ANNAMALAI UNIVERSITY

409 - M.Sc. BIOTECHNOLOGY

Programme Structure and Scheme of Examination (Under CBCS)
(Applicable to the candidates admitted in Affiliated Colleges from the academic year 2022-2023 onwards)

Course code	Study Components & Course Title	Hours /Week	Credit	Maximum Marks		
				CIA	ESE	Total
SEMESTER - I						
22PBTHC11	Core Course –I : Biochemistry	4	3	25	75	100
22PBTHC12	Core Course – II : Microbiology	3	3	25	75	100
22PBTHC13	Core Course – III : Cell and Molecular Biology	4	3	25	75	100
22PBTHP14	Core Practical –I : Biochemistry, Microbiology & Cell and Molecular Biology	12	6	40	60	100
22PBTHE15	Core Elective – I	4	4	25	75	100
22PBTHO16	Open elective - I	3	3	25	75	100
	Total	**30**	**22**			**600**
SEMESTER - II						
22PBTHC21	Core Course –IV : Bioprocess Technology	4	3	25	75	100
22PBTHC22	Core Course – V: Immuno Technology	4	3	25	75	100
22PBTHC23	Core Course –VI : Genetic Engineering	4	3	25	75	100
22PBTHP24	Core Practical –II : Bioprocess Technology, Immuno Technology & Genetic Engineering	12	6	40	60	100
22PBTHE25	Core Elective – II	4	4	25	75	100
22PHUMR27	Compulsory Course : Human Rights	2	2	25	75	100
	Total	**30**	**21**			**600**

List of Core Electives (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	Hours /Week	Credit	CIA	ESE	Total
I	22PBTHE15-1	Enzyme Technology	4	4	25	75	100
	22PBTHE15-2	Medicinal Plants	4	4	25	75	100
	22PBTHE15-3	Biodiversity Prospecting	4	4	25	75	100
II	22PBTHE25-1	Pharmaceutical Biotechnology	4	4	25	75	100
	22PBTHE25-2	Nano Biotechnology	4	4	25	75	100
	22PBTHE25-3	Analytical Techniques	4	4	25	75	100

List of Open Electives (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	Hours /Week	Credit	CIA	ESE	Total
I	22PBTHO16-1	Tools in Biotechnology	3	3	25	75	100
	22PBTHO16-2	Food Biotechnology	3	3	25	75	100
	22PBTHO16-3	Toxicology	3	3	25	75	100

SEMESTER: I	COURSE CODE: 22PBTHC11 COURSE TITLE: CORE COURSE- I: BIOCHEMISTRY	CREDIT:3 HOURS:4

COURSE OBJECTIVES

1) To understand the structure of various carbohydrates and their functions.
2) To describe the classification and structural organization of lipids.
3) To understand the amino acid structures, classifications, and proteins.
4) To understand the structure and functions of enzymes and coenzymes.
5) To understand the significance of different forms of nucleic acids.

Unit I: Carbohydrates **Hours:10**

Classification and reactions: occurrence, properties, and biological reactions. Structural features of carbohydrates, Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Gluconeogenesis; interconversion of hexoses and pentoses. Carbohydrate metabolic disorders. Glycogen storage diseases. Lectins – characteristics and functions in biological system.

Unit II: Lipids **Hours:10**

Classification, Structure, functions, and reactions of Lipids, Biosynthesis of fatty acids, triglycerides, phospholipids, and Sterols, Catabolism of Fatty acids - Oxidation(α, β, and ω), Catabolism of triglycerides and phospholipids, Essential fatty acids and their physiological functions. Disorders associated with lipid metabolism and its therapeutic intervention - ketone bodies and ketosis; fatty liver, atherosclerosis.

Unit III: Amino Acids **Hours:10**

Classification and Biosynthesis. Peptides, Classification of Protein, Primary structure of proteins, structural comparison at secondary and tertiary levels (Ramachandran Plot), quaternary and domain structure and architecture. Regulation of Protein metabolism. Protein metabolism in prolonged fasting. Diseases related to protein folding – Alzheimer's and mad cow disease.

Unit IV: Enzymes and coenzymes **Hours:09**

IUBMB classification of enzymes, active site, Lock and key Model, and induced fit hypothesis. Factors affecting enzyme activity, Mechanism of enzyme catalysis: Lysozyme, Enzyme kinetics- Michaelis – Menten (MM) equations, Transformations of MM equation and their significance, Enzyme inhibition: Reversible – Competitive, Noncompetitive, Uncompetitive, Irreversible inhibition, Kinetics of Enzyme inhibition. Isoenzymes, allosteric enzymes, ribozymes, abzymes, and artificial enzymes. Diseases Caused by Deficiency of digestive enzymes-Obesity, Galactosemia, Maple Syrup Urine Disease.

Unit V: Nucleic acids **Hours: 09**

Classification, structure, functions, and reactions of nucleic acids, Conformation of Nucleic acids: Structural characteristics of A, B, and Z-DNA. 3D structure of t-RNA, ribozymes, and riboswitches. Biosynthesis of Nucleotides –De nova and Salvage pathway, Regulations of Purines and Pyrimidine, Metabolism of Purine and Pyrimidine. Disorders of nucleic acids metabolism- Gout, Lesch-Nyhan syndrome, orotic aciduria, and xanthinuria.

COURSE OUTCOMES

1) The student will easily understand the basics of nanomaterials.
2) The student will be able to characterize nanomaterials.
3) The student will be able to diagnose diseases using nanomaterials.
4) The student will be able to use nanomaterials for environmental cleanup.
5) The student will be able to understand the ethics and toxicological effects of nanomaterials.

