Engineering	4	4	75	25	**100**
	Theory BT-3.2	Microbial Biotechnology	4	4	75	25	**100**
	Theory BT-3.3	Plant Biotechnology	4	4	75	25	**100**
Specialization (Choice)	Theory BT-3.4	A) Medical Biotechnology B) Food Biotechnology	4	4	75	25	**100**
Core	Practical BT-3.5	Genetic engineering	4	2	50	-	**50**
	Practical BT-3.5	Microbial Biotechnology	4	2	50	-	**50**
	Practical BT-3.6	Plant Biotechnology	4	2	50	-	**50**
Specialization (Choice)	Practical BT-3.7	A) Medical Biotechnology B) Food Biotechnology	4	2	50	-	**50**
Interdisciplinary Elective (Choice)	Theory 3.7	Diagnostic Biotechnology	2	2	40	10	**50**
		Total		24	Marks		**650**

Mandatory courses: 1. Personality Development -2 credits
2. Communication Skills-2 credits
3. Computer applications-2 credits

M.Sc. Biotechnology IV Semester

Course	Paper Code	Paper Title	Hrs / Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-4.1	Bioprocess engineering	4	4	75	25	**100**
	Theory BT-4.2	Animal Biotechnology	4	4	75	25	**100**
	BT 4.3	Dissertation	6	6	75	*Viva-25	**100**
Specialization	Theory BT-4.4	A) Immunotechnology B) Pharmaceutical biotechnology	4	4	75	25	**100**
Core	Practical BT-4.5	Bioprocess Engineering	4	2	50	-	**50**
	Practical BT-4.6	Animal Biotechnology	4	2	50	-	**50**
Specialization	Practical BT-4.7	A) Immunotechnology B) Pharmaceutical biotechnology	4	2	50	-	**50**
				24	Total Marks		**550**

*Viva for Disseration to be conducted at the time of end semester examination in presence of two examiners (One internal and one external)

1) Total Marks for the Course : 2400
2) Total Credits for the Course: 104
   (including mandatory courses)

DAVANGERE UNIVERSITY
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Shivagangothri, Davangere-007

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Courses having focus on employability/ entrepreneurship/ skill development
M.Sc. 2017-18

Course code	Title of the Paper (Theory & practical)	Activities/content with direct bearing on employability/entrepreneurship/skill development
BT 2.4	Biophysics, Bioinformatics & Biostatistics	Employing numerical techniques for biology- Statistical concepts. Computer application skills in biological field - Biological database & search tools, sequence analysis.
BT 3.1	Genetic Engineering	Skill development - Molecular tools in genetic engineering, gene analysis techniques.
BT 3.3	Plant Biotechnology	Employability in plant tissue culture laboratories- Plant tissue culture.
BT 3.4	Elective: a) Medical Biotechnology b) Food Biotechnology	Employability in Medical laboratories- Diagnosis of microbial disease & organ function tests. Employability in Food industries- Food processing & quality assurance.
BT 3.7	Elective: Diagnostic Biotechnology	Employability in diagnostics- Enzymes in diagnosis
BT 4.1	Bioprocess engineering	Employability in Biotech industries- Bioreactors
BT 4.4	a) Immunotechnology b) Pharmaceutical Biotechnology	Employability in diagnostics- Production of Antibodies, Enzyme immunoassays, Immunohaemotology. Employability in Pharma industries- Drug discovery & drug design

I Semester

Theory paper: BT 1.1- Cell Biology

Total: 50 hrs.

Unit 1: Introduction cell biology, brief history of cell theory, emergence of modern cell biology, prokaryotic and eukaryotic cellular organization, structural and functional features of cell, units of measurements in cell biology, the chemistry of the cell, macromolecules of the cell. **10 hrs.**

Unit 2: Cells and organelles: Cellular components; membrane-structure, function and chemistry, membrane models, transport across the membrane, signal transduction mechanisms, extracellular structures, cell adhesion and cell junctions, cytoplasm; endoplasmic reticulum, golgi comples, endosomes, lysosomes, peroxisomes, Chloroplast. **10 hrs.**

Unit 3: Nuclear organization, structural basis of cellular information, Chromosomes-structural and biochemical organization; euchromatin and heterochromatin, histones, nucleosome, nuclear envelop, nucleolus, nucleoplasm, nuclear matrix and nuclear lamina, involvement of nucleolus in ribosome formation, types of chromosomes- mitotic chromosomes, polytene chromosome, lampbrush chromosomes **10 hrs.**

Unit 4: Cell Cycle, overview of cell cycle, nuclear and cell division, regulation of cell cycle, stages in cell cycle, mitosis, events during mitosis, significance of mitosis in growth, meiosis-stages, genetic recombination, significance of meiosis in genetic variability, techniques for studying cell division. **10 hrs.**

Unit 5: Cytoskeletal systems, major structural elements of cytoskeleton, microtubules, microfilaments; cellular movement, motility and contractility, microtubule based movement, kinesin and dynein, actin-based motility, myosins, structure of cilia, flagella, techniques for studying the cytoskeleton **10 hrs.**

Theory paper: BT 1.2 – Genetics

Total: 50 hrs.

