Maharashtra Education Society's

Abasaheb Garware College

(Autonomous)

(Affiliated to Savitribai Phule Pune University)

Two Year Master's Program in Biotechnology

(Faculty of Science and Technology)

Syllabi under Autonomy

M.Sc. I (Biotechnology)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2022-2023

M.Sc. (Biotechnology)

Preamble

Biotechnology is a field that combines basics of life science (biology) and technology. It has been one of the most fast-growing fields in last few decades. The realm of Biotechnology involves understanding and application of basic sciences such as Physics, Chemistry, Mathematics as well as applied sciences such as Microbiology, Food technology, Bioinformatics, Recombinant DNA technology. State of the art technologies such as Artificial Intelligence and Machine learning are now being explored for their application in Biotechnology. Biotechnology is one such course that provides an educational environment where STEM- Science Technology Engineering and Mathematics are not only taught but practised together. India has recently implemented its NEP2020- New educational policy. One of the major objectives of NEP is to bridge gaps in education and industry by empowering the students by providing them with training in skill-based courses. To provide such training there is a need to develop courses/syllabi with subjects which provide knowledge about the current and most relevant technologies. This syllabus includes an amalgamation of theory as Practicals of classical subjects such as Cell Biology, Molecular Biology, Genetics, Molecular Biology and Advanced subjects such as Genomics, Proteomics, Bioinformatics, Nanobiotechnology and Genetic Engineering. Along with the training of basics of core subject the students need to be exposed to subjects such as entrepreneurship and intellectual property rights to inculcate interest in product development. Subjects such as Clinical Database management, Bioethics, Biosafety Pharmaceutical Biotechnology & Drug Designing have been critically curated to prepare students for Industry jobs. Environment Biotechnology, Agriculture Biotechnology and Food Biotechnology subject syllabi have been designed in order to expose students to state-of-the art techniques used in these fields. The proposed credit-based curriculum ensures the requirement of academia and industry. Theory supplemented with extensive practical skillsets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) without any additional training. benefit of society and sustainable development.

Programme Outcomes:

1. To impart advanced knowledge in life sciences and cutting-edge technologies
2. To equip students with skill sets to provide academic and professional excellence
3. To inculcate interdisciplinary research aptitude in students
4. To encourage independent thinking, develop analytical ability through research project
5. To inculcate scientific, social and environmental awareness in students

Eligibility:

Bachelor of Science in Biotechnology, B.Sc. Blended, B.Sc. with Vocational Biotechnology and B.Sc. (with Biotechnology, as one of the principal subjects) with 55% marks as minimum for general category and 50% marks as minimum for reserved category students.

Structure of the Course: M.Sc. Biotechnology

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
1	I	Core Compulsory Theory Papers	**PSBT-111**	Biological Chemistry	**T**	4	60
			PSBT-112A	Cell Biology	**T**	2	30
			PSBT-112B	Molecular Biology	**T**	2	30
			PSBT-113A	Genetics	**T**	2	30
			PSBT-113B	Immunology	**T**	2	30
		Core Practical Paper	**PSBTP-114**	Laboratory Course I - Biological Chemistry, Cell, Molecular Biology, Immunology and Genetics	**P**	4	30
		Choice Based Optional Papers	**PSBTELE-115A** **PSBTELEP-115A**	Environmental Biotechnology Practicals in Environmental Biotechnology	**Choose any one of the optional papers**	2T 2P	30 15
			PSBTELE-115B **PSBTELEP-115B**	Food Biotechnology Food Biotechnology		2T 2P	30 15
	Semester II						

	II	**Core Compulsory Theory Papers**	**PSBT-121**	Genetic Engineering	**T**	4	60
			PSBT-122	Bacteriology and Virology	**T**	4	60
			PSBT-123	Plant Biotechnology	**T**	4	60
		Core Practical Paper	**PSBTP-124**	Laboratory Course II - Genetic Engineering, Bacteriology and Virology, Plant Biotechnology	P	4	30
		Choice Based Optional Papers	**PSBTELE-125A**	Clinical Research, Data Base management, & IPR	**Choose any one of the optional papers**	4	60
			PSBTELE-125B	Medical Biotechnology		4	60
2	**III**	**Core Compulsory Theory Papers**	**PSBT-231**	Animal and Stem Cell Technology	**T**	4	60
			PSBT-232	Bioprocess engineering	**T**	4	60
			PSBT-233	Bioinformatics & Biostatistics	**T**	4	60
		Core Practical Paper	**PSBTP-234**	Laboratory Course III- Animal Biotechnology, Bioprocess engineering, Bioinformatics & Biostatistics	**P**	4	30
		Choice Based Optional Papers	**PSBTELE-235A** **PSBTELEP-235A**	Nano Biotechnology Nano Biotechnology	**Choose any one of the optional papers**	2T 2P	30 15

			PSBTELE-235B **PSBTELEP-235B**	Agricultural Biotechnology Agricultural Biotechnology		2T 2P	**30** 15
	IV	**Core Compulsory Theory Papers**	**PSBT-241A**	Genomics	**T**	2	30
			PSBT-241B	Proteomics	**T**	2	30
			PSBT-242	Advanced Bio analytical Techniques	**T**	4	60
2		**Core Practical Paper**	**PSBTP-243**	Research Project	**P**	**4**	
		Choice Based Optional Papers	**PSBTELE-244A**	Bio entrepreneurship & Start up Designing	**Choose any two of the optional theory papers**	4	60
			PSBTELE-244B	Pharmaceutical Biotechnology & Drug Designing		4	60
			PSBTELE-244C	Research Methodology & Scientific Communication		4	60
			PSBTELE-244D	Quality Control, Bio safety & Bioethics		4	60
		Total Credits			80		

Semester I

Course Code and title: PSBT-111 Biological Chemistry

Credits: **04** **Total Lectures: 60**

Course Outcomes:

1. To understand protein biochemistry, secondary metabolites and how their functions are governed by their structures.
2. To help students to understand the applications of enzymes and secondary metabolites in the biological field.