Text Books

1) U Satyanarayana. (2014). *Biochemistry:* Elsevier Health Sciences. 812 pages.
2) J.L. Jain. (2005). *Fundamentals of Biochemistry:* S. Chand Limited, - 1230 pages.
3) Rastogi, C.S. (2003). *Biochemistry*: (3rd edition), Tata McGraw Hill Publication, India.

Supplementary Readings

1) David. L. Nelson, Michael Cox. M. M. Lehninger's. (2012) *Principles of Biochemistry*:(6th edition) Freeman.
2) Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper's (2006). Biochemistry:(27th ed), Tata McGraw HillPublication, India.
3) Jeremy M. Berg, Lubert Stryer. (2015) Biochemistry: (8th edition), Macmillan Learning.1120 pages.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	3
CO2	2	3	3	2	2
CO3	3	3	3	3	3
CO4	3	3	2	2	3
CO5	1	2	3	3	2

1: Low; **2:** Moderate; **3:** High

SEMESTER: I	COURSE CODE: 22PBTHC12 COURSE TITLE: CORE COURSE-II: MICROBIOLOGY	CREDIT:3 HOURS:4

COURSE OBJECTIVES

1) To understand the microbial diversity and systematics.
2) To categorize microbial growth.
3) To understand the genetic makeup of microbes.
4) To understand the applications of microbes in various industries.
5) To understand the interaction between microbes and environment.

Unit I: Microbial diversity **Hours:10**

Discovery and origin of microbial world, Theories- Spontaneous generation. Germ theory of diseases. Diversity and distribution of microbes. Criteria for classification; Classification of Bacteria according to Bergey's manual. Classification of fungi. Molecular classification of microbial kingdom (rRNA phylogeny). General characteristics of virus, life cycle and classification of viruses.

Unit II: Microbial growth and culture **Hours:10**

Microbial Growth; The definition of growth, Mathematical expression of growth curve, measurement of growth and its yields, Synchronous growth, Continuous culture, Growth influenced by environmental factors like temperature, acidity, alkalinity, water availability, osmotic pressure, hydrostatic pressure and oxygen. Culture collection and maintenance of cultures. Media Formulation; Sterilizationand its methods - Physical and Chemical sterilization.

Unit III: Microbial genetics and nutrition **Hours:10**

Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Operon concept (lac and trp). Nutritional types of microbes, Enrichment culture technique. Role of microbes in Biogeochemical cycles. Transformation of elements: Carbon, Nitrogen, Phosphorous and Sulphur.

Unit IV: Applied Microbiology **Hours:09**

Food production by microbes – Microbial cell as food (SCP), Fermented products - Cheese, Yoghurt, kumiss, kefir. Sauerkraut, pickles and sausage. Fermented alcohol beverages – Beer and Wine. Production of organic acids.

Unit V: Microbes and Environment **Hours: 09**

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.

COURSE OUTCOMES

1) The student will easily classify microorganisms based on their general characteristics.
2) The student will be able to analyze the growth pattern of microbes.
3) The student will be able to understand the methods of gene transfer in microbes.
4) The student will be able to understand the appropriate applications of microbes in industry.
5) The student will be able to design the role of microbes in diverse environment.

Text Books

1) Pelczar. Microbiology. Tata McGraw-Hill Education, 1998. 900 pages.
2) D.K.Maheshwari. A Textbook of Microbiology. S. Chand Publishing, Revised edition 2013. 912pp.
3) Maloy SR, Cronan JE Jr., and Freifelder D, 2006. Microbial Genetics, 3rd edition, Jones Bartlett Publishers, Sudbury, Massachusetts, USA.

Supplementary Readings

1) Prescott's Microbiology. 10th Edn. McGraw-Hill Education, 2016.1104 pages.
2) Ananthanarayan and Paniker's Textbook of Microbiology. Orient Blackswan, 7th Edn. 2005. 657pp.
3) Jeffrey C. Pommerville Alcamo's Fundamentals of Microbiology 9th edition Jones & Bartlett Publishers, 2010 860 pages.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	3	3
CO2	2	3	3	3	2
CO3	3	3	3	3	3
CO4	3	3	2	2	3
CO5	2	3	3	3	2

1: Low; **2:** Moderate; **3:** High

SEMESTER: I	COURSE CODE: 22PBTHC13 COURSE TITLE: CORE COURSE-III : CELL AND MOLECULAR BIOLOGY	CREDIT:3 HOURS:4

COURSE OBJECTIVES

1) To learn in detail about the cellular organization and function.
2) To Study about membrane transport.
3) To learn the basics of cell division.
4) To understand the differentiation of cell signaling.
5) To study the gene expression.

Unit-I: Cell and Tissue Organization Hours:10

Prokaryotic and eukaryotic cells – basics, evolutionary and functional difference. Structure and functions of subcellular organelles, mitochondria, nucleus and nucleolus. Cell motility and shape - actin, myosin, microtubules and intermediate filaments, microtubule dynamics and associated proteins, kinesin, dynein. Types of tissues - Epithelium- organization and types, Composition of membranes-the lipid bilayer, peripheral and integral proteins. The fluid mosaic model. Brief account of membrane rafts.