Unit 1: Historical developments in genetics, the continuity of life, early theories of genetics; the role of genetics in biology, Genetic diversity and evolution; divisions of genetics, the fundamental basis of genetics; the future of genetics. **06 hrs.**

Unit 2: Basic principles of heredity, Mendel's concepts, genetic terminology, principle of segregation and the concept of dominance, monohybrid cross, test cross, incomplete dominance, genetic symbols, principle of independent assortment, dihybrid cross, testing phenotypes, genotypes, Mendelian ratios, multiple alleles, incomplete dominance, over dominance, codominance, lethal alleles, blood grouping systems. **08 hrs.**

Unit 3: The chemical nature of the gene, DNA as the source of genetic information, Watson and Crick's model of DNA, denaturation and renaturation of DNA, RNA as the genetic material, chromosome structure and transposable elements, bacterial and eukaryotic chromosomes, chromatin structure, centromere and telomere structure, general characteristics of transposable elements, transposable elements in bacteria and eukaryotes. **14 hrs.**

Unit 4: Pedigree analysis, applications and genetic testing; human genetics, sex determination and sex-linked characteristics; autosomal recessive traits, autosomal dominant traits, X-linked recessive traits, X-linked dominant triats, y-linked traints, concordance, effects of genes and environment on variation in traits, genetic diseases and condition, prenatal and postnatal genetic testing. **12 hrs.**

Unit 5. Chromosome variation, chromosome mutation, chromosomal rearrangements-duplications, deletions, inversion, translocations, fragile sites; types and effects of Aneuploidy, uniparental disomy, autopolyploidy, allopolyploidy; linkage, recombination, crossing over, recombination frequency, physical basis of recombination, three-point test cross.

10 hrs.

Theory paper: BT1.3 – Microbiology

Total: 50 hrs.

Unit 1: Historical developments in microbiology, spontaneous generation theory, biogenesis theory, germ theory of diseases; scope of microbiology. **06 hrs.**

Unit 2: **14 hrs**.

i) General characteristics and significance of viruses, viroids and prions.

ii) Classification concepts, bionomial nomenclature, taxonomic ranks, hierarchical organization. Linnaeus concepts of taxonomy; Haeckel's three-kingdom classification; Whittaker's five-kingdom classification; three-domain concept of Carl Woese.

iii) General characteristics, classification and reproduction of bacteria, fungi, algae and protozoa.

iv) **Microbial Classification:** Identification and nomenclature; Criteria for microbial classification: Morphological, physiological, ecological, genetic analysis, molecular characteristics, phage typing, serotyping, G+C ratio, comparison of proteins, nucleic acid hybridization, nucleic acid sequence comparison, DNA and RNA homology, significance of rRNA in microbial taxonomy, Chemotaxonomy and Numerical Taxonomy.

Unit 3: Microbial growth: Growth curve, measurement of growth, synchronous growth, continuous culture, factors affecting growth like temperature, acidity, alkalinity, water availability and oxygen; culture collection and maintenance of cultures.

Microorganisms and environment: Biogeochemical cycles; microbial ecology – soil microorganisms, aquatic microbiology, aeromicrobiology, role of microorganisms in the environment. **10 hrs.**

Unit 4: **Microbiological techniques: Microscopy** – principles and applications of light, fluorescent, phase contrast and electron microscopes, principles and protocols of staining techniques, sampling techniques for microorganisms, preparation media, sterilization methods, pure culture techniques, microbial safety measures. **10 hrs.**

Unit 5: **Microbial diseases:** Important infectious diseases of humans - tuberculosis, AIDS, rabies, mycoses, emerging and reemerging infectious diseases. important diseases of plants-rusts, downy mildews, powdery mildews, smuts.
Chemotherapy/antibiotics: Types, mode of action, resistance to antibiotics.
10 hrs.

Theory paper: BT 1.4 - Biochemistry

Total: 50 hrs.

Unit- 1: Concepts in Biochemistry **04 hrs**

An overview of Macromolecules, Properties of water as suitable solvent in Biological System.Acid, Bases, pH, Buffers, Effects of pH on Biological Process, Buffer Solutions for Biological Investigation.

Unit -2: Biomolecules

a. Chemistry of amino acids, peptides and proteins: Definition, Classification, Structure, Primary, secondary, tertiary, quaternary structure of proteins, (general, properties,) stereoisomers, Chemical methods of detection for amino acids and proteins. **06hrs**

b. Chemistry of carbohydrates: Definition, Classification, Structure and General properties, inter conversion of monosaccharides, osazone formation. Determination of ring size. Importance and properties of glucose, fructose, sucrose, lactose, maltose, starch, cellullose, dextrins, hemicellulose, gellans, pulluans, lignins, agar and bacterial cell wall polysaccharides. **06 hrs**

c. Chemistry of lipids and fats: Definition, classification, structure and importance of lipids and fats, quantitative analysis of lipids, biological membranes, bacterial lipids. Lipid aggregates, lipoproteins **04 hrs.**

d. Chemistry of nucleotides: Purines, pyrimidines, structure and properties of nucleosides and nucleotides. **03hrs**

e. Vitamins: Definition, classifycation, structure and importance **02 hrs**

f. Porphyrins: Definition, structure, properties and importance of chlorophyll, cytochrome and haemoglobin **02 hrs**

Unit -3: Enzymes:

Classification, nomenclature, general properties principles of catalytic power and specificity of enzymes, kinetics, coenzymes, activator inhibitors, isoenzymes, multi-enzyme complex, allosteric enzymes, mechanism of enzyme action. **05 hrs**

Unit -4: Biochemical techniques: **18 hrs**

a. Centrifugation techniques: Basic principles of sedimentation. Methods and applications of density-gradient centrifugation, preparative centrifugation, ultracentrifugation.

b. Chromatographic techniques: General principles and techniques. Methods and applications of paper chromatography, thin-layer chromatography, exclusion chromatography affinity chromatography, ion-exchange chromatography, HPLC, Gas- liquid chromatography. MALDI-TOF, LC-MS/MS.

c. Electrophoretic techniques: General principles and applications of electrophoresis and isoelectric focusimg.

d. Spectroscopic techniques: General and laws of radiation, colorimetry, ultraviolet-visible spectrophotometry.

e. Radio isotopic techniques: General principles, nature of radio activity, detection and measurement of radioactivity, applications of radioisotopes in biological investigation.

