



SYLLABUS FOR B.SC. BIOTECHNOLOGY

HONOURS PROGRAMME UNDER NEP, 2020



DEPARTMENT OF BIOTECHNOLOGY -MANIPUR UNIVERSITY



APRIL 1, 2022

OBJECTIVES OF THE PROGRAMME

The objectives of the B.Sc. Biotechnology programme is to empower the students from the basics of interdisciplinary life-sciences to the recent trends in Biotechnology and its applications for the benefit of the community. The course empowers the students with conceptual and practical skills of biotechnology and introduces the students to the latest developments in biotechnology. It is fast emerging as a top course providing distinct advantages to students as it finds applications in various aspects of life sciences. The curriculum for the Biotechnology Four-Year Undergraduate Program is based on the LOCF-CBCS system of the UGC with value addition courses which are envisaged in the NEP-2020. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours) Biotechnology is intended to provide a comprehensive foundation for the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with the required skills at various stages. This course serves a plethora of opportunities in different fields right from classical to applied aspects in Biotechnology.

OUTCOME OF THE PROGRAMME

By the end of the program the students will be able to:-

- ❖ *A detailed knowledge in the structure, function and applications of living organisms.*
- ❖ *Understand concepts in Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology and molecular biology.*
- ❖ *Skill sets in handling microorganisms in the laboratory and their applications in academia and industry.*
- ❖ *Understanding and implementation of the applications of biotechnology in industry, health-care, environmental protection, food and agricultural research.*
- ❖ *Understanding the current trends in biotechnology and its applications.*
- ❖ *Demonstrating the ability to design, perform and interpret the experiments during the practical courses with an emphasis on technological aspects.*
- ❖ *Demonstrate comprehensive innovations and skills in the field of biomolecules, cell biology, molecular biology, bioprocess engineering and genetic engineering of plants, animals, microbes with respect to applications for human welfare.*
- ❖ *Apply knowledge and skills of immunology, bioinformatics in computational modelling of proteins, drug design and simulation to test the models and aid in drug discovery.*
- ❖ *Critically analyze, interpret data and apply tools of bioinformatics in various sectors of biotechnology including health and food.*
- ❖ *Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all fields of Biotechnology.*
- ❖ *Learn and practice professional skills in handling microbes, animals, plants and demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animal handling, intellectual property rights, biosafety, and biohazards.*
- ❖ *Gain through knowledge and apply good laboratory practice and good manufacturing practices in biotech industries.*
- ❖ *Understand and apply molecular biology techniques and principles in forensics and clinical biotechnology.*
- ❖ *Explore the biotechnological practices and demonstrate innovative thinking in addressing the current day and future challenges with respect to food, health, and environment.*

**COURSE STRUCTURE OF B.SC. BIOTECHNOLOGY HONOURS PROGRAMME UNDER
NEP, 2020**

Semester	Core (Credit)	DSE (Credit)	GEC (Credit)	AECC (Credit)	SEC (Credit)	VAC (Credit)	Semester Credit)
I	BT5-11: FUNDAMENTALS OF CHEMISTRY AND BIOCHEMISTRY (6)			AECC-1 English/MIL (4)	SEC-1 (Any one of the following) BT5-13A: Mushroom cultivation Or BT5-13B: Biofertilizer Production Or BT51-3C: Fermentation Technology (4)	VAC-1 (2)	24
	BT5-12 Cell biology (6)					VAC-2 (2)	
II	BT5-14: FUNDAMENTALS OF BIOTECHNOLOGY (6)			AECC-2 Environmental Sciences	SEC-2 (any one of the following)	VAC-3 (2)	24
	BT5-15 BIOPHYSICS AND BIOINSTRUMENTATION (6)			(4)	BT5-16A Ornamental/Medicinal Plant Micropropagation or BT5-16B Food Biotechnology (4)	VAC-4 (2)	
Exit option with Bachelor's Certificate in a Discipline on completion of courses equal to a minimum of 46 Credits							
III	BT6-11 MICROBIOLOGY (6)		GEC-1 (6)			VAC-5(2)	26
	BT6-12 GENETIC (6)						
	BT6-13 PLANT AND ANIMAL PHYSIOLOGY (6)						
IV	BT6-14 ENZYMOLOGY (6)		GEC-2 (6)			VAC-6 (2)	26
	BT6-15 IMMUNOLOGY (6)						
	BT6-16 MOLECULAR BIOLOGY (6)						
Exit option with Bachelor's Diploma in a Discipline on completion of courses equal to a minimum of 96 Credits							

V	BT7-11 GENETIC ENGINEERING (6)	BT7-15: NANOBIOTECHNOLOGY (6)	GEC-3 (6)			VAC-7 (2)	26
	BT7-12 BIOSTATISTICS (6)						
VI	BT7-13 PLANT BIOTECHNOLOGY (6)	BT7-16: MEDICAL BIOTECHNOLOGY (6)	GEC-4 (6)			VAC-8 (2)	26
	BT7-14 ANIMAL BIOTECHNOLOGY (6)						
Exit option with Bachelor's Degree in a Discipline on completion of courses equal to a minimum of 140 Credits							
VII	BT8-11 BIOINFORMATICS (6)	BT8-15: BIOSAFETY AND BIOETHICS (6)	GEC-5 (6)				24
	BT8-12 BIOPROCESS TECHNOLOGY (6)						
VIII	BT8-13 ENVIRONMENTAL BIOTECHNOLOGY (6)	BT8-16: Dissertation/ Project Work/ Internship	GEC-6(6)				24
	BT8-14 INTELLECTUAL PROPERTY RIGHTS (6)						
Award of Bachelor's Degree with Honours in a Discipline on completion of course equal to a minimum of 182 Credits							