Unit -II: Transport, Cell Microenvironment and Secretory Pathway Hours:10

Membrane transport: types. Diffusion-passive and facilitated. General classes of transport systems- uniport, symport, antiport. Active transport - primary and secondary. Functional importance of ATPases, ABC transporters, ionophores, aquaporins, ion-channels. Endocytosis and exocytosis. Major classes of cell junctions - anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs) cadherins, integrins. Collagen and noncollagen components. Overview of secretory pathway, Translocation of secretory proteins across the ER Membrane. Golgi and post-golgi protein sorting. Molecular mechanisms of vesicular traffic.

Unit-III: Cell Division, Differentiation, Cell Cycle and Cell Death Hours:10

Cell division - molecular events of mitosis and meiosis. The cell cycle: phases, regulation by cyclins and cyclin-dependent kinases, checkpoints. Cell cycle control in mammalian cells. Cell differentiation and trans-differentiation. Epithelial-mesenchymal transition (EMT). Cell death: types - necrosis - causes and mechanism. Apoptosis: morphology, mitochondrial and death receptor pathways. Starvation and autophagic cell death.

Unit-IV: Cell Signaling Hours:9

Fundamental concepts and features of cell signaling. Endocrine, paracrine, autocrine and juxtacrine signaling. Types of receptors. Nuclear, cytosolic and transmembrane receptors. G-protein coupled receptors. Second messengers: cAMP, cGMP, diacylglycerol, inositol triphosphate and Ca^{2}. Receptor tyrosine kinases - Ras-Raf, MAP kinase (ERK, JNK, p38) and JAK-STAT pathways.

Unit –V: Genome and Gene Expression **Hours:9**

Chromosome, DNA replication, genetic recombination. Epigenetics - DNA methylation and histone acetylation (HAT and HDACs). Central dogma of gene expression, protein coding genes and pseudogenes, promoter, enhancer, open reading frame, transcription factor. Transcription - initiation, elongation and termination. RNA - mRNA, rRNA, and tRNA. Other RNA types- miRNA, lncRNA. Translation machinery, post-translational modifications.

COURSE OUTCOMES

At the end of the course, the students will be able to

1) Understand the basic concepts of cell biology
2) Comprehend the role of transport and sub cellular organelles
3) Know the role of cell death in physiological and pathological processes
4) understand the role of cell signaling in cellular homeostasis
5) Recognize the role of various biomolecules in gene expression

Text Books

1) Leubert Stryer et al, Biochemistry 9th ed, 2019, W.H. Freeman
2) Karp. Cell and Molecular Biology. Wiley. 8th ed. 2016
3) Lodish et al. Molecular Cell Biology. Freeman. 8th ed. 2017
4) Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017
5) De Robertis, E.D.P. and De Robertis, E.M.F, Cell and Molecular Biology Lippicott Willin

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	3	3
CO2	2	3	3	3	2
CO3	3	3	3	3	3
CO4	3	3	2	2	3
CO5	2	3	3	3	2

1: Low; **2:** Moderate; **3:** High

SEMESTER: I	COURSE CODE: 22PBTHP14 COURSE TITLE: CORE PRACTICAL - I : BIOCHEMISTRY, MICROBIOLOGY & CELL AND MOLECULAR BIOLOGY,	CREDIT:6 HOURS:11

CELL AND MOLECULAR BIOLOGY

1) Microscopic examination of blood cells
2) Isolation of lymphocytes
3) Trypan blue cell viability assay
4) Microscopic examination of epithelial cells, plant cells, tissue types
5) Karyotype analysis: Onion and human
6) Isolation of plasmid DNA from E coli
7) Isolation of rat liver DNA and RNA
8) Agarose gel electrophoresis
9) Tissue protein extraction and SDS- PAGE

BIOCHEMISTRY

1) Estimation of total Protein and albumin from serum
2) Estimation of glucose from serum
3) Estimation of Vitamin C from Citrus fruits
4) Estimation of total amino acids from serum
5) Estimation of DNA & RNA
6) Determination of blood cholesterol
7) Separation of amino acids from serum Paper Chromatography

MICROBIOLOGY

1) Isolation of enzyme producing Bacteria from soil
2) Isolation of Fungi from spoiled food
3) Isolation of Antibiotic producing microorganisms against given pathogen
4) Observation of Bacterial growth rate
5) UV mutagenesis

SEMESTER: I	COURSE CODE: 22PBTHE15-1 COURSE TITLE: ENZYME TECHNOLOGY – CORE ELECTIVE	CREDIT:4 HOURS:4

COURSE OBJECTIVES

1) To understand the basic concepts of enzyme action.
2) To know about kinetics.
3) To study the use of enzymes in industry and medicine.

Unit-1: Enzymes - Classification, Kinetics and Inhibition **Hours: 10**

Enzymes - Classification and IUB nomenclature. Enzyme kinetics - steady state kinetics. Effect of pH, temperature, enzyme and substrate concentration. Michaelis -Menten plot, Lineweaver Burk plot, significance of Km and Vmax. Effect of competitive, non-competitive and un- competitive inhibitors on Km and Vmax. Allosteric regulation. Brief account on non-protein enzymes and extremozymes.

Unit-II: Functional Forms and Regulation **Hours: 10**

Coenzymes - coenzymic role of thiamine pyrophosphate, FAD, NAD, pyridoxal phosphate, coenzyme A, biotin, folic acid and cobalamine. Multienzyme complexes (PDH). Metal-dependent and metalloenzymes. Isoenzymes (LDH). Enzyme regulation: feedback inhibition and feedforward stimulation. Enzyme repression, induction and degradation. Zymogen activation. Covalent modification of enzymes - phosphorylation. Compartmentation (Scaffolds, Subcellular localization).