II Semester

Theory paper: BT 2.1 - Molecular Biology

Total: 50 hrs.

Unit 1: Molecular basis of life, structure and types of DNA, Chargaff's rule, DNA replication, Meselson and Stahl's experiment, modes of replication, requirements for replication, direction of replication, bacterial DNA replication, eukaryotic DNA replication, DNA synthesis and cell cycle, replication of ends of chromosomes, replication in archaea.

10 hrs.

Unit 2: Transcription, the structure and classes of RNA, mechanism of prokaryotic ranscription, transcription apparatus, initiation, elongation, termination, transcription in eukaryotes-nuclosome structure, promoters, RNA processing, spliceosome, structure of mRNA, tRNA and rRNA. **10 hrs.**

Unit 3: Gene regulation: One gene one enzyme hypothesis, genetic code, degeneracy, reading frame, initiation codons, termination codons, universality of genetic code, control of gene expression in prokaryotes-operon structure, lac operon, trp operon, attenuation, riboswitch; control of gene expression in eukaryotes, DNase I, histone modification, chromatin remodeling, DNA methylation. **10 hrs.**

Unit 4: Gene mutation and DNA repair: Mutation, types of mutations, phenotypic effects of mutations, suppressor mutations, mutation rates, spontaneous replication errors, induced mutations, analysis of reverse mutations, detecting mutations, Ames test; site directed mutatgenesis, DNA repair mechanisms, mismatch repair, direct repair, base-excision repair, nucleotide-excision repair and other types of DNA repair. **10 hrs.**

Unit 5: Molecular genetic analysis: Molecular genetics revolution, Genetic model organisms – *Escherichia coli*, *Drosophila*, *Arabidopsis*, *Cenorhabditis*, lampda phage, brief account of developmental genetics, quantitative genetics, population genetics and evolutional genetics

10 hrs.

Theory paper: BT 2.2 - Immunology

Total: 50 hrs.

Unit 1: Overview of the immune system: history, early theories of immunity, types of immunity-innate immunity and acquired immunity, Cells and organs of immune system: central lymphoid organs-bone marrow and thymus; peripheral lymphoid system-spleen, lymph nodes, gut associated lymphoid tissues: immune reactive cells- development of T and B-lymphocytes, macrophages, granulocytes and natural killer cells. **12 hrs**

Unit 2: Antigens and antibodies: immunological properties of antigens, factors influencing immunogenicity, epitope, hapten, Immunoglobulins: immunoglobulin classes, basic structure and chemistry of IgG, IgM, IgA, IgE and IgD; antigenic determinants of immunoglobulins-isotypic, allotypic and idiotypic determinants; diversity and specificity of antibodies; genetics of antibody diversity, immunoglobulin genes **14hrs**

Unit 3: Immune response: primary antibody response and secondary antibody response and immunological memory; antigen processing and presentation; cytokines; major histocompatibility complex; role of complements in immune response, hypersensitivity-Type I, II, III and IV; immune response against infectious agents. **12 hrs**

Unit 4: Autoimmune disorders, transplantation immunology; tumor antigens, graft rejection and acceptance, types of grafts, HLA typing, role of MHC proteins in transplantation; immunodeficiency disorders, immunization schedules, types of vaccines and their significance. **12 hrs**

Theory paper: **BT 2.3 - Metabolism**

Total: 50 hrs.

Unit 1: Microbial nutrition: Nutritional requirements of microorganisms- carbon, hydrogen, oxygen, nitrogen, phosphorus and sulphur; nutritional types of microorganisms- photolithotrophic autotrophy, photoorganotrophic heterotrophy, chemolithotrophic autotrophy, chemoorganotrophic heterotrophy; growth factors, uptake of nutrients by the cell- facilitation diffusion, active transport, group translocation, iron uptake; growth yields and limiting nutrients. **8hrs**

Unit 2: Enzyme Kinetics: Structure-function relationship, protein-ligand binding; enzyme reactions- single- substrate and multiple substrate, chemical mechanisms of enzyme catalysis; experimental measurements of enzyme activity, inhibitors, time-dependent inhibition, cooperatively in enzyme catalysis. **8hrs**

Unit 3:(i) Metabolism: Generation of energy- an overview of metabolism; Glycolytic pathway, Pentose Phosphate Pathway, Entner Doudoroff pathway, Tricarboxylic Acid cycle; electron transport and oxidative phosphorylation, yield of ATP in glycolysis and aerobic respiration, fermentations, anaerobic respiration, catabolism of carbohydrates, intracellular reserve polymers, lipid catabolism, protein and amino acid catabolism; oxidation of inorganic molecules, photosynthesis- light reactions in eukaryotes **10 hrs**