Units	Topics	Number of Lectures
1	**Overview of Protein Structure, Protein Chemistry**: Structure of Proteins: Primary, Secondary, Tertiary, quaternary. Ramachandran plot Study of protein motifs and protein families. Specific protein structures in details- Keratin, Collagen, Myoglobin and Haemoglobin. Include Introduction to Protein Sequencing, Edman Degradation • Protein folding mechanisms and Pathways, Factors affecting stability- Molten globule, energy funnel, chaperons. • Protein misfolding and disease- Sickle cell anaemia, Crohn's Disease, Prion diseases •Protein –protein interaction (immune system and immunoglobulin's) and protein –DNA interaction (DNA binding motifs- helix-turn-helix, leucine zipper, zinc finger, helix-loop-helix and interaction with drugs) • Structure –function relationship • Protein Engineering and its applications • Peptides and Therapeutic Proteins, Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors	20
2	**Enzymes** • Overview of Enzymes structure and function– Concept of active site, binding sites, Stereospecificity of enzyme and ES complex formation. • Multienzyme complexes • Enzyme Activity- Various factors influencing enzyme activity and enzyme inhibition Mechanism of enzyme action and Enzyme regulation.	10

	• Enzyme kinetics- Rate of reactions, steady state enzyme kinetics, Michaelis-Menten Equation - form and derivation. Significance of Vmax and Km, K/cat. Bisubstrate reactions. Graphical procedures in enzymology. Lineweaver Burke's Plot, Ediee Hofstee plot, Hane's Plot • Clinical and Industrial Applications of enzymes: Diagnostics and therapeutic enzymes used in a Biosensors (glucose oxidase, Cholesterol Oxidase), • Enzyme Engineering	
3	Metabolomics: • Overview of metabolism, Integration of Metabolism • The Metabolome – Metabolic flux, Metabolic flux analysis • Metabolic engineering – 2 eg. Polyketides Synthesis, Xenobiotics	10
4	Phytochemistry • Introduction to classes of naturally occurring compounds: Fatty acids, Alkaloids, Terpenoids, Steroids, Flavonoids, Anthocyanins, Carbohydrates, Complex compounds, Essential oils Introduction to secondary Metabolism, primary metabolite as precursors of secondary Metabolite • Pathways for secondary Metabolite 1. Mevalonate pathways 2.Shikimate Pathway 3.Isoprene Unit Pathways (IPP) • Study of secondary Metabolite 1. Alkaloids 2. Phenolics 3. Terpenoids **Extraction methods** – Physical and chemical a. Extraction of Phytochemicals: Maceration, Soxhlet extraction, Steam distillation, Hydrodistillation, Wax extraction, Fractional crystallization, Fractional distillation, Spinning band distillation etc. b. Analysis of Crude Extracts and Pure Phytochemicals: Physical Methods, Elemental analysis, Chromatographic Techniques, Spectral methods	20

References:

1. Proteins: Biotechnology and Biochemistry, (2001),1st edition, Gary Walsch, Wiley, USA

2. Pharmacognosy, (2008), 14th edition, Dr. C. K. Kokate, A. P. Purohit, S. B. Gokhale, Nirali Prakashan, India.

3. Trease and Evans' Pharmacognosy, (2009), 16th edition, William Charles Evans, Saunders Ltd. USA.

4. Metabolic Engineering: Principles and Methodologies. (1998). Gregory N Stephanopoulos, Aristos A Aristidou, Jens Nielsen. Publisher: Academic Press, San Diego, US

5.Fundamentals of Biochemistry. (2008), 3rd Edition, Donald Voet & Judith Voet, John Wiley and Sons, Inc. USA

6.Lehninger, Principles of Biochemistry. (2021), 8th Edition David Nelson& Michael Cox and Aaron Hoskins, MacMillan International, NY.

7.Biochemistry: (2012), 7th Edition, Jeremy Berg, Lubert Stryer, W.H. Freeman and company, NY

8. Nucleic acids in Chemistry and Biology; (2022), 4th Edition, G. M. Blackburn, Martin Egil, Michael J Gait, Jonathan k Watts, RSC Publication, UK.

Course Code and title: PSBT-112A Cell Biology

Credits: 02 **Total Lectures: 30**

Course outcome:

1. To understand molecular mechanisms of intracellular transport, cell communication and cell signaling,

2. To introduce students to mechanisms of cell death, cell differentiation and cancer

Units	Topics	Number of Lectures
1	**Cell structure and transport across membranes** • Specialized Cells: Muscle & Nerve cells, Structure & functions •Molecular basis of muscle contraction. •Mechanism of nerve transmission- Resting and action potential, electrical and chemical transmission, Neurotransmitters and their receptors. •Plasma membrane types (animal, plant and bacterial) •Transport across plasma membrane and intra-cellular transport (vesicular and membrane transport) at molecular level •Organelles and membrane trafficking	10
2	**Cell communication:** • Extracellular matrix and cell junctions- relevance to tissue structure and function • Cell signalling: communication between cells and environment •Signalling at cell surface, signalling molecules, hormones and receptors •Signalling pathways that control gene activity, signal transduction and second messengers	10
3	**Cell Differentiation, Cell Cycle, Cell Death, Cell transformation:** •Cell differentiation in plants and animals •Cell division: An over view of mechanics of Cell Division •Assembly and disassembly of cytoskeletal elements, role in cell division •Cell cycle and its regulation- Cyclins, Cyclin dependent kinases, inhibitors. •Cell death- Role of hormones and growth factors, Programmed cell death in plants and animals •Cell transformation and etiology of cancer	10