Unit-III: Enzyme Reactors, Engineering and Production **Hours: 10**

Enzyme reactors: types (stirred tank, continuous flow), Immobilization of enzymes: principles, parameters, carriers (inorganic, polysaccharides, polymers), binding methods (adsorption, covalent), applications. Enzyme engineering: principles, steps, enzyme engineering with reference to lysozyme. Enzyme production and purification: enzyme sources (plant, animal, wild type and recombinant microorganisms), processes to improve enzyme yield. Downstream processing and chromatographic purification of enzymes.

UNIT-IV: Industrial Application of Enzymes **Hours: 9**

Enzyme electodes. Biosensors: components, types, (calorimetric, potentiometric, amperometric), applications. Enzymes of industrial significance: use of enzymes in detergents, textiles, and leather industry, production of glucose syrup (α-amylase), cheese production. Synzymes and solvent engineering. Soluble enzymes - introduction and applications in food, starch processing and detergents.

Unit-V: Therapeutic uses of Enzymes **Hours: 9**

Enzymes as diagnostic aids. Therapeutic uses of enzymes: enzymes as thrombolytic agents (myocardial infarction and pulmonary embolisms), enzybiotics, digestive-aids, anti-inflammatory (Trypsin and Serratiopeptidase), fibrinolytic and anti-cancer agents. Microbial therapeutic enzymes - regulations and safety criteria for production of enzymes and their use. Regulations governing use of enzymes produced in wild - type or recombinant organisms.

COURSE OUTCOMES

At the end of the course, the students will be able to

1) Understand the basic concepts, kinetics and regulatory role of enzymes
2) Comprehend the methods for enzyme production and immobilization
3) Design the strategies of enzyme engineering
4) Large scale production and downstream processing
5) Apprehend the industrial application of enzymes

Text Books

1) Palmer T. Understanding enzymes. Prentice Hall. 2004.
2) Buchholz et al Biocatalysts and Enzyme Technology. Wiley-Blackwell. 2nd ed. 2012
3) Pandey et al. Enzyme Technology. Springer. 2010.
4) Nelson, Cox. Lehninger Biochemistry. Freeman. 7th ed. 2017.
5) Balasubramanian et al. Concepts in Biotechnology. Univ Press 2007.

Supplementary Reading

1) Dixon and Webb. Enzymes. Elsevier. 2rd ed. 2014.
2) John E. Smith. Biotechnology. Cambridge university press, 5th ed. 2009.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	2
CO2	2	3	2	2	3
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: I	COURSE CODE: 22PBTHE15-2 COURSE TITLE: MEDICINAL PLANTS – CORE ELECTIVE	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) To enable to students to know about the various technologies used in herbal preparations.
2) To knowledge about the concepts of Ethano botany.
3) Acquires knowledge of the common medicinal plants.
4) To understand the traditional medicinal plant's parts and local name.
5) To knowledge the Medicinal plants cultivation methods.

Unit I: Introduction to Herbal medicines **Hours: 10**

Introduction: Herbal Medicine–History of Traditional Medicine – History of Islamic Medicine, Siddha, Ayurveda, Homeopathy, Allopathy and Unani medicine.

Unit II: Ethano botany **Hours: 09**

Ethano botany: Withania somnifera (Amukkara), Glycyrrhiza glabra (Athimathuram), Myristica *fragrans* (Jathikkai), *Gymnema sylvestre* (Cakkaraikkolli), *Pongamia pinnata* (Punkam) - Properties and Medicinal uses.

Unit III: Common medicinal plants **Hours: 10**

Common medicinal plants: Family, Local Name, Common name, Medicinal uses – *Ocimum sanctum, Solanum trilobatum, Cardiospermum halicacabum, Adhatoda vasica, Catharanthus roseus,* and *Eclipta alba*.

Unit IV: Parts of Medicinal plants **Hours: 10**

Parts of Medicinal plants: Fruit – Amla, Bulb – Garlic, Rhizome – Ginger, Seed –Castor, Bark – Cinchona, Leaves – Neem and Flower – Clove.

Unit V: Medicinal plants cultivation methods **Hours: 09**

Cultivation methods– crop protection – Harvesting– Storage and Protection– Marketing utilization – Export of medicinally important plant (General aspects).

COURSE OUTCOMES

1) The student will be able to gain knowledge on traditional medicine
2) The student will be able to study some important medicinal plants.
3) The student will be able to know the common herbal plants.
4) The student will be able to know the preservation of herbal medicine.
5) The student will be able to learn cultivation methods of herbal plants.

Text books

1) Sinha, R.K., & Sinha, S. (2001). *Ethnobiology*. Jaipur: Surabhe Publications.
2) Pal, D.C., & Jain, S.K. (1998). *Tribal medicine*. Calcutta: Naya Prakash.
3) Jain, S.K. (1995). *Contribution to Indian ethnobotany*. (3rd ed.). Jodhpur: Scientific publishers.