(ii) Metabolism: Use of energy in biosynthesis- principles, photosynthesis fixation of CO_2; carboxylation, reduction, regeneration, synthesis of sugars and polysaccharides; phosphorous assimilation, sulphur and nitrogen, synthesis of amino acids, anaploerotic reactions, biosynthesis of purines, pyrimidines and nucleotides; lipid synthesis; peptidoglycan, cellulose and chitin synthesis. **8hrs**

Unit 4: Bioenergetics: Principles of thermodynamics, high energy compounds-ATP, NAD, FAD, FMN, quinines; components and mechanisms of respiratory chain, mechanisms of oxidative and substrate level phosphorylation. **06 hrs**

Unit 5: Secondary metabolism: Secondary metabolites from fungi and bacteria; regulations of secondary metabolism; structure and outline of synthesis of antibiotics; bacterial toxins; fungal toxins, plant metabolites; alkaloids; bioluminescence - mechanisms and significance. **10 hrs**

Theory paper: BT 2.4 - Biophysics, Bioinformatics and Biostatistics

Total: 50 hrs.

Unit 1: Biophysics: 25 hrs.

i) Introduction, Chemical buildings blocks; structure of atoms, bonds within molecules-ionic, covalent, hydrogen, electrostatic and peptide bond, Vander Waals forces, bond length, bond energies, bond angles; isomerism structural, geometrical, optical isomerism; secondary bonding; weak interactions **05 hrs**

ii) Proteins: Molecular organization of proteins – primary, secondary, tertiary and quaternary structures; principles of ionization; predicting properties from amino acid composition: unusual amino acid, stabilizing forces, conformational properties of polypeptides, Ramchandran's plot, domains and motifs; structure-function relationship; study of three dimensional structures of proteins – cytochromes, lysozyme. trypsin, immunoglobulins **06 hrs.**

iii) Nucleic acids: Purine and pyrimidine bases, nucleosides and nucleotides, conformational parameters of nucleic acids and their constituents, nucleic acid geometrics, base pairing, base stacking, DNA polymorphism, DNA supercoiling: hyperchromicity; modified nucleotides, tertiary structure of nucleic acids. **05 hrs.**

iv) Membranes: Lipid structure and their organization, phase titration in lipids, polysaccharides, molecular shapes and conformation; comparison of different membrane models **04 hrs.**

v)Methods in biophysical analysis: Spectroscopy-UV, IR, fluroscence. Raman spectroscopy; CD, ORD, EM, NMR, X-ray diffraction. **05 hrs.**

Unit 2: Bioinformatics 15 hrs.

Introduction, data bases types, nucleotide databases, protein data bases, NCBI, DDBJ,EMBO, OMIM, oligo analysis, BLAST, genomics and the genome projects, computer tools for sequence analysis, finding and retrieving sequences, similarity searching, sequence alignments, pairwise and multiple alignments and comparison; molecular phylogenetics, molecular clock hypothesis, concept of phylogenetic tree, types of trees, clustering and cladistics methods.

Unit 3: Biostatistics 10 hrs.

Introduction to biostatistics, mean, median, mode, measure of dispersion, range, standard deviation, mean deviation, standard errors, confidence limits, simple significance tests based on the normal distribution, use of t-tests, regression analysis, ANOVA, multiple regression, LSD, Chi-square test, statistical basis of biological assays-dose-response metameter, direct and indirect assays, probit, logit, LD_{50}, ED_{50}, PD_{50}, slope ratio assay, use of calculators and computer programs for statistical analysis.

III Semester

Theory paper: BT 3.1 - Genetic Engineering

Total: 50 hrs.

Unit 1:

Introduction and tools of genetic engineering: Extraction and purification of genomic and plasmid DNA isolation of RNA, handling and quantification of nucleic acids.

Restriction Enzymes: Types and nomenclature, recognition of sequences; cleavage patterns and their modifications of cut ends, application of restriction endonucleases. DNA ligase, DNA modifying enzymes: DNA polymerase, polynucleotide - kinase, terminal deoxynucleotidal transferase, reverse transcriptase, alkaline phosphatase and their applications. **10Hrs**

Unit 2:

Cloning vectors: Host cell types-prokaryotic hosts, eukaryotic hosts, uses of promoters, types and properties of good vectors: Plasmids-pBR322 and pUC18; Hybrid plasmid/phage vectors-Cosmids, animal viruses-SV40, adenoviruses, retroviruses, baculopapiloma viruses; Bacteriophage vectors-lambda phage as natural vector, construction of lambda vector, single stranded DNA phages; Plant vectors-Ti-plasmid, Cauliflower Mosaic Virus., artificial chromosomes-BAC,YAC and HAC. **10 Hrs**

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Unit 3:

Cloning strategies: Genomic libraries, Preparation of DNA fragments for cloning; Ligation, packaging, and amplification of libraries; Expression of cloned DNA molecules; Cloning large DNA fragments in BAC and YAC vectors. Delivery of Phage mediated r-DNA molecules into host cells. Screening of recombinant DNA: Use of Chromogenic substrates, Insertional inactivation, colony hybridization, replica plating technique. **10Hrs**

Unit 4:

DNA Mapping and cDNA: Nucleic acid hybridization: RNA and DNA probes-Radioactive and non-radioactive probes, cDNA probes and Nick translated probes, Restriction mapping, DNA Sequencing, Fluorescent *in situ* Hybridization, DNA finger printing, comparative genome hybridization (CGH). mRNA enrichment, Reverse transcription, DNA primers, linkers, adapters. cDNA library construction-Cloning cDNA in plasmid vectors.
10Hrs

Unit 5:

Screening techniques: Southern, Northern, Western, southwestern blotting technique and Gel retardation. DNA Amplification and its Application: Polymerase Chain Reaction (PCR), The essential features of the PCR, The design of primers for PCR, DNA polymerases for PCR and applications of the PCR. Microarray and subtractive hybridization. **10Hrs**

Theory Paper: BT 3.2 - Microbial Biotechnology

Total: 50 Hrs.