References:

1. Molecular Cell Biology. (2012) 7th Edition, Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, (2007) 5th Edition Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, (2010) 6th edition, Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, (2013), 6th edition Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA

Course Code and title: PSBT-112B Molecular Biology

Credits:02 **Total Lectures: 30**

Course Outcomes:

1. To understand concept of genome and its organization

2. To learn the concept of genes and the principles underlying the process of gene expression in life forms.

Units	Topics	Number of Lectures
1	Information flow in biological systems: •Central dogma, Properties of DNA: UV absorption, Denaturation and renaturation kinetics thermodynamics of melting of the double helix, kinetics of unwinding of the double helix, Interaction with small ions. **Genome Structure and Gene family**: • Chromatin organization and remodelling, chromosome, centromere, telomere. •Gene families, clusters, Pseudogenes, super-families •Organelle genomes. C-value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequences, Cot ½ and Rot ½ values, satellite DNA, DNA melting and buoyant density. •Mobile genetic elements: Transposable elements in bacteria, IS elements composite transposons, replicative and non-replicative transposons, Mu transposition, Controlling elements in TnA and Tn 10 transposition. •Transposable elements of Eukaryotes: Maize, Drosophila and Yeast. SINES and LINES, retrotransposons	8
2	Mechanism of Replication: •Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Eukaryotic DNA polymerases and mechanism of replication.	10

	Telomere synthesis-Telomerases, Replication of viral DNA, rolling circle model. Inhibitors of replication. •Recombination Homologous and site-specific recombination, •Models for homologous recombination-Holliday junction, NHEJ, Proteins involved in recombination- RecA, RuvA, B, C, Gene conversion • DNA damage and Repair: DNA damage- alkylation, deamination, oxidation, UV radiation. Repair mechanisms- photo reactivation, excision repair, post replication repair, mismatch repair and SOS repair	
3	**Gene Expression in Prokaryotes and Eukaryotes** •Mechanism of Transcription: Mechanism of transcription and regulation function of bacterial RNA polymerases. Eukaryotic RNA polymerases-transcription factors, mechanism of transcription and regulation. •Post transcriptional modifications of mRNA: Caping, poly-adenylation, mechanism of splicing, Group I, II and III, spliceosome assembly, splicing editing, Group IV splicing Processing of tRNA and rRNA. Inhibitors of transcription. •Translation mechanisms in prokaryotes and eukaryotes: detailed processes •Regulation of Gene expression in prokaryotes: Operon model- Inducible and repressible systems. Attenuation, positive and negative regulation with respect to tryptophan and arabinose operon. Role of cAMP and CRP in the expression of lac genes, catabolite repression with respect to lactose operon. •Regulation of gene expression in eukaryotes: transcriptional control, cis control elements, promoters, enhancers, transacting factors, homeobox in the control of developments in insects and vertebrates. DNA binding motifs of transcription factors, post-transcriptional control. •Gene Silencing: concept, transcriptional and post transcriptional gene silencing, RNAi pathway (si RNA and mi RNA). •Co and post translational mechanisms	12

References:

1. Genes XI, (2012), 11th edition Benjamin Lewin, Publisher - Jones and Barlett Inc. USA

2. Molecular Biology of the Gene (2008). 6th Edition James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

3. Molecular Biology, (2011), 5th Edition. Weaver R., McGrew Hill Science. USA

4. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford

University Press. India

5. Molecular Biology: genes to proteins. (2011), 4th edition. Burton E Tropp, Jones & Bartlett Learning, USA
6. Nucleic acids in Chemistry and Biology; (2022), 4th Edition, G. M. Blackburn, Martin Egil, Michael J Gait, Jonathan k Watts, RSC Publication, UK.

Course Code and title: PSBT-113A Genetics

Credits:02 **Total Lectures: 30**

Course Outcomes:

1. To study of mendelian and non mendelian genetics.
2. To understand genetics of flowering, self-incompatibility, androgenesis, apomixis in angiosperms.
3. To understand the medical genetics and its clinical significance
4. To study population genetics, importance of genetic mapping, marker technology with special reference to recent trends in the field of genetics

Units	Topics	Number of Lectures
1	Overview of Mendelian genetics. • Concepts of exceptions to Mendel's laws. Advanced Genetics, Genetics of Flowering in Angiosperms, Genetics of Androgenesis, Genetics of apomixis, self-incompatibility, mutation studies. • Genetics of Drosophila as a model organism. • Hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanisms.	8
2	Population genetics and genetics of evolution. • Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy Weinberg equilibrium, factors affecting Hardy Weinberg equilibrium (selection, mutation, migrations and genetic drift) • In-breeding depression & mating systems; population bottlenecks, , Bayesian statistics; adaptive landscape, spatial variation & genetic fitness.	6
3	Human genetics and methodologies • Clinical genetics, diagnostic tools and techniques for human genetic disorder • Genetic approaches to complex genetic diseases-hypertension, diabetes and Alzheimer's. Genetics of Cancer	8
4	Genetic Mapping Genetic recombination and linkage • Genetic mapping and physical mapping • Molecular markers & marker based genetic linkage maps • Linkage Disequilibrium Genome-wide association study and haplotype mapping Applications of genetic maps	8