**PROPOSED SYLLABUS FOR B.Sc. BIOTECHNOLOGY HONOURS PROGRAMME UNDER
NEP, 2022
Manipur University**

FIRST SEMESTER

BT5-11 FUNDAMENTAL OF CHEMISTRY AND BIOCHEMISTRY 4 Credits

UNIT I: Ionic equilibrium and electrochemistry: Concepts of acids and bases, ionization constants of weak acids and bases, ionic product of water, hydrogen ion concentration (pH), buffer solution, common buffer solutions used in biological experiments, salt hydrolysis, solubility and solubility products. Chemical bonding and Stereochemistry: Concept of chemical bonding – ionic, covalent and metallic bond, their general characteristics, valence bond approach, valence shell electron pair repulsion theory (VSEPR theory), shape of simple molecules like BeF₂, BF₃, NH₃, H₂O, PCl₅, SF₆ etc., molecular orbital theory, hybridization, intermolecular forces and hydrogen bonding, Atomic chemistry-electromagnetism, Basics of stereochemistry, optical Isomerism - optical isomers, isomeric number and tetrahedral carbon atom, enantiomers, diastereomers, racemic modification; geometrical isomerism, condition of geometric isomer, cis-trans and E-Z nomenclature, R-S nomenclature.

UNIT II: Basics in organic chemistry: Nomenclature, hydrocarbons – aliphatic and cycloalkanes, alcohols, carboxylic acid, ethers, alkyl halides, amine, nitrile, isocyanide, acid derivatives, nitro and diazonium salt, oxidations, reductions, eliminations, nucleophilic and electrophilic substitution reactions, addition reactions, synthesis of small molecules, Quantitative structure-activity relationships (QSAR)

UNIT III: Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebroside, gangliosides, Prostaglandins, Cholesterol. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of protein. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines.

UNIT IV: Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids.

PRACTICALS:**2 Credits**

1. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study the relation between absorbance and % transmission.
2. Preparation of buffers.
3. Separation of Amino acids by paper chromatography.
4. Qualitative tests for Carbohydrates, lipids and proteins

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd.
6. Physical chemistry - P.W. Atkins, ELBS. 6. Physical Chemistry – G.M. Barron – Mc Grow Hill.
7. Essentials of Physical Chemistry – Bahl and Tuli
8. Organic Chemistry by Morrison and Boyd, Prentice Hall of India Pvt. Ltd, New Delhi
9. Guide book to Mechanism in Organic Chemistry by Peper Sykes, Orient Longman
10. Organic Chemistry by I.L. Finar, Volume-II
11. An introduction to Electrochemistry by Samuel Glasstene

BT5-12 CELL BIOLOGY**4 Credits**

- UNIT I:** Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell membrane and permeability: Chemical components of biological membranes, organization and fluid mosaic model, membrane as a dynamic entity, cell recognition and membrane transport.
- UNIT II:** Cytoskeleton and cell motility: structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including roles in protein segregation. Golgi complex: structure, biogenesis and functions including roles in protein secretion.
- UNIT III:** Lysosomes: vacuoles and microbodies: structure and functions; Ribosomes: structures and functions including roles in protein synthesis. Mitochondria: structure and function, Genomes, biogenesis. chloroplasts: structure and function, genomes, biogenesis nucleus: structure and function, chromosomes and their structure.
- UNIT IV:** Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of

receptor expression and function. Signal transduction. Cell Cycle, Cell Division, Cell senescence, Apoptosis.

PRACTICALS

2 Credits

1. Study the effect of temperature and organic solvents on semi-permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of the structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

BT5-13A: Mushroom Cultivation

4 credits

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|-----------------|---|
| UNIT I | Introduction, history of mushroom cultivation and its present status in India, record of cultivated edible fungi, definition of mushroom cultivation, importance of mushroom. |
| UNIT II | Identification and classification of mushroom, life cycle, food values and composition, medicinal values, general morphology features, important characters for identification of mushroom, edible and poisonous mushroom. |
| UNIT III | Selection of mushroom to be cultivated, definition of spawn and their types, characteristics of good spawn, storage, types of substrate, substrate preparation and its sterilization, spawning or inoculation, post spawning, incubation, cropping and harvesting |
| UNIT IV | Factor affecting mushroom cultivation, major pest, diseases and contamination, control measure, packing, economic importance, preservation and processing, advantages of cultivation of <i>Pleurotus</i> spp. |

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Handbook of Mushroom Poisoning, Diagnosis & Treatment by David G, Spoerke and Barry Rumack
2. Mushroom Production & Processing Technology by Pathak Yadav Gour
3. A Handook of Mushroom Cultivation by RP. Pandey & S.K Ghosh
4. Modern Mushroom Cultivation by Ruti Singh & UC. Singh

BT5-13B: BIO-FERTILIZER PRODUCTION

4 Credits

- UNIT I:** Introduction, History and concept of Biofertilizers, status scope and importance of Biofertilizers, Classification of Biofertilizers. Nitrogen fixation.
- UNIT II:** Structure and characteristic features of bacterial Biofertilizers- Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cyanobacterial biofertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza.
- UNIT III:** Production technology: Strain selection, sterilization, growth and fermentation, equipment, mass production of carrier-based and liquid biofertilizers. FCO specifications and quality control of biofertilizers.
- UNIT IV:** Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers - Storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

SUGGESTED READING: (All the books should be of the latest edition/version)