Suggested Readings

1) Jain, S.K. (1995). *A Manual of Ethnobotany*. (2nd ed.). Jodhpur: Scientific publishers.
2) Sharma, A.K., Keservani, R.K., & Gautam, S.P. (2020). *Herbal Product Development: Formulation and Applications*. U.S: Auerbach Publications, CRC Press.
3) Gokhale, S.S., Kokate, C.K., & Purohit, A.P. (1994). *Pharmacognosy*. Niraliprakashan, Pune.
4) Faroogi, A.A., & Sreeramu, B.S. (2004). *Cultivation of Medicinal and Aromatic crops*. University Press (India) P. Ltd., Hyderabad.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	2
CO2	2	3	2	2	3
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: I	COURSE CODE: 22PBTHE15-3 COURSE TITLE: BIODIVERSITY PROSPECTING – CORE ELECTIVE	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) The importance of biodiversity and various methods of conservation
2) The Bioprospecting potentials of available natural resources
3) The regulations related with biodiversity and bioprospecting

Unit I Biodiversity- Overview and Acts **Hours: 10**

Biodiversity- Facts about global & Indian biodiversity- Hot spots of Indian Biodiversity- Types of Biodiversity- Measures of Biodiversity(alpha, beta & gamma)- Threats to Biodiversity, Endemic, threatened, Red List of IUCN- National biodiversity strategy and action plan(Initiatives to conservation (international & national)- Organization involved in Biodiversity conservation and research(NBA,BSI,ZSI etc)- The biological diversity act 2002

Unit II Biodiversity Management **Hours: 10**

BMC-Biodiversity Management Committee (Roles & Responsibility,Functions) – Operationalisation of BMC- People's Biodiversity Registers- SBB- State Biodiversity Boards roles and responsibilities- Biodiversity informatics(Global &Indian perspectives)-Biodiversity mapping (History, techniques & uses)

Unit III Bioprospecting Overview & Products **Hours: 10**

Bioprospecting-Methods- Major areas- sustainable utilization of bio resource practices-types- Challenges- Access and Benefit sharing policies – INBio&Merck agreement- Kani tribes benefit sharing model-Economically valuable Products from plant, animals and other bioresources- Bio piracy issues

Unit IV Methods of screening for bioprospecting **Hours: 9**

Screening for different bioactivity- Antimicrobial activity- Enzymes- Plant growth promoting Activity- Antifouling & biofilm activity- anti cancer activity- Anti diabetic activity. High throughput screening- Drug discovery and development.

Unit V Bioprospecting Regulations **Hours:9**

Regulations on bio-prospecting, access and benefit-sharing (National Environmental Management: Biodiversity act, 2004)- Bioprospecting case studies – Regulatory innovations for bioprospecting in India- Regulation of Bio-Prospecting and Related Intellectual Property Rights in India

COURSE OUTCOMES

1) Articulate the types of biodiversity, the threats to the biodiversity and Biodiversity hotspots
2) Illustrate the management strategies for biodiversity and biodiversity mapping
3) Infer the sustainable utilization of resources and benefit sharing

4) Report the screening process of various bioactive substances
5) Formulate regulations and laws for biodiversity

Text books

1) Bull, A.T., 2004, Microbial Diversity and Bioprospecting, 1st edition, ASM Press, USA
2) Jeffries, M.J., 2006, Biodiversity and Conservation, 2nd edition, Routledge, USA.

Supplementary Readings

1) Jeffries, M.J., 2006, Biodiversity and Conservation, 2nd edition, Routledge, USA
2) Vanesha, S., 2010, Marine Bioprospecting and Natural Product Research, 1st edition, LAP Lambert Academic Publishing, Germany
3) Dubey, K.N. and Yadav, G.P., 2011, Biodiversity - Threats to Conservation, Axis Publication, 1st edition, Axis Publication, India.
4) Krishanmurthy, K.V. , 2018, An Advanced Textbook on Biodiversity, 1st edition, Oxford and IBH Publishing Co Pvt Ltd., India

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	3	2
CO2	2	3	2	2	3
CO3	3	3	2	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER:II	COURSE CODE: 22PBTHC21 COURSE TITLE:CORE COURSE-IV: BIOPROCESS TECHNOLOGY	CREDIT: 3 HOURS: 4

COURSE OBJECTIVES

1) To understand the bioreactors design and different types of bioreactors then its application in different field.
2) To depict the information in fermentation techniques and about the sterilization of bioreactors.
3) The course objectives are framed to give an adequate knowledge about fermentation process and types of fermentation process.
4) To learn about the physical, chemical and enzymatic methods used in the downstream processing.
5) To provide adequate knowledge in primary and secondary screening methods in drug designs.

Unit I: Bioreactors design of a basic Fermentor **Hours: 10**

Bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Unit II: Gas- liquid exchange and mass transfer **Hours: 10**

Oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation and its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

Unit III: Fermentation Process Growth of cultures **Hours: 10**

Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flask to industrial fermentation.

Unit IV: Downstream Processing **Hours: 9**

Downstream Processing Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods.

Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

Unit V: Fungal metabolites **Hours: 9**

Chemically creative fungi; screening for industrially useful fungal metabolites; drugs and pharmaceuticals from fungi; Ecotaxonomic approach in chemical screening; primary and secondary products of metabolism; classification of secondary metabolites; primary and secondary screening of antibiotic producers; auxanography; enrichment culture, techniques for strain improvement and Strain development; Industrial fungal strains preliminary and high throughput screening (HST); leads and lead optimization, IPR issues and patents.

COURSE OUTCOMES

1) Gain knowledge of bioreactor.
2) Understand the application and functioning of bioreactors.
3) Understand the fermentation process growth of cultures in the fermentor.
4) Understand the downstream procedure and fermenter waste treatment.
5) Know the role of fungi in food and feed industries viz. Edible mushrooms, different cultivation and nutritional aspects of mushrooms.

Textbooks

1) McDuffie, N. G. (2013). *Bioreactor design fundamentals*. USA: Butterworth-Heinemann.
2) Tapobrata, P. (2011). *Bioreactors analysis and design*. (1st ed.). New York: McGraw Hill Education
3) Carl-Fredrik, M. (2016). *Bioreactors design, operation and novel applications*. (1st ed.). New Jersey: Wiley-VCH.