References:

1. Hartl, D. L., & Jones, E. W. (1998). Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.

2. Pierce, B. A. (2005). Genetics: a Conceptual Approach. New York: W.H. Freeman.

3.Principles of Genetics 5th Edition by D. Peter Snustad (Author), Michael J. Simmons (Author)

4. Genetics Author B. D. Singh Edition 2, reprint Publisher Kalyani Publishers

5. Genetic Mapping and DNA Sequencing edited by Terry Speed, Michael Waterman

Course Code and title: PSBT-113B Immunology

Credits:02 **Total Lectures: 30**

Course Outcomes:

1. To introduce different types of immunities and components of immune system
2. To understand interaction between antigens and antibodies, the basic principle behind the immunodiagnostic techniques.
3. To introduces different types of vaccines and development of vaccines

Units	Topics	Number of Lectures
1	**Immunology**: • Fundamental concepts and overview of the immune system • Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); • innate immune response; mucosal immunity; • antigens: immunogens, haptens; • Major Histocompatibility Complex: MHC genes, • Organs of immune system, primary and secondary lymphoid organs Immune Dysfunction and Its Consequences	6
2	**Immune responses generated by B and T lymphocytes** • Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, Immunoglobulin super family. • antigenic determinants; • multigene organization of immunoglobulin genes; • B-cell receptor; • B cell maturation, activation and differentiation; • generation of antibody diversity; • T-cell maturation, activation and differentiation and T-cell receptors; • functional T Cell subsets; cell-mediated immune responses, • ADCC; • cytokines: properties, receptors and therapeutic uses; • antigen processing and presentation- endogenous antigens, exogenous antigens	12
3	• Terminologies for assessing antigen antibody interaction: Specificity, Affinity, Avidity, titer.	6

	• Antigen-antibody interactions Precipitation, agglutination and complement mediated immune reactions • Advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immune fluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance. • Biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphocyte proliferation assay, mixed lymphocyte reaction	
4	**Vaccinology:** • History of vaccine development**:** Active and passive immunization; live, killed, attenuated, subunit vaccines; • Vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, peptide vaccines, conjugate vaccines; • T cell based vaccine. Phage display as a tool for vaccine and immunotherapy development	**6**

References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). Kuby Immunology.New York: W.H. Freeman.

2. Brostoff, J., Seaddin, J. K., Male, D., &Roitt, I. M. (2002). Clinical Immunology.London: Gower Medical Pub.

3. Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.

4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.

5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.

6. Parham, P. (2005). The Immune System. New York: Garland Science.

Course Code and title: PSBT-114 Lab Course I: Practicals Based on Biological Chemistry, Cell Biology, Molecular Biology, Genetics and Immunology

Credits: 04 **Total Practicals: 30**

Course Outcomes:

1. To study the process of enzyme extraction, purification and enzyme kinetics
2. To learn to isolate, analyze and quantify cell organelles and biomolecules
3. To learn the technique of various immunodiagnostic procedure based on antigen antibody interactions.
4. To solve logical and numerical problems based on concepts in population genetics and non-mendelian gene interaction.

Units	Topics	Number of Practicals
1	Isolation of nuclei and chromatin, Mononucleosome size determination by agarose gel electrophoresis	2
2	Extraction and Analysis of Histones	2
3	Isolation of RNA and analysis by agarose gel	1
4	Isolation of genomic DNA and quantification by UV spectrophotometry	1
5	Isolation of mitochondria and lysosomes and assay of SDH and acid phosphatase activity respectively	1
6	Programmed cell death during limb development In Chick	1
7	Staining of animal cells (Histone by Fast green; DNA by Feulgen; RNA by Methyl green Pyronin)	1
8	Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation	1
9	Separation of leucocytes by dextran method	1
10	Double diffusion, Immuno-electrophoresis and Radial-Immuno diffusion, Rocket Immunoelectrophoresis	4
11	Widal test	1
12	Antibody titre by ELISA method/Western blotting	2
13	Extraction, purification and characterization of protein: Beta galactosidase • Extraction and assay of enzyme activity • Isolation, precipitation and Dialysis • Enzyme Purification by using Column Chromatography- Ion exchange/ Gel filtration • Characterization by Native and SDS PAGE. • Calculation of Km and Vmax of purified enzyme	7

14	Problems based on Population genetics, gene interactions	2
15	Isolation of secondary metabolites from a natural source. Methods of extraction: Single step and Multi step Extractions; Hot and Cold Extractions. Purification of extracts using separation techniques (TLC, Column Chromatography etc.)	2
16	Visit to any Research Institute/laboratory and Report writing	1

References

1. Introduction to Practical Biochemistry, (2000), S. K. Sawhney, Randhir Singh Narosa,

2. Practical Enzymology, 2nd edition (2011), Hans Biss Wanger, Wiley-Blackwell, USA.

3. Biochemical Calculations, (1997), 2nd Edition, Segel Irvin H., Publisher: John Wiley and Sons, New York.

4. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

5.An Introduction to Practical Biochemistry. (2001), 3rd Edition, David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. India

6.Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India

Course Code and title: PSBTELE-115A Environmental Biotechnology

Credits: 02 **Total Lectures: 30**

Course Outcomes:

1. To develop a basic understanding and awareness about the concepts of biotic and abiotic factors of the environment and the principles of biodiversity.
2. To generate awareness about sustainable development goals, Environmental Impact assessment, environmental laws and policies