Unit 1:

Introduction to Food Preservation Technology: Food Preservation by use of Heat (Pasteurization and Canning), Low temperature, Radiation, Chemicals, Antioxidants, Dehydration and Osmotic pressure.

Fermentation Technology involved in production of microbiologically-fermented foodproducts: Idli, Butter, Soy Sauce and Cheese.

08Hrs

Unit 2:

Kinetics of microbial growth & death, and fermentation kinetics: Growth and fermentation kinetics in batch and continuous cultures; microbial death kinetics; monitoring microbial growth in culture; analysis of mixed microbial populations. Hydrogenation, oxidation, esterification, polymerization.

08 Hrs

Unit 3:

Enzyme Biotechnology: Sources of enzymes; Enzyme production involving isolation, purification, encapsulation and immobilization; immobilized enzymes (or whole cells) and their industrial application; representative enzymes: lipases, proteases, amylases, glucose isomerase, glucoamylase, pectinase, rennin, L-asparaginase; enzymes used in medicines and different industries like textile, food, detergent, baking and beverage.

10Hrs

Unit 4:

Metabolic engineering: Recombinant Microorganisms for commercial products: Metabolic engineering for cloning and overexpression of heterologous genes; limitations in metabolic engineering; synthesis of commercial products like ascorbic acid, indigo, amino acids, antibiotics and biopolymers, vitamin C, acrylamide.

10Hrs

Unit 5:

Bio ethics,biosafety and nanobiotechnology

Definition and need for bioethics, Public perception of Biotechnology; Socio-economic, legal and ethical issues. Biosafety: Definition and need for biosafety, Levels and criteria used for biosafety, Cartagena protocol, applications of biosafety. Intellectual Property Rights (IPR): Introduction and forms of IPR, International and regional agreement in IPR, IPR related legislation in India. Patent-Definition and characteristics, Patenting application in India, requirements for patenting, International patents, Patenting genetically modified organisms (GMOs).

Introduction to nanobiotechnology, industrially important nano particals:- Drug nanoparticles-structure and preparation, liposomes, cubosomes and hexosomes. Lipid based nanoparticles, liquid nanodispersions, Solid lipid nanoparticles (SLP), Biofunctionalisation of SLP, Physicochemical principles of nanosized Drug Delivery systems, Nantubes, Nanorods, Nanofibers and fullerenes for nanoside drug delivery. Carbon nanotubes biocompatibility and drug delivery

14 Hrs

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Theory Paper: BT 3.3 - Plant Biotechnology

Total: 50 Hrs.

Unit 1:

Plant tissue culture: Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants preparation for organogenesis. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation , somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines.

10Hrs

Unit 2:

Gene transformation techniques: Mechanism of DNA transfer – Direct gene transfer methods-particle bombardment, electroporation and microinjection. *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors, Binary vectors, plasmid vectors-p Bluescript IIKs, pBin19, pGreen vectors.

10Hrs

Unit 3:

Biofertilizers and Biopesticides : Biological nitrogen fixation, importance and mechanism. Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorrhiza, Actinorhiza Vermicomposting technology. Biopesticides.

Eco-biotechnology: Bioremediation ; Bioleaching, Biosensors; Biofuels; Plant genetic resources: Patenting of biological material; Plant breeder's rights (PBRs) and farmers rights.

10Hrs

Unit 4:

Metabolic engineering of plants: Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.

Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

09 Hrs

Unit 5:

Agriculture Biotechnology : Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato.

Stratagies for engineering stress tolerance transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds.

11 Hours

Theory Paper: BT 3.4.A - MEDICAL BIOTECHNOLOGY

Total: 50 Hrs.

UNIT 1:

Microbial Diseases of Humans and Evaluation of organ functions: Mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Viruses (AIDS, Hepatitis- B, Rabies.) Bacteria (Typhoid, TB,) Fungi(Aspergillosis, Histoplasmosis,) Protozoa(Malaraia) function of liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase.

10Hrs

UNIT 2:

DNA-based Vaccines, Monoclonal Antibodies and Regenerative Medicine : Introduction. Subunit vaccines, Newer vaccines; Peptide vaccines, Minicells as Vaccines, Recombinant DNA (rDNA) vaccines, Attenuated vaccines. Vector vaccines, Vaccines directed against Bacteria and Edible vaccines. *Monoclonal Antibody* in Therapy; Targets in Therapy, Generation of MAbs, Antibody Engineering/Recombinant MAbs, Humanized MAbs, Immunotherapy using MAbs, Immunomodulation.