Suggested Readings

1) Anuj, K. R. (2012). Downstream processing techniques in biotechnology: Purification Techniques of Biological Compounds. New Delhi: Global Vision Publishing House.
2) Jane, K. (2015). Reverse osmosis design, processes and applications. (2nd ed.). Beverly, MA: Scrivener Publishing LLC.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	3	3	2	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: II	COURSE CODE: 22PBTCH22 COURSE TITLE:CORE COURSE – V: IMMUNO TECHNOLOGY	CREDIT: 3 HOURS: 4

COURSE OBJECTIVES

1) The mechanism of immune system.
2) Various detection methods of antigen antibody interaction.
3) To impart knowledge in vaccine development

Unit I Cells and Organs of Immune system **Hours: 10**

History and scope of immunology. Types of Immunity: Passive, Active and Acquired immunity. Humoral, Cell Mediated immunity. Cells and organs of immune response and their functions. Antigens -Types, haptens, epitopes and Factors influencing antigenicity. Antibody – Structure, types, properties and functions. Immunoglobin gene rearrangements.

Unit II Antigen Antibody Reactions **Hours: 10**

Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Agglutination reactions and Precipitation reactions. Immuno assays – Immuno Diffusion and Immunoelectrophoresis, RIA, ELISA, Western blotting, ELISPOT assay, immunoflu orescence, Surface plasmon resonance, Biosensor assays for assessing ligand – receptor interaction.

Unit III New Generation Antibodies **Hours: 10**

Antibody engineering; Hybridoma and monoclonal antibody (MCAb) techniques, Production of murine hybridoma, Production of MCAbs in cultures and animal (Ascites), Purification of MCAbs. Characterization of MCAbs/ and Labelling of antibodies. Phage display libraries; Antibodies as in vitro and in vivo probes.

Unit IV Vaccine Technology **Hours: 9**

Rationale vaccine design based on clinical requirements: Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant - based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immune - competent cells, Stem cell therapy, Cell based vaccines.

Unit V Hypersensitivity and Transplantation **Hours: 9**

Hypersensitivity – Mechanism and Types. Auto immune disorders - Type I diabetes, Rheumatoid arthritis. Tumor immunology: tumor antigens, oncogenes, immune responses, detection of cancers and therapy- chemotherapy and radiation therapy. Transplantation Immunology.

COURSE OUTCOMES

1) Understand about basic of immune response.
2) Know the antigen – antibody related test.
3) Learn about new generation of antibody production techniques.

4) Awareness on vaccine immunological types and its role in immune system
5) Know about allergic reaction, tumour immunology and its effect on immune system.

Textbooks

1) Rao CV, 2006, "Immunology A Textbook", 2nd Edition, Narosa PublishingHouse Pvt. Ltd, New Delhi.
2) Khan FH, 2009, "The Element of Immunology" , 1st Edition, PearsonEducation, New Delhi.

Supplementary Readings

1) Kuby J, 1997, "Immunology", 3rd Edition, W.H. Freeman and Company, New York
2) Riot and Ivan, 1988, "Essentials of Immunology", 6th Edition, Blackwell Scientific Publications, London.
3) Hay FC, 2002, "Practical immunology", 4th Edition, Blackwell Scientific Publications, London.
4) Harlow E, 1988, "Antibodies Laboratory Manual", 2nd Edition, Cold Spring Harbor Laboratory Press, United States.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	3	3	2	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: II	COURSE CODE: 22PBTC23 COURSE TITLE:CORE COURSE : GENETIC ENGINEERING	CREDIT: 3 HOURS: 4

COURSE OBJECTIVES

1) To learn various types of vector system.
2) To study different host systems.
3) To learn steps in creating rDNA molecule.
4) To gain knowledge on various recombinant DNA techniques and their applications
5) To learn gene silencing techniques.

Unit I Basics concepts **Hours: 10**

Genetic engineering – Overview and scope. Steps involved in recombinant DNA constructions, enzymes involved in genetic engineering, role of linkers, adaptors and Homopolymer tailing. Selectable and Screenable markers. Labeling of DNA - Radioactive and non-radioactive probes.

Unit II Cloning Vectors **Hours: 10**

Plasmids –pBR322 and pUC vectors, Bacteriophage vectors - M13 vectors, Lambda vectors (Insertion and Replacement vectors), Phagemids, Cosmids, Yeast vectors, Shuttle vectors, Animal Viral vectors - SV-40, baculo& retroviral vectors, Expression vectors – pMal, GST and pET-based vectors, Plant vectors -Ti and Ri Plasmids

Unit III Cloning Methodologies **Hours: 10**

Introduction of cloned genes into cell – transformation, particle bombardment, liposome mediated transfer, electroporation, microinjection and calcium phosphate mediated transfer. Construction of cDNA and genomic libraries. Hybridization techniques - *Northern, Southern and Colony hybridization

Unit IV PCR and Its Applications **Hours: 10**

Primer design; Fidelity of thermostable enzymes, *DNA polymerases, PCR and Types – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products, PCR in molecular diagnostics, PCR based mutagenesis.

Unit V Gene silencing and Therapy **Hours: 10**

DNA sequencing- Chain termination method and NGS. Gene silencing techniques - Introduction to siRNA technology, Micro RNA Principle and application of gene silencing. Gene knockouts and Gene Therapy - Creation of knockout mice, Disease model, Gene targeting. Gene Editing.