1. General Microbiology- Dubey and Maheswari
2. Motsora, M.R., P. Bhattacharya and Beena Srivastava. Biofertilizer Technology, Marketing and Usage-A Source Bookcum-Glossary.
3. Subbarao, N.S. 1993. Biofertilizers in Agriculture and Forestry (Oxford and IBH Pub. Co., New Delhi)
4. Mahendra K. Rai. Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
5. Kannaiyan S. Bioetchnology of Biofertilizers, CHIPS, Texas

BT5-13C: FERMENTATION TECHNOLOGY

4 Credits

- UNIT I:** Fermentation as an ancient tradition, development of fermentation microbiology: historical background. Fermentor: Main components and its uses, peripheral parts and accessories. Control systems and sensors. Fermentor preparation and use: disassembly and cleaning of vessel, autoclaving, inoculation of fermentor vessel, sampling from fermentor vessel and routine maintenance of a fermentor. Specialized bioreactors (pulsed, fluidized bed, airlift bioreactor).
- UNIT II:** Medium formulation, energy source, carbon sources, nitrogen sources, minerals, growth factors, buffers, inhibitors and precursors, antifoaming agents. Air and medium sterilization. Inoculum preparation and scale up of fermentations.

UNIT III: Batch, fed batch and continuous fermentations. Multiple fermentation and solid substrate fermentations. Microbial growth cycle, diauxic growth, growth yields. Kinetics of microbial growth and death. Framework for kinetic models- stoichiometry, reaction rates, yield coefficients and linear rate equation. Isolation, preservation and improvement of industrially important microorganism ,Isolation of industrially important microorganisms.

UNIT IV: Primary and secondary screening. Preservation of industrially important microorganisms. Strain improvement by genetic recombination approaches and directed screening for mutants with altered metabolism. Removal of microbial cells and solid matter, foam separation, cell disruption, precipitation, filtration, centrifugation, liquid-liquid extraction, chromatography, membrane process, drying and crystallization. Physical, chemical and biological assays for detection of fermentation products

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Bioprocess Engineering by Michael L.Schuler and F.Kargi .Prentice Hall of India
2. Biochemical Engineering Fundamentals. J.E. Bailey and D.F. Ollis Mcgraw Hill International Editions
3. Process Biotechnology Fundamentals by S.N. Mukhopadhyaya. Vivi Books Pvt. Ltd.
4. Principles of Fermentation Technology by P.F. Stanbury,A. Whittaker & Hall Pergaman. McNeul & Harvey Publications.

SECOND SEMESTER

BT5-14 FUNDAMENTALS OF BIOTECHNOLOGY

4 Credits

UNIT I: Introduction to biotechnology: Origin and definitions, history of biotechnology- ancient, classical and modern, major scientific discoveries in biotechnology, an interdisciplinary activity-strain choice, mass culture, optimization of cell responses, process of operations, product recovery. Scope and importance, commercial potential. Biotechnology in India and its global trends, Major biotechnology institutes and companies in India.

UNIT II: DNA fingerprinting, cloning (DNA cloning, animal cloning), Transgenic plants and animals, in vitro fertilization, artificial insemination, artificial insemination, stem cell technology.

UNIT III: Biotechnology and its application: Applications of biotechnology in Agriculture, medicine, environment, veterinary sciences, food industry, chemical industry, pharmaceutical industry forensic science; Bioremediation and waste treatment biotechnology

UNIT IV: Emerging fields of biotechnology: nanobiotechnology, bioinformatics, pharmacogenomics,

regenerative medicine, therapeutic proteins, bio-robotics, biosensors; Brief account of safety guidelines and risk assessment in biotechnology; Ethical issues related to biotechnology.

PRACTICALS

2 Credits

1. Basic operations in laboratory
2. Documentation: The Lab Notebook & Lab Report
3. Biotechnology Laboratory Security & Safety
4. Lab Equipment & Reagent Orientation
5. Math Skills for the Laboratory
6. Basic tools in the biotechnology laboratory
7. Calibrating Lab Instruments
8. Preparing solutions

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Mathuriya A S. *General introduction to biotechnology Industrial Biotechnology* (New Delhi: Ane Books Pvt) p 2
2. Biotechnology: Progress and Application by [Saif Hameed](#)
3. Hulse JH. *Biotechnologies: Past history, present state and future prospects.* Trends Food Sci Technol
4. Wohlgemuth R. *Industrial biotechnology – past, present and future.* New Biotechnology
5. *Biotechnology Fundamentals and Application* by S. S. Purohit Ex-Head, P.G. Department of Botany Dungar College, Bikaner.
6. Seidman & Moore, *Basic Laboratory Methods for Biotechnology: Textbook & Laboratory Reference*,
7. Laboratory security: <http://ehs.uky.edu/ohs/labsecurity.html>
8. *Molecular Biology Problem Solver* edited by Alan S. Gerstein
9. *Basic Laboratory Methods for Biotechnology*, by Lisa A. Seidman & Cynthia J. Moore. Prentice Hall

BT5-15 BIOPHYSICS AND BIOINSTRUMENTATION

4 Credits

UNIT I: Energetic of a living body: Sources of heat limits to temperature, heat dissipation and conservation, Lambert-Beer law, spectrophotometer and colorimetry, primary events in photosynthesis, strategies of light reception in microbes, plants and animals, correction of vision faults, electrical properties of biological compartments, electricity as a potential signal, generation and reception of sonic vibrations, hearing aids, intra- and intermolecular interactions in biological systems, spatial and charge compatibility as determinant of such interactions.