10Hrs UNIT 3:

Gene Therapy: Definition and salient features. Approaches for gene delivery; SMART, Antisense, Triple-helix-forming Oligonucleotides. Gene therapy strategies developmental stage approach, DNA Recombination, *Ex vivo* in Humans. Gene therapeutic strategies against diseases - HIV; Mechanism of HIV-1 Entry into cells, therapeutic strategies against HIV in cell culture, HIV with ribozymes. Clinical Trials. Cystic Fibrosis (CF); Molecular mechanism of CF pathogenesis, CFTR Gene Transfer in animal Models, clinical Trials . Human Genome Project- Features and applications.

10Hrs

UNIT 4:

Antisense and RNA-Based Therapeutics: *Antisense Therapeutics* - Introduction. Ribozymes-Delivery, Stability, Bioavailability, and target specificity. Recommendations of Phosphorothioate oligonucleotides; Characteristics, pharmacological and toxicological properties, Applications of RNAi, advantages of antisense drugs. *RNA Interference Technology* - Mechanism of RNAi, siRNA synthesis and delivery strategies. Micro RNA. Applications of RNAi: RNAi studies in embryonic stem cells, Hematopoietic stem cells (HSCs).

10Hrs

UNIT 5:

Tumor biology ,Enzyme and Hormone therapies: Introduction, properties of tumor cell, causes of tumors, tumor antigens, immune response and diagnosis. Proto-oncogenes, oncogenes (RAS, WNT, MYC, ERK and TRK), tumour suppressor genes (pRb, p53). Culturing of tumor cells, tumor cell lines and their applications. Introduction. Enzymes as Therapeutics. Therapeutics Enzymes; DNase I, Alginate Lyase, Adenosine Deaminase, Dihydrofolate Reductase, Lipase (Glucocerebrosidase) and Streptokinase. *Hormone Therapy:* Introduction, uses of Insulin (Humulin), Human growth hormone. Somatostatin and Erythropoietin hormones.

10Hrs

Theory Paper: BT 3.4.B - Food Biotechnology

Total: 50 hrs.

UNIT 1:

Food chemistry : Carbohydrates, amino acids, proteins, lipids, vitamins – water soluble and fat soluble, macro and micro nutrients. Digestion, absorption and metabolism. Nutraceuticals, anti oxidents, organic acids

05 Hrs

UNIT 2:

Enzymes used in food industry- proteases, amylases, invertases, pectinase, xylanase, Lipase, papain, chymosin, lactase, cellulose, production of novel sweeteners , corn sweeteners, artificial sweeteners- saccharin, aspartame, sucralose.

06 Hrs

UNIT 3:

Foods spoilage - Sources of contamination , micro organism- bactria, yeast, mould affecting various food items (milk**,** bread, canned food, vegetables and fruits, meat, egg, fish, poultry)

Food preservation: Functional and fermented foods; bakery and cereal products, preservation of fruits and vegetables – dehydration, pickling. Low temperature processing and storage- chilling, cold storage. High temperature processing- Drying, heat sterilization. Irradiation- types and source of irradiation, impact of radiation on foods, irradiation of packing material, health consequences of irradiated food.

Chemical preservation – organic, inorganic preservatives, Sulphurdioxide, benzoic acid, sorbic acids, antioxidants, cleaning, sanitizing, fungicidal agents. High concentration- sugar and salt concentrates. Bio preservatives, ohmic heating, micro wave, hurdle technology.

15 Hrs

UNIT 4:

Food born infections and intoxication – Bacterial – Brucella, bacillus, clostridium, Escherichia ; food intoxication – botulism, staphylococcal toxin, mycotoxin(aflatoxin, patulins, ATA, ochratoxins, fuminosins, ergot alkaloids) ; food born out breaks (laboratory testing procedures and preventive measures) ; moulds, algae, protozoa, viruses. Biosensors in food industry

08 Hrs

UNIT 5:

Food processing – Food processing types- physical, chemical and biological ; definition of shelf life, perishable food, semi perishable food, shelf stable food. Fermentation of beer and wine. Cheese production. Milk- pasteurization, fermented and non-fermented milk products. Canning and bottling of fruits and vegetables- process, containers, lacquering, spoilage. Layout of food processing unit and components- grinders, mixers, sterilizers, driers, cold storages. Packaging materials – origin, types, characteristics and packaging techniques.

Food quality assurance : Quality standards- food safety act, FSSAI, ISO series, HACCPL, national laws and regulations; PFA,FPO,BIS and agmark and international laws and regulations. FAO and CODEX alimentarius

16 Hrs

SPECIALIZATION- 3.7: Diagnostic Biotechnology

Total: 25 Hrs.

UNIT 1:

Introduction:

An over view of medical biotechnology significance of microbial diseases of humans, microbial specimen : collection procedure and transport of body fluid specimens, gastro-intestinal specimens, genital specimens, respiratory specimens, urine specimens and wound specimen. Specimen processing: general methods, microscopy, culture methods and serology. In vitro techniques based on antigen interaction: principles, methodology and application of agglutination, complement fixation, precipitation, immune electrophoresis, immunofluorescence and HLA typing.

10Hrs

UNIT 2:

Enzymes in diagnosis:

clinical diagnostic market, enzyme as analytical agent ,assay of blood glucose, assay of blood cholesterol and triglycerides, assay of blood urea and uric acid creatinine analysis, neonatal screening, gastric disorder diagnosis , diagnosis of myocardial infarction, diagnosis of muscle disorder, diagnosis of cancer, antimicrobial drug testing procedure, laboratory safety measures and sample disposal.