Units	Topics	Number of Lectures
1	**Energy and Environment** • Introduction to environmental Science Natural energy resources and their exploitation (Conventional)	2
2	**Pollution and Environment** • Introduction to environmental components, carbon foot prints, causes and consequences of climate change (global warming, Ozone hole, Sea level rise),	2
3	**Waste management –** • waste water analysis - BOD, COD theory in detail and their experimental techniques. • waste water technology - waste water treatment plant, Activated sludge process and its mathematics, • Solid waste management: Sources and types, Impact of solid waste disposal, Recycle, Reuse and Recovery solutions	7
4	**Bioremediation Removing Pollutants from Environments-** • Use of biological agents in pollution control, • Types of Bioremediation (Advantages, limitations, applications, Principle, natural and engineered any one case study) and Factors affecting. • Xenobiotic degradation by microbes (enzymes involved and any case study) , • Biomining, Biomethanation, Bioleaching, • Bio plastic technology, Bio plastic types, Phytoremediation	7
5	Environment monitoring Remote sensing: • Principle, and objectives, Energy sources for remote sensing,	6

	• Types of remote sensing, Applications- Agricultural, Forestry Wildlife Ecology (any case study from the above applications of remote sensing) and Environmental Informatics • Environmental Impact Assessment: Introduction, Objectives, Classification, and Guidelines. Case Study. • Environmental Audit: Introduction, Types, General Methodology, International and Indian Eco-standards ISO14000 series overview.	
6	**Environmental Laws and Policies International:** • in the view of global concerns, • objectives of laws/regulations, • importance Stockholm conference, • Nairobi declaration, • Rio conference, • India: Environmental Policy, Anti-Pollution Acts: The water Act. 1974, The Air Act 1981, The Environment Protection Act 1986- Their important objectives	6

References:

1. Alternative Energy: S. Vandana; APH Publishing Corporation

2. Groundwater Geochemistry: Fundamentals and Applications to Contamination, 1997, William J. Deutsch, Lewis Publishers

3. Agenda 21: Guidelines for Stakeholders Patwardhan & Gunale

4. Bioremediation (1994) Baker, K.H and Herson, D.S.McGraw Hill, Inc. New York

5. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levin and Gealt, M.A McGraw Hill. Inc

6. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd edition, Prentice Hall, Inc.

7. Environment Impact Assessment (1996) Larry W. Canter McGraw-Hill Book Company

8. Environmental biotechnology (2010) Rana Rastogi Publications

9.Soil and Water Conservation Engineering (1981) G. O. Schwab, Richard K. Frevert, Talcott W. Edminster, and Kenneth K. Barnes

10. Textbook of Remote sensing and GIS (2006) M. Anji Reddy 3rd

11. Waste Water Engineering: Treatment and Reuse (2002) Met Calf & Eddy INC, Tata mc raw Hill edition, Prentice-Hall

Course Code and title: PSBTELEP-115A Practicals in Environmental Biotechnology

Credits: 02 **Total Practicals: 15**

Course Outcomes:

1. To learn basic methods used for soil and water analysis,

2. To study genotoxic and cytotoxic effects of water pollution, Biochemical and chemical oxygen demand

3. To get introduced to GIS.

Units	Topics	Number of Practicals
1	Water Analysis- Determination of biological oxygen demand and chemical oxygen demand of sewage sample. Estimation of Total Solids	3
2	Genotoxicity assay on polluted water- Onion root tip and pollen germination assay.	2
3	Bioburden assay of wastewater	1
4	Anaerobic digestion of wastewater sample	1
5	Study of soil characteristics: Colour/texture/Water holding capacity/pH/Alkalinity/Organic content	1
6	Removal and estimation of pollutant from soil/water samples by biostimulation/ phytoremediation	1
7	Qualitative and quantitative estimation of biodegradation of pesticide/ insecticide/fungicide.	1
8	Acquisition of “Google Earth” images for the known and unknown area for land use - land cover mapping	2
9	Review on EIA case study.	2
10	Visit to Waste Water Treatment Plant/ Waste recycling plant/ Water-Soil testing laboratory	1

References:

1. Textbook of Remote sensing and GIS (2006) M. Anji Reddy 3rd

2. Waste Water Engineering: Treatment and Reuse (2002) Met Calf & Eddy INC, Tata mc raw Hill edition, Prentice-Hall

Course Code and title: PSBTELE-115B Food Biotechnology

Credits:02 **Total Lectures: 30**

Course Outcomes:

1. To learn basics and application of biotechnology in fermentation, nutraceuticals and, prebiotics and probiotics,
2. To get awareness regarding different laws in the food industry and QA and QC of food.

Units	Topics	Number of Lectures
1	Microbial biotechnology • Genetically modified microorganisms • Fermentation Technology- Use of microbes in the production of alcohols (Beer, Wine), bread, Yogurt, Organic acids (Acetic acid, Lactic acid, Citric acid), Vitamins • Pigments, Flavors, sweeteners Enzyme in Food Technology • Production of food related enzymes- Amylases, Proteases, Lipases, Cellulases, Pectinases. Applications of these enzymes in food processing • Applications of Biotechnology in food waste management and development of value added products	**9**
2	Prebiotics and Probiotics • Food Sources- Prebiotics [Dietary fibre, Oligosaccharides (Galacto-oligosaccharides, Fructo-oligosaccharides), Resistant Starch, Sugar alcohols], • Traditional Fermented Foods as sources of Probiotics Role in Health and Disease, Mechanism of Action, Levels of Probiotics required for therapeutic efficacy	**5**
3	**Nutraceuticals** • Nutraceuticals • Concept of Neutraceuticals and functional foods • Major nutraceuticals and their health applications- Bioactive peptides, Curcumin, Conjugated Linoleic acid, Glucosamine, Carnitine, Creatine • Safety and adverse effects associated with the consumption of functional foods and nutraceuticals	**6**

	Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defense services, sportsmen, space food	
4	Food Processing: • Definition and Difference between Food Processing and Food Preservation; Functions, Benefits and Drawbacks of Food Processing • Primary Processing Techniques – dicing, slicing, mincing, macerating, liquefaction, emulsification • Novel Food Processing – mushrooms, algae, leaf protein concentrates, protein from yeast, food analogues, edible insects	**5**
5	Role of QC and QA Quality: • Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries • Food Laws Food Laws and Standards: National and International food laws overview	**5**

References:

1. Anthony Pometto (2005). Food Biotechnology, 2nd Edition. CRC Press

2. Byong H Lee (2014). Fundamentals of Food Biotechnology, 2nd Edition, Wiley Blackwell

3. Goldberg, I 1994. Functional Foods: Designer Foods, Pharma foods, Nutraceuticals Chapman & Hall

4. Gibson, GR and William, CM. 2000. Functional foods - Concept to Product. Woodhead publishing.

5. Aluko, R.E. (2012). Functional Foods and Nutraceuticals. Springer

6. Inteaz Alli. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL,USA.

7. Ronald H. Schmidt and Gary E Rodrick. 2003. Food Safety Handbook. John Wiley & Sons, Inc., Hoboken. New Jersey, USA.

Course Code and title: PSBTELEP-115B Practical in Food Biotechnology

Credits: 02 **Total Lectures: 30**

Practicals:

1	Lab scale production and estimation of acetic acid	2
2	Testing of food adulteration (milk/ milk products/any food sample)	1
3	Extraction and Detection of Aflatoxin in foods	2
4	Isolation and identification of starter organisms from fermented food	2
5	Lab scale production and estimation of quality of cheese	2
6	Isolation and identification of probiotics from fermented food	2
7	Isolation, extraction and characterization of curcumin by TLC	2
8.	Emulsions and Emulsifying Agents – Preparation of Mayonnaise & Vinaigrettes	2

Semester II

Course Code and title: PSBT-121 Genetic Engineering

Credits: 04 **Total Lectures: 60**

Course Outcomes:

1. To develop an approach towards applications of molecular biology techniques in developing recombinant molecules.

2. To understand the concept of genetically modified organisms.

3. To develop the basic conceptual underlying of advanced molecular biology techniques

Units	Topics	Number of Lectures
1	Introduction and tools for genetic engineering • Impact of genetic engineering in modern society; • general requirements for performing a genetic engineering experiment; • endo and exonucleases, RNAses, restriction endonucleases and methylases; DNA ligase, *E.coli* DNA polymerase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; • linkers; adaptors; homopolymeric tailing; • labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes • hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.	12
2	Different types of vectors • Plasmids- pBR322. pBR 325, PUC19 and Bluescript vectors, • Bacteriophages M13 mp vectors, phagemids, • Lambda vectors; Insertion and Replacement vectors, • Cosmids, • Artificial chromosome vectors (YACs; BACs), • Expression vectors: pMal, GST, pET-based vectors; • Mammalian expression and replicating vectors • Baculovirus and Pichia vectors system, • yeast vectors, shuttle vectors, Intein-based vectors	12
3	Different types of PCR techniques,	12

	• Principles of PCR, primer design; • fidelity of thermostable enzymes, • DNA polymerases, • types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; • PCR based site specific mutagenesis; PCR in molecular diagnostics for viral and bacterial detection; • Sequencing methods: enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing, RNA sequencing; chemical synthesis of oligonucleotides; • Mutation detection: SSCP, DGGE, RFLP.	
4	Gene manipulation and protein-DNA interaction • Insertion of foreign DNA into host cells, transformation, electroporation, transfection; transduction- viral vectors, • construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; • construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; • Study of protein-DNA interactions: electrophoretic mobility shift assay; • DNase footprinting; methyl interference assay, • chromatin immunoprecipitation.	12
5	Gene silencing and genome editing technologies • Gene silencing techniques; • introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; • gene knockouts, • Genome editing by CRISPR-CAS with examples, • Cre Lox P recombination system • Genetic diseases-Detection and Diagnosis, • Gene therapy – ex vivo, in vivo, • DNA fingerprinting, Genetically engineered biotherapeutics and • vaccines and their manufacturing	12

References:

1. Principles of Gene Manipulation: An Introduction to Genetic Engineering (2001). Old, R. W., Primrose, S. B., &Twyman, R. M. Oxford: Blackwell Scientific Publications.

2. Green, M. R., &Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

3. Brown, T. A. (2006). Genome (3rd ed.). New York: Garland Science Pub.

4. Principles of gene manipulation and genomics. (2006) 7th Edition. Sandy Primrose and Richard Twyman, Blackwell Publishing.