UNIT II: Physical methods applied to find out molecular structure by general spectroscopy: UV-Vis, fluorescence, atomic absorption, IR, Raman spectra, atomic absorption spectrophotometer (AAS) and atomic emissions (AES), ESR/EPR and circular dichroism analysis using light scattering and NMR. Biosafety Cabinets. Physical methods of imaging intact biological structures; ultrasound, optical filters, X-ray, CAT scan, **ECG**, EEG and MRI. X-rays and lasers-X-ray crystallography, X-ray diffractometer and X-ray fluorescence Spectrometer (XRF).

UNIT III: Isotopes and radiation-radioactivity, isotopes, measurement of radioactivity, monitoring accumulation of isotopes with Geiger counter, Scintillation counter, autoradiography. Separation techniques; chromatography - TLC,

Column chromatography, gas chromatography, HPLC, ion-exchange, mass-spectrometer, electrophoresis, centrifugation, - ultracentrifugation, density gradient, lyophilization. Vacuum drying. Tools using light- colorimeter, types of photometer, fluorimetry, Gel-Doc, PCR.

UNIT IV: Microscopes-light: phase-contrast dark field microscope, electron microscope (SEM & TEM), scanning probe microscope (SPM), atomic force microscope (AFM) and scanning tunneling microscope (STM) (For topography, gene mapping, DNA analysis). Interactions of laser beam with tissues, Isotope separation by laser beam with tissues. Flow cytometry and immunofluorescence microscopy, detection of molecules in living cells.

PRACTICALS:

2 Credits

1. Determination of "g" by bar pendulum.
2. Determination of viscosity of liquid.
3. Determination of surface tension by capillary rise method.
4. Determination of focal lengths of convex lenses.
5. Determination of horizontal component of Earth's magnetic field.
6. Determination of radius of curvature of a convex lens by Newton's ring method.
7. Demonstration of the following instrumentations/methods:
8. Chromatography, Centrifugation, Fluorescence, Biosafety Cabinets, PCR Handling Basics.
9. Paper chromatography of amino acids, sugars, and purine and pyrimidine bases.
10. Colorimetric determination of any one amino acids.
11. Separation of pigments by adsorption chromatography.
12. Thin Layer chromatography separation - sugars & lipids.

Suggested Reading Materials: *(All the books should be of the latest edition/version)*

1. Perspectives of modern physics – Arthur Beiser (Mc Graw Hill)
2. Nuclear physics an introduction – S.B. Patel (New Age International)
3. Introduction to atomic spectra – H.E. White (Mc Graw Hill)
4. Textbook of optics and atomic physics – P.P. Khandelwal (Himlaya Publishing House)
5. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell (W.H. Freeman and Co.)
6. Biophysics - Cotrell (Eastern Economy Edition)
7. Clinical Biophysics – Principles and Techniques- P. Narayanan (Bhalani Pub., Mumbai)
8. Biophysics – Pattabhi and Gautham (Narosa Publishing House)
9. Instrumentation measurements and analysis – Nakara, Choudhari (Tata Mc Graw Hill)
10. Handbook of analytical instruments – R.S. Khandpur (Tata Mc Graw Hill)
11. Biophysical Chemistry- Upadhyay, Upadhyay and Nath – (Himalaya Pub. House, Delhi)
12. Principles and Techniques of Practical Biochemistry, Keith Wilson (Editor) and John Walker (Editor): Cambridge University Press
13. Principles of Physical Biochemistry, K. E. Van Holde, *et al.*: Prentice Hall
14. Principles of Instrumental Analysis, Douglas A. Skoog, *et al.*: Harcourt College Publishers

15. Quantitative Chemical Analysis, Daniel C. Harris: W. H. Freeman & Co. Bk & cdr edition
16. Spectrophotometry and Spectrofluorimetry: A Practical Approach, Michael G. Gore(Editor): Oxford Univ Press,
17. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, Irwin H. Segel: John Wiley & Sons

BT5-16A ORNAMENTAL/MEDICINAL PLANT MICROPROPAGATION 4 Credits

- UNIT I** Definition of ornamental/medicinal plants, different types, usefulness and applications, different vegetative propagation methods, advantages and limitations of natural propagation.
- UNIT II** Propagation of plants through plant tissue culture, Historical background, Laboratory organization, culture facilities, general equipments and glasswares, different sterilization methods, dry and wet, flame sterilization. Laboratory contaminants- different control measures.
- UNIT III** Culture media preparation, media constituents, role of micro and macro nutrients, vitamins, carbon source in culture media, solidifying agent, pH and temperature adjustment in media preparation, preparation of different media like MS, B5, Mitra etc. Plant growth hormones, different types, role and uses in tissue culture, preparation of stock solutions, explants selection, different sterilization methods and explant inoculation.
- UNIT IV** Micropropagation, different stages, micropropagation of ornamental/medicinal plants, proliferation of axillary buds, Somaclonal variation, somatic embryogenesis, production of protocorms/protocorm like bodies, adventitious buds, shoot and root induction, seedling developments, acclimatization and hardening process. Limitation and advantages of micropropagation.

Suggested Reading Materials: *(All the books should be of the latest edition/version)*

1. Plant Cell, Tissue and organ culture, by O.L. Gamborg and GC, Phillips
2. Plant Biotechnology, by A. Slater, N. Scott and M. Flower
3. Plant Tissue Culture: Theory and Practice, by S.S. Bhojwani and M.K. Razdan
4. Introduction to Plant Biotechnology, by H.C. Chawla
5. Plant Cell and Tissue Culture, by I.K Basil and T.A. Thorpe

BT5-16B FOOD BIOTECHNOLOGY

4 Credits

- UNIT I** Principles of food biotechnology: Basic principles and application of biotechnology in food industries with regard to production, processing regulatory aspect of modern biotechnology application in food industry in the context of environment protection of human and animals.
- UNIT II** Fermentation technology: natural and synthetic media. Fermenters types and cell bioreactors, Process development: shake flask fermentation, upstream

processing, Disintegration of cells, separation, extraction, concentration and purification of products.