10Hrs

UNIT 3:

Diseases and their diagnosis:

Air born disease : tuberculosis and its diagnosis, water born : cholera and its diagnosis, food born: botulism and its diagnosis, STDs: HIV and its diagnosis, Malaria and its diagnosis.

05Hrs

IV Semester

Theory Paper: BT 4.1 - Bioprocess Engineering

Total: 50 Hrs.

UNIT 1: Introduction: Bioprocess Technology, Principles of fermentation and historical back ground. **Microbial Strain Improvement:** Isolation, selection and improvement of microbial cultures; Screening of microorganisms for primary and secondary metabolites, enrichment, specific screening for the desired product. Strain improvement for the selected organism -random and strategic screening methods; Role of DNA technology; Protoplast fusion techniques; Problems associated with strain improvement programme; Preservation of improved strains.

08 Hours

Unit 2:

Bioreactors: Typical structure of advanced Bioreactor and their working mechanism; Design features; Heat transfer and Mass transfer; Specialized bioreactors- design and their functions; Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photo bioreactors.

Sterilization: Media sterilization, batch and continuous media sterilization processes; Sterilization of fermenter; Sterilization of the feeds, sterilization of air Theory of fibrous filters, and filter design. Development of inocula: Yeast, bacteria, fungal and actinomycetes. Techniques of inoculation.

12 Hours

Unit 3:

Fermentation media and Fermentation Process: Natural and synthetic media; Strategies for media formulation, sources of carbon, nitrogen, vitamins and minerals. Role of buffers, precursors, inhibitors, inducers and antifoam agents.

Types of fermentation process-submerged fermentation, surface or solid state fermentation, batch fermentation, continuous fermentation, kinetics of fermentation process, bioprocess control, monitoring of variables-temperature, agitation, pH and pressure.

10 Hours

UNIT 4:

Down Stream Processing: Cell disintegration- Physical, chemical and enzymatic methods. Biomass separation by centrifugation, filtration and flocculation. Extraction- solvent, two phase, liquid extraction,whole broth and aqueous multiphase extraction. Purification – Chromatography, concentration, ultra-filtration, reverse osmosis, drying and crystallization.

07 Hours

UNIT 5:

Microbial Products: Metabolic pathways and metabolic control mechanisms; Microbiological fermentation Products:-Alcohol- Ethanol, Alcoholic beverage – Wine , Beer & Whisky, Organic acids – Citric acid, Amino acids– Glutamic acid and Vitamin– $B_{12.}$ Microbial Production of Therapeutic Compounds: Classification and characteristics of antibiotics, Microbial production of Penicillin, Streptomycin, Rifamycin and Quinolinones.

13 Hours

Theory Paper: BT 4.2 - Animal Biotechnology

Total Hours: 50 Hrs.

UNIT 1:

Introduction, mammalian reproduction and Artificial Animal Breeding: Introduction, scope and development of Animal Biotechnology. An overview of mammalian reproduction – Structure and formation of male and female gametes, fertilization, early developmental stages. Concept of cell differentiation. Artificial insemination and germ cell storage, *In vitro* Fertilization (IVF) and Embryo transfer; IVF Breeding programmes, Embryo transplantation, embryo transfer, Objectives and Applications of ET, Superovulation: Physiological basis, Influencing factors, Freezing of embryos, Embryo sexing, Micromanipulation of embryos - Embryo splitting, Nuclear Transplantation and Gene injection techniques, Advantages of Cell Manipulation. Hazards of Artificial Breeding.

10Hrs

UNIT 2:

Cell Culture and cell lines : Historical background, Development and scope, Requirements for cell culture- Laboratory design, culture vessels, equipments, aseptic handling and safety regulations. Advantages and limitations of tissue culture. Culture Medium: Physico-chemical factors of medium, Natural media-Lymph clot, Blood plasma, Blood serum and Embryo extract. Synthetic media- Composition of Balanced Salt solutions, composition of Minimal Essential Medium and growth media. Disadvantages of serum, advantages of Serum and protein free media. -Evolution of cell lines, functional environment of cultures. Sub culturing and designation of cell lines, Cell selection- Finite/continuous cell line, species, normal or transformed; growth characteristics and growth phases. Routine maintenance. **10Hrs**

UNIT 3:

Basic techniques selection and cloning of cells: Primary culture- Animal selection, isolation of tissue, Tissue disaggregation; Mechanical and enzymatic disaggregation: Trypsinisation-warm and cold methods, disaggregation by collagenase. Primary explanation technique , Introduction, Objectives of cloning, cloning, monolayer and suspension cells; Limiting-dilution and soft-agar methods; Selection and isolation of clones.