COURSE OUTCOMES

1) Understand the steps in recombinant DNA preparation and labeling
2) Explain the features of various types cloning vectors for bacteria, yeast , animals and plants.
3) Understand the methods of gene transfer and hybridization
4) Describe various molecular techniques and its applications
5) Knowing different types of sequencing and gene therapy

Text Books

1) Brown TA, 1998,"Introduction to Gene Cloning", 3rd Edition, Stanley Thornes Publishing Ltd, United Kingdom.
2) Primrose SB, 2003, "Principles of Gene Manipulation", 6th Edition, Blackwell Science Ltd, United States.

Supplementary Readings

1) Bernard Glick R and Jack Pasternak J, 2010, "Molecular Biotechnology: Principles and Applications of Recombinant DNA" 4th Edition, ASM press, United States.
2) Singh BD, 2008, "Text book of Biotechnology", 4th Edition, Kalyani Publishers, New Delhi.
3) Sambrook J and Russel DW, 2001, " Molecular Cloning: A Laboratory Manual", 3rd Edition, CSHL, United States.
4) James Watson D, 2001, "Recombinant DNA technology". 2nd Edition, WH Freeman and company, United Kingdom.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	3	3	2	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: II	COURSE CODE: 22PBTHP24 COURSE TITLE: CORE PRACTICAL - II : BIOPROCESS TECHNOLOGY, IMMUNO TECHNOLOGY & GENETICS ENGINEERING	CREDIT:6 HOURS:12

BIOPROCESS TECHNOLOGY AND IMMUNO TECHNOLOGY

1) Purification of IgG antibodies using affinity chromatography.
2) Ouchterlony Double diffusion
3) Rocket Immunoelectrophoresis
4) Single Radial Immuno diffusion
5) Latex agglutination test.
6) Blood grouping
7) Immobilization of yeast cells
8) Production & estimation of biomass (SCP)
9) Wine production and estimation of alcohol content.
10) Demonstration of acetic acid oxidation (vinegar production).

GENETIC ENGINEERING

1) Isolation of genomic DNA from human blood sample
2) Bacterial conjugation
3) Bacterial Transformation
4) RFLP analysis

SEMESTER: II	COURSE CODE: 22PBTHE25-1 COURSE TITLE: PHARMACEUTICAL BIOTECHNOLOGY – CORE ELECTIVE	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) Biotechnology has a long promise to revolutionize the biological sciences and technology.
2) To understand the concepts of Biopharmaceuticals Industrial development.
3) Scientific application of biotechnology in the field of genetic engineering
4) Biotechnology is leading to new biological revolutions in diagnosis, prevention and cure of diseases, new and cheaper pharmaceutical drugs.
5) Acquires knowledge of the gene therapy and clinical development.

Unit I: Introduction to Pharmaceutical Biotechnology **Hours: 10**

Pharmaceutical Biotechnology – Introduction, concepts, technologies and applications – pharmaceutical industries in India.

Unit II: Biopharmaceuticals Industrial development **Hours: 10**

Biopharmaceuticals - Expression in plants. Industrial development and production process - scientific, technical. Economic aspects of vaccine research and development.

Unit III: DNA vaccines **Hours: 10**

DNA vaccines – Vaccine from mice to humans. Characterization and bioanalytical aspects of recombinant proteins as pharmaceutical drugs. Biogeneric drugs.

Unit IV: Therapeutic proteins **Hours: 9**

Therapeutic proteins – Special pharmaceutical aspects. Pharmaceutical and pharmacodynamics of biotech drugs, Formulation of biotech products – Rituximab. Clinical development of the first therapeutic antibody for cancer.

Unit V: Gene therapy **Hours: 9**

Gene therapy – Somatic, Nonviral gene transfer systems in somatic gene therapy. Advanced biotechnology products in clinical development. Xenotransplantation in pharmaceutical biotechnology, Pharmaceutical enzymes.

COURSE OUTCOMES

1) Understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.
2) Acquire knowledge on novel biotechnological and Biopharmaceuticals Industrial development.
3) Understanding of current topical and newly emerging aspects of pharmaceutical biotechnology.
4) Understand the legal steps involved in progressing a new drug to market.
5) Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

Text Books

1) Richard, A.H., Pamela, C.C., Finkel, R., Cubeddu, L., Michelle, A.C. (2009). *Lippincott's Illustrated Reviews Pharmacology*. (4th ed.). New York: Lippincott Williams & Wilkins.
2) Purohit, S.S., & Saluja, A.K. (2003). *Pharmaceutical Biotechnology*. Jodhpur: Agrobios
3) Satoskar, R.S., Bhandarkar, S.D., Nirmala, N.R., & Satoskar, R.R. (2017). *Pharmacology and Pharmacotherapeutics.* (20th ed.). India: Elsevier.

Suggested Readings

1) Torchilin, V.P. (2012). *Immobilized enzymes in medicine*. (Vol. 11). Berlin/Heidelberg, Germany: Springer Science & Business Media.
2) Katzung, B.G., Masters, S. B., & Trevor, A.J. (2012). *Basic and Clinical Pharmacology*. (12th ed.). New York: The McGraw-Hill Companies, Inc.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: II	COURSE CODE: 22PBTHE25-2 COURSE TITLE: NANO BIOTECHNOLOGY – CORE ELECTIVE	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) Covers the whole spectrum of nanomaterials ranging from overview, synthesis, properties.
2) To understand the DNA based artificial nanomaterial fabrication.
3) Imparting the state of art of Nanomaterials to the society
4) Acquires knowledge of the Chemical fixation technique for biological samples.
5) To apply gained knowledge for various clinical applications of nanotechnology.