UNIT III Lactic acid bacteria-put a dash distribution, classification and physiology; antimutagenic, antimicrobial and health-promoting effects; malo-lactic. Protective factors of lactic bacteria in food preservations. Yeasts and moulds associated fermented food. Technology for the production of Sauerkraut, Kimchi, Bamboo shoot, rice beer, idli, dosa, yogurt, dahi, kefir, cheese, miso, tempeh and salami, traditional fermented food of India, nutritional changes.

UNIT IV Microbes in food technology: microbial starters for industrial production; sources, propagation, preservation, and use of starters. Improvement of starters by classical and molecular biological techniques. Microbial protein as food and feed: SCP and economics of SCP and microbially derived additive flavours and odors, Pathogenic microbes – infections; bacterial toxins and mycotoxins sources, physiological effects; methods of prevention and control in foods and feeds.

Suggested Reading Materials: *(All the books should be of the latest edition/version)*

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1. Food biotechnology Ed .dietrich knorr, Marcell dekker inc.
 2. Handbook of food analysis (vol I & vol II) Leo M Nollet, Marcel Dekker
 3. Food microbiology _ W.C Frazier; Mc Graw Hill Book Co.
 4. Modern food microbiology J. M. Jay, D. Van; Nostrand co.
 5. Fermented food (7)-Ed. by A.H Rose; Academics Press
 6. Microbial food poisoning _Ed.A.R. Elev. Chapman & Hall
 7. Principles of enzymology for food science – whittaker ,J.R Marcle Dekker
 8. Introduction to fermentation technology -Whittaker
 9. Biochemical Reactors _JM Lee; Prentice Hall Inc,USA
 10. Bioprocess technology: Fundamentals and application, KTH, Stocholm.

THIRD SEMESTER

BT6-11 MICROBIOLOGY

4 Credits

UNIT I: Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used-including molecular approaches, Classification of bacteria.
Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II: Cultivation and Maintenance of microorganisms: Nutritional requirements and nutritional types of micro-organisms, methods of isolation, Purification and preservation.
Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.
Bacterial Reproduction: Transformation, Transduction and Conjugation.
Endospores and sporulation in bacteria.

UNIT III: Control of Microorganisms: Concept of sterilization. Sterilization by physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

UNIT IV: Diseases caused by gram negative and gram positive bacteria:

B.anthraxis, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae etc E.coli, N. gonorrhoea, N. meningitidis, S. typhi, S. dysenteriae, Y. pestis, H. influenzae, V. cholerae, M. pneumoniae etc

Diseases caused by viruses:Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses; SARS

Fungal and Protozoan infections. Dermatophytoses, Subcutaneous infection, systemic infection and opportunistic fungal infections, Gastrointestinal infections, Blood-borne infections.

PRACTICALS:

2 Credits

1. Preparation of media & sterilization methods.
2. Isolation and enumeration of the number of bacteria from soil, air and water
3. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
4. Culture techniques – Streak plate, pour plate and spread plate.
5. Determination of bacterial cell size by micrometry.
6. To perform antibacterial testing by Kirby-Bauer method.
7. To prepare temporary mounts of Aspergillus and Candida by appropriate staining.

SUGGESTED READINGS: *(All the books should be of the latest edition/version)*

1. Alexopoulos CJ, Mims CW, and Blackwell M. Introductory Mycology. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. Brock Biology of Microorganisms. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

BT6-12 GENETICS

4 Credits

UNIT I: Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by t-test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

UNIT II: Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III: Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abnormalities– Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex-linked inheritance.

UNIT IV: Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

PRACTICALS:

2 Credits

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -*Rhoeo* translocation.
5. Karyotyping with the help of photographs

6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. Principles of Genetics. John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. Benjamin Cummings.
4. Russell, P. J. Genetics- A Molecular Approach. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis, W. H. Freeman & Co.

BT6-13 PLANT AND ANIMAL PHYSIOLOGY

4 Credits

UNIT I: The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf). Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT II: Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport. Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene). Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization.

UNIT III: Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice.
Respiration: Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.
Composition of blood, Plasma proteins & their role, blood cells, Haemopoiesis, Mechanism of coagulation of blood.
Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT IV: Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.
Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

Mechanism of action of hormones (insulin and steroids).
Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

PRACTICALS

2 Credits

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of opening & closing of stomata
3. Separation of photosynthetic pigments by paper chromatography.
4. Demonstration of aerobic respiration.
5. Preparation of root nodules from a leguminous plant.
6. Finding blood coagulation time
7. Determination of blood groups
8. Counting of mammalian RBCs
9. Determination of Haemoglobin

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Dickinson, W.C. Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Hopkins, W.G. and Huner, P.A. Introduction to Plant Physiology. John Wiley and Sons.
3. Mauseth, J.D. Plant Anatomy. The Benjamin/Cummings Publisher, USA.
4. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA.
5. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd.
6. Taiz, L. and Zeiger, E. Plant Physiology, Sinauer Associates Inc. MA, USA
7. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. Harcourt Asia PTE Ltd. /W.B. Saunders Company.
8. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. John Wiley & sons, Inc.