10Hrs

UNIT 4:

Cytotoxicity assays and molecular pharming : Introduction and background, Drug exposure and recovery period. Toxicity and Viability Assays - Membrane integrity: ^{51}Chromium release, Enzyme release, Dye exclusion, MTT and Fluorescent dyes. Introduction. Creating Transgenic, Biopharmaceuticals: Generation of Vaccines. Transgenic Animals; Methods for production of Transgenic Animals, Applications of Transgenic Mice, Transgenic fish, Transgenic Sheep, Transgenic Chickens Transgenic Pigs and cow. **10 Hrs**

UNIT 5:

Separation of viable cells and scale up of animal cell culture : Introduction, Physical methods-Density gradient centrifugation and Centrifugal elutriation. Biological Methods Panning, Magnetic cell sorting and Fluorescence-activated cell sorter (FACS).Applications of separation methods. Cryopreservation of Animal Cells and Tissues - Principles of freezing and thawing of cells. Generation of Cell Banks. General methods and parameters, practical consideration of growth kinetics, medium and nutrients, pH, oxygen. Monolayer cultures- Roller bottle modifications, large capacity stationary cultures, unit process system microcarrier cultures. Suspension cultures-Stirred bioreactors, airlift fermenters. Immobilized cultures- immurement cultures, entrapment cultures and porous carriers. **10Hrs**

Theory Paper: BT 4.4.A - Immunotechnology

Total: 50 Hrs.

UNIT 1

Production of antibodies: Biology and regulation of the immune response: cellular aspects of immune system, immunoregulation, tolerance. Production of polyclonal antisera: Preparation of immunogens, adjuvants, immunization procedures, breeding procedures and collection of serum and antibodies.

Production of monoclonal antibodies: Strategies, methodology for production of hybridoma-cells, media, *in vitro* immunization, fusion, additives, ascites tumors, storage of hybridoma cells, *in vivo* immunization, initial growth, screening, selection and cloning. Recurrent problem in the hybridoma technique, T- cell cloning: principles and strategies.

10Hrs

UNIT 2

Purification of immunoglobulins and preparation of Fab fragments: Preparation of immunoglobulins from ploYclonal sera- principles and procedures of salting-out, purification with ion-exchangers, purification of IgA, purification of IgM by gel filtration, electrophoresis, preparative ultracentrifugation, affinity chromatography, purifications of IgY from egg yolk, purification of monoclonal antibodies, assessment of purity and quality of immunoglobulins, preparation of Fab fragments- standard proteolytic cleavage methods,purification of Fab and Fab fragments, production of recombinant antibodies.

10Hrs

UNIT 3

Nature of antibody-antigen interactions: Physico-chemical basis of antibody-antigen interaction, antibody specificity, cross reactivity, affinity and avidity, influence of the pH, ionic strength, temperature and organic solvents on the antibody-antigen interaction, measurements of the affinity of antibodies. *In vitro* techniques based on antigen-antibody interaction: principles, methodology and applications of agglutination, complement fixation, precipitation, immunoelectrophoresis, immunofluorescence and HLA typing.

10Hrs

UNIT 4

Enzyme immunoassays (EIA): Properties of enzymes used in EIA, Horse radish peroxidase, galactosidase, alkaline phosphatase, glucose oxidase, urease, enzymes used in enzyme immunohistochemistry, preparation of enzyme-antibody conjugates, conjugation of haptens, immobilization of immunoreactants on solid phases, quantitative enzyme immunoassay techniques, substrates, chromogenic reagents, enzyme mmunohistochemistry in light and electron microscopy, toxic hazards associated with EIA and applications. Radioimmunoassay (RIA) and chemiluminiscent assays: General principles, procedure and applications.

10Hrs

UNIT 5

Immunohaemotology: Overview, blood grouping, Rh factor determination, significance of blood cell based antigens.

Immunotherapy: Modulation of the immune and inflammatory response, antigen-specific therapy, antigen-nonspecific therapy.

Vaccinology: Nature, types of vaccines, strategies for the production of whole organisms, purified macromolecules, recombinant antigens, subunit, recombinant- vector based, peptide, multivalent, anti idiotypic, DNA based plant vaccines.

10Hrs

Theory Paper: BT 4.4.B - Pharmaceutical Biotechnology

Total: 50 Hrs.

UNIT 1:

Introduction to drug discovery and development: History and scope of ayush, medicinal plants and animal models and their purpose - Mice, Rats, Rabbit and Primates, sources of drugs, approaches to new drug discovery, Antibacterial antibody : β–lactam, aminoglycosides tetracyclines, Antifungal antibiotics: Griseofulvin, Antiviral drug : interferon peptide antibody, synthetic antibodies: sulphonamides, chloramphenicol. 12 Hrs

UNIT 2:

Pharmaceuticals: Biologics and biopharmaceuticals, sources of biopharmaceuticals, biopharmaceuticals in production and research, cytokines, heamopoetic growth factors, hormones, blood products, therapeutic enzymes (Asparaginase, Streptokinase, beta lactamases), bacterial and viral vaccines, New vaccine production (DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines and their trials), Case studies. Spoilage of pharmaceutical products, regulatory practices and policies in pharmaceutical industries , production of monoclonal antibodies.

16Hrs

UNIT 3:

Quality assurance and validation : Quality control in pharmaceuticals : In- process and final product control ;sterilization control : physical, chemical & biological indicators ; sterility testing (sampling & methods), regulation and pharmacopoeia, Reimbursement of drugs and biological, GMP in pharmaceuticals, quality control through WHO, ICH process, design of sterile product manufacturing unit. **12 Hrs**

UNIT 4:

Drug design and chemical testing:

Role of molecular recognition in drug design, enzymes and receptors as drug targets, prodrug design and applications, computer aided drug design, preclinical and clinical trials rational drug design, Concept of lead drug, pro drug and its application, structure based and combinational approach, peptidomimetic and strategies for drug discovery; Biopolymers for drug delivery, role of alkaloids steroids and hormones as drug. **10Hrs**