Unit I: Biosynthesis of nanomaterials **Hours: 10**

Introduction – Nanoscale, Types of nanomaterial, Physical and chemical properties. Biosynthesis of nanomaterials - Bacteria, Fungi, Algae, Plants, Gold, Silver, Cadmium, Copper.

Unit II: Nanomaterial fabrication **Hours: 10**

DNA based artificial nanostructure, fabrication, properties and application. Nucleic acid engineered nanomaterial and their application. Protein patterning for application in biomaterials. DNA lipoplexes – Lipofection efficiency in In-vitro and In-vivo, Polymer controlled deliver of therapeutic nucleic acid.

Unit III: Instruments of Nanomaterial analysis **Hours: 10**

X-ray diffraction (XRD), UV-Visible Spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM).

Unit IV: Chemical fixation technique **Hours: 9**

Cryofixation technique, Dehydration, Embedding biological samples section, Sectioning, Staining, Mechanical milling, Chemical etching, Ion etching, Conductive coating.

Unit V: Nanomaterial Applications **Hours: 9**

Medicine – Diagnosis, Therapeutic agents - Gene therapy, Antimicrobial activity and wound healing, Tissue engineering, Cosmetics. Communication in Bacteria - Satellite Communication. Environment – Nano material for Pollution abatement, Environmental sensors.

COURSE OUTCOMES

1) Acquire knowledge about importance of nanotechnology and nanomaterials.
2) Understand application of nanomaterials in day to day life.
3) Insight into process involved in production of metal nanoparticles and its application.
4) Understanding critical factors in synthesis of nanoparticles.
5) Learn about recent developments and application of nanoparticles.

Text Books

1) Murty, B.S., Shankar P., Raj B., Rath B.B., & Murday, J. (2013). *Textbook of Nanoscience and Nanotechnology*. India: Springer Publishers.
2) Vo-Dinh, T. (2019). *Nanotechnology in Biology and Medicine: Methods, Devices, and Applications*. (2nd ed.). New York: CRC Press.
3) Demetzos, C. (2016). *Pharmaceutical Nanotechnology Fundamentals and Practical Applications*. New Singapore: Adis.

Suggested Readings

1) Pradeep T. (2012). *A Textbook of Nanoscience and Nanotechnology*. Tata McGraw Hill Education Pvt. Ltd.
2) Hari Singh Nalwa. (2002). *Nanostructured Materials and Nanotechnology*. New Delhi: Academic Press.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	3
CO2	3	3	2	3	2
CO3	3	3	3	2	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High

SEMESTER: II	COURSE CODE: 22PBTHE25-3 COURSE TITLE: ANALYTICAL TECHNIQUES – CORE ELECTIVE	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) To understand the principles and applications of microscopy and spectroscopy.
2) To understand the concept of Chromatography techniques.
3) Acquires knowledge of the electrophoresis techniques.
4) To gain knowledge of the Tools and Techniques in Molecular Diagnosis.
5) Understand the knowledge of radioisotopes in biological sciences

Unit I: Microscopy and Spectroscopy **Hours: 9**

Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Properties of electromagnetic radiations. Principles, instrumentation and applications of UV visible, infrared, NMR spectroscopy. Spectrofluorimetry and mass spectrometry, X-ray diffraction. Flow cytometry.

Unit II: Chromatography techniques **Hours: 10**

Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC. Basic principles of sedimentation. Applications of preparative and analytical ultra centrifuges. Principles and applications of lyophilization.

Unit III: Electrophoresis techniques **Hours: 10**

General principles of electrophoretic techniques. Poly Acryl amide Gel Electrophoresis. Isoelectric focusing. 2-D Electrophoresis. Capillary electrophoresis. Agarose gel electrophoresis of DNA and RNA. Blotting techniques. DNA fingerprinting.

Unit IV: Molecular Diagnosis **Hours: 9**

Tools and Techniques in Molecular Diagnosis, ELISA and Western blotting, PCR and Real Time PCR, Flow cytometry, Immunohistochemistry and Hybridization, Sequencing methods

Unit V: Radioactive isotopes **Hours: 10**

Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences. Autoradiography. Non-isotopic tracer techniques. Principles and range of electrochemical techniques. Operation of pH electrodes. Principles and applications of Ion-selective and gas sensing electrodes. Oxygen electrodes.

COURSE OUTCOMES

1) Understand the knowledge of applications of microscopy and spectroscopy.
2) Acquires knowledge of the concept of Chromatography techniques and its applications.
3) Gain knowledge of the Electrophoresis techniques.
4) Understand the tools and techniques in Molecular Diagnosis.

5) Understand the radioactive isotopes and its applications

Text Books

1) Wilson, K., & Walker, J. M. (2010). *Principles and techniques of biochemistry and molecular Biology*. UK, New York: Cambridge University Press.
2) Katoch, R. (2011). *Analytical techniques in biochemistry and molecular biology*. New York: Springer.
3) Silverstein, R. M. (2005). *Spectrometric identification of organic compounds*. (7th ed.). Hoboken, NJ: John Wiley & Sons.

Suggested Readings

1) Harvey, D. (2000). *Modern analytical chemistry*. Boston: McGraw-Hill.
2) Chatwal, G.R., & Anand, S. (1984). *Instrumental methods of chemical analysis*. New Delhi. Himalaya Publishing House.

OUTCOME MAPPING

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

1: Low; **2:** Moderate; **3:** High