FOURTH SEMESTER

BT6-14 ENZYMOLOGY

4 Credits

UNIT I: Enzyme classification (rationale, overview and specific examples); Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of K_m and V_{max} and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT II: Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of K_i , suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical

modification of active site groups, specific examples:- chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

UNIT III : Enzyme regulation: Product inhibition, feed back control, covalent modification. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes.

UNIT IV: Allosteric enzymes with special reference to aspartate transcarbamylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co- operativity and half site reactivity. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

PRACTICALS

2 Credits

1. Quantitative estimation of proteins by Bradford/Lowry's method.
2. Calculation of kinetic parameters such as K_m , V_{max} , K_{cat}
3. Assay of enzymes (any two) - Amylase, Protease, Catalase, Urease, Galactosidase, Alcohol dehydrogenase, Cellulase & Glucose oxidase.
4. Molecular weight determination of enzymes / proteins by Gel filtration, SDS-PAGE.

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Biochemistry, Lubert Stryer, WH Freeman
2. Harper's Illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil, McGrawHill,
3. Biochemistry, Donald Voet and Judith Voet, Publisher: John Wiley and Sons
4. Biochemistry by Mary K. Campbell & Shawn O. Farrell, Cengage Learning
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press
7. Practical Enzymology Hans Bisswanger Wiley-VCH
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press

BT6-15 IMMUNOLOGY

4 Credits

UNIT I: Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T- lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination, Antigens.

UNIT II: Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity, Monoclonal Antibodies

UNIT III: Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Complement system, Autoimmune diseases, Immunodeficiency-AIDS, Hypersensitivity reactions

UNIT IV: Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

PRACTICALS

2 Credits

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA Demonstration

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. Roitt's Essential Immunology. Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. Kuby's Immunology. W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. Janeway's Immunobiology. Garland Science Publishers, New York.
5. Peakman M, and Vergani D. Basic and Clinical Immunology. Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geffrey S. Immunology. Wiley Blackwell Publication.

BT6-16 MOLECULAR BIOLOGY

4 Credits

Unit 1 Molecular basis of life – DNA and RNA as genetic material, nucleic acids, structure and functions of DNA and RNA, Watson and Crick model of DNA and other forms for DNA (A and Z) Functions of DNA and RNA including ribozymes.

Unit 2 DNA replication prokaryotic and eukaryotic – Enzymes and proteins involved in replication, theta model and rolling circle model. DNA repair and mechanism-photo reactivation, excision repair, mismatch repair, SOS repair recombination in prokaryotes transformation, conjugation and transduction.

Unit 3 Structure of prokaryotic and eukaryotic gene- genetic code, properties and Wobble hypothesis. Transcription in prokaryotes and eukaryotes mechanism, promoters and RNA polymerase, transcription factors, post transcriptional modifications of eukaryotic mRNA. Translation mechanism of translation in prokaryotes and eukaryotes, post translational modifications of proteins.

Unit 4 Regulation of gene expression, regulation of gene expression in prokaryotes – operon concept (Lac and Tryp), regulation of gene expression in eukaryotes - transcriptional activation, galactose metabolism in yeast. Coding and Non-coding genes. Gene organization and expression in mitochondria and chloroplasts. Insertional elements and transposons. Transposable elements in maize and drosophila.

PRACTICALS

2 Credits

1. Preparation of solutions for molecular biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA or plasmid DNA

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. JohnWiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., Molecular Biology of the Gene .Cold Spring Harbour Lab. Press, Pearson Pub.

FIFTH SEMESTER

BT7-11 GENETIC ENGINEERING

4 Credits

UNIT I: Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Transfection, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II: Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT III: Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV: Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal

expression vectors. Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice,

PRACTICALS:

2 Credits

1. PCR
2. Preparation of restriction enzyme digests of DNA samples
3. Analysis of PCR products
4. Making of competent cells

Suggested Reading Materials: *(All the books should be of the latest edition/version)*

1. Molecular Biology of the Gene: Waston J. D.
2. Molecular Biotechnology: Glick
3. Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S.Resnikoff
4. DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
5. Principles of Gene Manipulation & Genomics – Primrose and Twyman,
6. Molecular cloning – a laboratory manual – Sambrook and Russell (Vol. 1-3)

BT7-12 BIOSTATISTICS

4 Credits

UNIT I: Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II: Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III: Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV: Correlation and Regression. Emphasis on examples from Biological Sciences.

PRACTICALS

2 Credits

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Le CT Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D Advanced Biology Statistics, Oxford University Press.
4. Danial W Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

SIXTH SEMESTER

BT7-13 PLANT BIOTECHNOLOGY

4 Credits

UNIT I: Introduction- Definition, Classical vs modern approach. Production of disease free plants- explant, shoot tip culture, shoot tip grafting, viricidal Compounds. Micropropagation: Basic technique, Automation in the area, scope as a commercial venture. Tissue Culture as source of Genetic Variability- Somaclonal and gametoclonal variation, Selection, Sources and causes of variation, Application in crop improvement. Applications of somatic hybrids in crop improvement.

UNIT II: In vitro haploid production Androgenic methods: Anther culture, Microspore culture androgenesis Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT III: Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclature, methods, applications basis and disadvantages.

UNIT IV: Molecular breeding: Concept and methodology of different types of molecular markers. Role of molecular markers in crop improvement, conservation of biodiversity; Marker assisted selection; QTL mapping. Some important Transgenic plants. Molecular farming: Use of plants for production of nutraceuticals, edible vaccines and other desired products. Biofertilizer and bioplastic, Biocontrol and biotechnology.

PRACTICALS:

2 Credits

1. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. Selection, pruning, sterilization and preparation of explant for culture.
4. Significance of growth hormones in culture medium.
5. Demonstration of various steps of Micropropagation.

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Bhojwani, S.S. and Razdan Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmons, M.J. Snustad, D.P. Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. Genetics – A Molecular Approach. Benjamin Co.
7. Sambrook & Russell. Molecular Cloning: A laboratory manual.
8. Slater, A., Scott, N.W. & Fowler, M.R. Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

BT7-14 ANIMAL BIOTECHNOLOGY**4 Credits**

UNIT I: Introduction to animal cell and tissue culture, laboratory organisation, media, Aseptic manipulation, invitro culture methodologies, primary cell culture, secondary cell lines, continuous cell lines, Growth kinetics.

UNIT II: Gene transfer methods in Animals – Physical, Chemical and Viral methods of Gene transfer.
Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Application of Biotechnology in animal diseases– Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III: Animal Breeding – Artificial insemination, IVF, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV: Genome analysis, Human Genome Project, Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, CRISPR, human genetic engineering, problems & ethics.

PRACTICALS:**2 Credits**

1. Sterilization techniques: Theory and Practical: Glassware, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue

SEVENTH SEMESTER

BT8-11 BIOINFORMATICS**4 Credits**

UNIT I: History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II: Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics and their problems.

UNIT III: Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple

Sequence Alignment.

UNIT IV: Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST,FASTA, Data Submission. Genome Anotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

2 Credits

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. S.C. Rastogi, Bioinformatics, Concept, Skills & Applications, CBS Publications.
2. Ghosh Z. and Bibekanand M. Bioinformatics: Principles and Applications. OxfordUniversity Press.
3. Pevsner J.Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
4. Campbell A. M., Heyer L. J. Discovering Genomics, Proteomics and Bioinformatics.. Benjamin Cummings.

BT8-12 BIOPROCESS TECHNOLOGY

4 Credits

- UNIT I:** Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.
- UNIT II:** Design of bioprocess Bioreactor- Significance of Impeller, Baffles, Sparger; Types of culture/production bioreactors - Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.
- UNIT III:** Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.
- UNIT IV:** Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

PRACTICALS

2 Credits

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Casida LE. Industrial Microbiology. Wiley Eastern Limited.
2. Crueger W and Crueger A. Biotechnology: A textbook of Industrial Microbiology. Panima Publishing Co. New Delhi.
3. Patel AH. Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. Principles of Fermentation Technology, Elsevier Science Ltd.

EIGHT SEMESTER

BT8-13 Environmental Biotechnology

4 Credits

UNIT I: Environmental impact of conventional and modern fuel: Renewable and nonrenewable resources of energy, conventional fuel and their environmental impact-Firewood, Plant, Animals, Wastes, Coal, Gas, Animal oil. Modern fuel and their environmental impact- Methanogenic bacteria, Biogas, Microbial Hydrogen production, conversion of sugars to ethanol, The Gasohol experiment, plant-based petroleum industries, cellulose degradation for combustible fuel.

UNIT II: Bioremediation: Bioremediation of soil and water contaminated with oil spills, heavy metals and detergents. Degradation of pectin and cellulose using microbes. phytoremediation. degradation of pesticides and other toxic chemical by microorganism -degradation of aromatic and chlorinated hydrocarbon and petroleum product, Superbugs for treatment of oil spills, Treatment of municipal waste and industrial effluents.

UNIT III: Biofertilizers \Biopesticides: Roles of symbiotics and asymbiotics Nitrogen fixing bacteria in the enrichment of soil. Algae and fungal biofertilizers (VAM), Vermicomposting, Biopesticides-Bacillus thuringiensis and traditional biocontrol method. Bioleaching enrichment of ores by microorganisms, plants and animals. (gold, copper and uranium). Environmental significance of genetically modified microorganism, plants and animals.

UNIT IV: Applied ecology: Environmental pollution; global environmental change; biodiversity- status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

PRACTICALS

2 Credits

1. Calculation of Total Dissolved Solids (TDS) of water sample.

2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

Suggested Reading Materials: *(All the books should be of the latest edition/version)*

1. Plants and environment - Dauentmire ,R:John Wiley
2. Concept of Ecology -Kormondy ,EJ;Prentice Hall of India , New Delhu
3. Environmentals ecology- B. Freeman Academic Press,UK
4. Biofertilizers in Agriculture _NS subba Rao (Ed_n ; OXFORD & IBH
5. Biological control -CD Huffakerr ; Plenum Press, New York.
6. Fundamentals of ecology- odum ,Ep, WB Sander, Philadelphia, USA

BT8-14 INTELLECTUAL PROPERTY RIGHTS (IPR)**4 Credits**

- UNIT I:** Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.
- UNIT II:** Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad
- UNIT III:** International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.
- UNIT IV:** Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies. Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

PRACTICALS**2 Credits**

1. Proxy Copyright Registration under Indian Copyright Act, 1957
2. Case study on handling and disposal of biowaste materials
3. Case study on unfair competition
4. Proxy filing of trade secret
5. A case study on infringement of IPRs

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd
2. S. V. Satakar, "Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi
3. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition
4. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education.
5. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd

Bt7-15: NANOBIO TECHNOLOGY**4 Credits**

- UNIT 1:** Introduction to Nanobiotechnology; Concepts, historical perspectives. Nanoparticles and nanotechnology, History, origin, principles. Chemical synthesis approach of nanoparticles, Physical synthesis of nanoparticles, Green synthesis approach for different nanoparticles applications and uses. Applications and limitations using physical and chemical approach. Advantages of using green synthesis using different examples.
- UNIT II:** Characterization of synthesized nanoparticles using XRD, SEM, TEM, HR-TEM, FTIR, UV spectrophotometer, Dynamic light scattering etc., Different types of nanoparticles and applications with examples, Safety and toxicity aspects of nanoparticles.
- UNIT III:** Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for enhanced permeation through various anatomical barriers
- UNIT IV:** Nanocomposites: Properties and applications; Nanoparticles for diagnostics and imaging (theranostics); Clinical Applications of Nanoparticles, Nanotech and cancer, Environmental impact of nanomaterials – Exposure and risk assessment – Mechanism of toxicity, Toxicological impacts of Nanomaterials-Ecotoxicological impact of Nanomaterials, Nanotechnology in Agriculture, Nano factories.

PRACTICALS**2 Credits**

1. To determine the crystal structure, grain size and lattice parameters using XRD data of a given sample.
2. To study the principles of microscopy - light, dark-field, phase contrast, fluorescence and electron microscope, fixing and preparation of samples.
3. Mining of biological databases: DNA/Protein search

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Gero Decher, Joseph B. Schlenoff; *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, *Bionanotechnology: Lessons from Nature*; Wiley-Liss
3. Neelina H. Malsch, *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson; *Bioconjugate Techniques*; Elsevier Recent review papers in the area of Nanomedicine

BT7-16 MEDICAL BIOTECHNOLOGY**4 Credits**

- UNIT I:** Introduction – Origin, significance & worldwide market of Medical Biotechnology. Revolution in clinical diagnosis, Antibody and Nucleic Acid Hybridization techniques, Imaging techniques (Nanodiagnosis).

UNIT II: Revolution in treatment – Recombinant DNA technology for human insulin, Hepatitis B vaccine. Therapeutic proteins and peptides – Erythropoietin, Tissue plasminogen activator, clotting factor VIII. Antibody Engineering and Therapeutic Antibodies. Phage therapy. Gene therapy- basic approaches and types of gene therapy, vectors used in gene therapy, application of gene therapy in medicine.

UNIT III: Genetic & Metabolic Disorders – Introduction, Classification, Impact of genetic diseases on human health - Chromosome errors - Down syndrome, Klinefelter's and Turner's syndrome. Metabolic disorders – Phenylketonuria, Homocystinuria, Mucopolysaccharidosis, Gangliosidosis, Gaucher's disease, Diabetes, Hemophilia and sickle cell anemia. Treatment of Genetic diseases - prenatal diagnosis, Genetic Counseling - Ethical, Legal and Social Issues.

UNIT IV: Cancer - Molecular, cellular and genetic basis of cancer, tumor virus and oncogenes, tumor suppressor genes (with examples). Biomarkers for disease management, types of Biomarkers.

PRACTICALS:

2 Credits

1. Extraction and separation of Antigen proteins from Bacteria & protozoa
2. Estimation of blood glucose.
3. Estimation of cholesterol in blood.
4. Estimation of iron in blood.
5. Detection of plasmodium pathogen using peripheral smear
6. Widal test.
7. Human Genetic disorders- Down syndrome, Klinefelter's and Turner's syndrome (Charts and spotters)

Suggested Reading: *(All the books should be of the latest edition/version)*

1. Glick B.R. and Pasurank..Molecular biotechnology – Principle and Applications of Recombinant DNA- J.I
2. Anthony D. Ho, Hoffman. R, and Esmail D. Zanjani, Stem Cell Transplantation .Wiley – liss publishers.
3. Hornyak. G.L , Moore. J.J. Tibbals H.F., Dutta. J. Fundamentals of Nanotechnology, CRC press,. Further Reading:
4. Jogdand. S. N. Medical Biotechnology -Himalayan publishing house.
5. Freshney.I, Stacey. G. N, Auerbach.J.M, Culture of Human Stem Cells , Wiley – Liss publishers.

BT8-15 BIOSAFETY AND BIOETHICS.

4 Credits

UNIT I: Biosafety: Introduction, Historical prospective, objectives, risk assessment in biotechnological research and their regulation, physical and biological contaminants, field trial and planned introduction of GMOs, Biosafety guidelines in India, Biosafety levels for plant, animal and microbial researches.

UNIT II: Bioethics: Introduction, Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues, possible benefits of successful cloning, Ethical concerns of gene cloning, hazards of environmental engineering, Ethical issues in Human Cloning and stem cell research.

UNIT III: Patents and patent processing: Introduction, Essential requirements, International scenario of patents, patenting of biological materials, significance of patents in India, Patent application, Procedures and granting, protection of biotechnological inventions, Patent Act (1970), Patent (Amendments) Act (2002).

UNIT IV: Regulatory framework in Biotechnology: Regulation of RDT research, Regulation of food and food ingredients, Regulatory framework in India governing GMOs, Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Prevention Food Adulteration Act (1955), Food Safety and Standards Bill (2005)

PRACTICALS:

2 Credits

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women's health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

SUGGESTED READING: *(All the books should be of the latest edition/version)*

1. Sateesh MK Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V. Bioethics and Biosafety in Biotechnology, New age international publishers
3. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
4. Intellectual property rights – Ganguli – Tat McGraw-Hill 5. Biotechnology-B. D. Singh- Kalyani Publications

BT8-16: Project Work

6 Credits

Project work should be carried out on any topic out of the syllabus and relevant to the course/programme. Students should be encouraged to work independently. However, each student should be assigned to a faculty member of the Department. At the end of the project work, each student should submit a report in the form of a dissertation to the Head of the Department within a dateline fixed by the Head of the Department. The dissertation should be examined and evaluated by a committee of faculty members consisting of one external examiner.

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