5. Gene cloning and DNA analysis: An introduction. (2010) 6th Edition. T. A Brow. Willey-Blackwell Publications

6. From genes to genomes. Concepts and applications of DNA Technology. (2012) 3rd Edition. J. W. Dale, M.V. Schantz, N. Plant. Willey-Blackwell Publications

Course Code and title: PSBT-122 Bacteriology and Virology

Credits:04 **Total Lectures: 60**

Course Outcomes:

1. To help students to understand the basic concepts of bacterial and viral classification,

2. To Understand structure, pathology and applications of bacteria in different fields

Units	Topics	Number of Lectures
1	New approaches in bacterial taxonomy • (numerical taxonomy, ribotyping, rRNA sequencing, fatty acid profile) ribosomal RNA analyses for tracing microbial evolution, genetic basis of evolution, evolution of physiological diversity. • Concept of 'unculturable' bacterial diversity. • Strategies for culture of 'unculturable' bacteria • The measurement of microbial diversity, Measures and indices of diversity.	6
2	Ultrastructure of Bacteria : • Cell wall (Gram positive, Gram negative and Archea), • Cell membrane (Gram positive, Gram negative and Archea), • Spore (endospore formation, germination, genetic basis and structure), • Flagella (Assembly, Chemotaxis mechanism) • Capsule, Fimbriae and Pilli , • Cell inclusions • Siderophores – Structure, Function and Significance	10
3	Extremophiles: • Archea, adaptations in extremophiles (acidophiles, halophiles , psychrophiles • Applications in biotechnology	4
4	Applied Bacteriology: • Bacteriology and Public health: Mycobacteria, Enteric bacteria (One example each, Pathogenicity, Virulence and methods of identification), Quorum Sensing (Concept and significance in Biofilm and pathogenicity of Bacteria) • Bacteriology and Agriculture: Biofertlizers, Biopesticides, Mass production of biofertilizers and quality control, Role of Agrobacterium • Pre and Probiotics	8

	• Bacteriology and environment: Bioremediation (Petroleum and Xenobiotic) • Microbial Fuel Cells • Bioluminescence • Bio surfactants	
5	Introduction to viruses: • General properties of viruses • Morphology and ultrastructure of Viruses, • Virus related structures – Viroid's and Prions • Classification of viruses: ICTV system, Baltimore system	4
6	Replication of viruses: • Mechanism of virus adsorption and entry into host cell • Genome replication • Post transcriptional processing • Translation of viral proteins • Protein nucleic acid interactions and genome packaging • Assembly, exit and maturation of progeny virions	8
7	Bacteriophages: • Morphology, Genome organization and Life cycle of lambda phage, M13	3
8	Cultivation of viruses: • In ovo: using embryonated chicken eggs • In vivo: using experimental animals • Ex vivo / In vitro: using various cell cultures - primary and secondary cell lines, suspension cell cultures and monolayer cell culture • In plants and plant cell cultures	5
9	Viral Diagnosis: • Microscopy, Cultivation, Serological and Molecular methods, Infectivity assays, immunodiagnostics Antivirals: • Physical and Chemical agents, Therapeutic agents, Vaccines • Viral Interference and Interferons. Nature and source of interferons, Classification of interferons.	7
10	Animal, Plant and Poultry viruses: • Diseases and Importance with examples • Re-emerging and New emerging viral diseases with example (Influenza, H1N1,SARS,Nipah and Marburg), Current outbreaks	3
11	Concept of Bioterrorism	2

References:

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition. Thomson Brooks / Cole.

2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. PearsonEducation Inc.

3. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.

4. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.

5. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition.Macmillan Press Ltd.

6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.

7. Wilson K. and Walker J.M. (2005) Principles and Techniques of Biochemistry and Molecular

8. Flint Jane. S. (1999), Principles of Virology 3rd edition, ASM (American Society of

Microbiology) Press Publisher, 2 volumes. USA.

9. Bernard.N. Fields, Lippincott and Williams Wilkins, USA Field's Virology - 2 volumes,

5th edition, (2006),

Course Code and title: PSBT-122 Plant Biotechnology

Credits: 04 **Total Lectures: 60**

Course Outcomes:

1. To understand the principles of plant tissue culture, cryopreservation, gene transfer methods and GMO technology.
2. To study the use of lower organisms (Algae and fungi) from a biotechnological perspective.
3. To broaden their research perspective in plant biotechnology.

Units	Topics	Number of Lectures
1	• **History of Plant biotechnology,** • **Overview of basic concepts of Plant tissue culture** - Micropropagation, Somatic embryogenesis, Artificial seeds, In vitro androgenesis, Somatic hybridization, Cybridization, • Production of bio active secondary metabolites by plant tissue culture. ' • Suspension culture: initiation, growth and application	4
2	**Algal biotechnology** – • qualitative (product improvement, strain improvement) and quantitative (yield) improvement in economically important algae like Spiruluna, Dunaliella, Botrycoccus, Chlorella. **Fungal biotechnology** – • qualitative (product improvement, strain improvement) and quantitative (yield) improvement in economically important fungi like mushrooms (Agaricus, Pleurotus, Lentinus), • yeasts- Aspergillus, industrially important fungi. • **Seed Plant Biotechnology**: Qualitative and quantitative improvement in economically important seed plants	8
3	**Cryopreservation** • Concept, theory and various methods and techniques of cryopreservation of plant culture till its revive back • Applications and Disadvantages of cryopreservation	6
4	**Genetic transformation Methods**: • Ti plasmid &Ri Plasmid vectors.	14

	• Mechanism of T-DNA transfer to plants, • Agro infection, • Plant viral vectors. • Physical Methods: electroporation, microinjection and particle bombardment and selection of transformants and regeneration of transgenic plants. • Selectable markers, Reporter genes and Promoters used in plant vectors and their role in genetic transformation.	
5	Genetic manipulation • Introduction, • Transgenic plants for biotic and abiotic stress, • Production of secondary metabolites • Concept of Synthetic Biology for production of bioactive secondary metabolites • Increase in productivity by manipulation of photosynthesis and nitrogen fixation, molecular farming (improvement in protein, lipids, carbohydrates), • vaccines, antibodies, therapeutic proteins, Approaches to marker-free transgenics • Debate over GM crops	14
6	Marker assisted plant breeding and QTL mapping • Introduction Concept and types of markers • Gene vs marker QTL mapping and marker- assisted selection (MAS) QTL mapping techniques • Important properties of ideal markers for MAS Selection for major genes linked to markers • Potential of marker-assisted selection for Crop improvement • Practical applications of MAS. MAS for major genes or improvement of qualitative and quantitative traits • Marker-assisted backcrossing : MABC procedure and theoretical and practical considerations • Marker-assisted gene pyramiding	14

References:

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)

2. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21st century (Academic press).

4. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture: Theory & Practice(Elsevier).

5. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the Genetic Manipulation of plants (Oxford Press)

6. Biotechnology in Crop Improvement, H S Chawla. International Book Distributing Company 1998

7.Gene transfer to Plants 1995, Polykus I and Spongernberg, G. Ed. Springer Scam.

8.Molecular Approaches to Crop Improvement1991. Dennis Liwelly Eds. PP 16

9. Plant Biotechnology 1994, Prakash and Perk, Oxford & IBH Publishers Co

10. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.

11. Anderson, J.A., S. Chao, and S. Liu, 2007: Molecular breeding using a major QTL for Fusarium head blight resistance in wheat. Crop Sci. 4.

12. Heffner, E.L., M.E. Sorrells, and Jannink, J.-L. 2009. Genomic selection for crop improvement. Crop Sc. 49: 1-12.

Course Code and title: PSBTP-124 Lab Course II: Practicals Based on Genetic Engineering, Bacteriology, Virology, and Plant Biotechnology

Credits: 04 **Total Practicals: 30**

Course Outcomes:

1. To perform and analyze recombinant DNA protocols
2. To get hands on training in plant tissue culture technique
3. To learn to isolate viruses in embryonated eggs, virus titration, bacterial isolation, identification and staining technique
4. To visit a tissue culture laboratory.

Units	Topics	Number of Practicals
1	Plasmid DNA isolation and DNA quantitation	1
2	Restriction mapping of plasmid DNA	1
3	Genetic Transfer by Conjugation	2
4	Polymerase Chain Reaction and analysis by agarose gel electrophoresis	1
5	Preparation of competent cells and their transformation with standard plasmids,	2
6	Vector and Insert Ligation	1
7	Southern hybridization	2
8	Isolation of the following types of bacteria from natural samples. Identification of the bacteria to at least the Genus level using the Bergey's Manuals: (The identification key must be designed for each isolated and identified bacterium. Students are expected to isolate at least one Genus from each group.) Mesophilic bacteria /Thermophiles / Anaerobes (any one method)	4
9	Propagation of viruses in animals/tissue culture /embryonated eggs.	2
10	Qualitative and quantitative detection of bacteriophages	1
11	Animal virus titration by Hemagglutination test	1
12	Electron microscopic observations of ultrastrucutre of animal viruses (Pox, Influenza, Rabies and TMV	1
13	Chlorella or Spirulina culture establishments and study of its growth using suitable parameters	1
14	Mushroom cultivation/ Yeast Cultivation and Physicochemical analysis	2

15	In vitro induction of somatic embryogenesis and preparation of artificial seeds	1
16	Micropropagation : initiations , multiplication and subculture	2
17	Initiation of suspension culture for the production of secondary metabolites	2
18	Hairy root induction and confirmation of transgenic	2
19	Visit to tissue culture laboratory and report writing	1

References:

1. Molecular Cloning: a Laboratory Manual. (2012). 4th edition. Green, M. R. and Sambrook, J. Cold Spring Harbor Laboratory Press. NY

Course Code and title: PSBTELE-125A Clinical Research, Data Management and IPR

Credits: 04 **Total Lectures: 60**

Course Outcomes:

1. To understand the regulatory requirements and different phases for conducting clinical trials and required documentation
2. To gain the knowledge of designing database, data management.
3. To know basics of IPR, copyrights and patents

Units	Topics	Number of Lectures
	CLINICAL RESEARCH AND DATA MANAGEMENT	
1	**Introduction to Clinical Research Drug Development Process** • Overview of Drug Development Process including clinical trials phases	**1**
2	**Protocol Designing:** • Definition of protocol, its importance and purpose • Protocol format: Chapters (Headings) and broad contents of protocol • Important scientific and administrative aspect included in protocol • Protocol writing team and role of each member • Clinical trial design: Types of study designs • Sampling, sample size, randomization, Inclusion & Exclusion criteria • Phases of clinical trial & Types of trials	**5**
3	**Good Clinical Practice (GCP)-ICH E6:** • Ethical Principles and their origin • Ethics in clinical research: As per ICMR & GCP • Ethics committees: Roles & responsibility of IEC and IRB • Ethics in relation to vulnerable groups & special situations • Responsibilities of Sponsors, Investigators & Regulators • ICH: Purpose, regulations & guidelines • Informed consent and Informed consent form • Essential Documents	**5**
4	**Drug Regulatory Affairs (Clinical Trial)**	**4**

	• Regulatory Authority in India (DCGI & CDSCO) • Schedule Y of Drugs & Cosmetics Act • International Scenario of Regulatory Aspects: FDA, CFR,	
5	**Clinical Safety &Pharmacovigilance:** • Definitions of AE, ADR, SAE, • Recording & reporting: Objectives & Importance • Pharmaco vigilance: International procedures • Pharmaco vigilance in India	**3**
6	Monitoring of Clinical Trials • Monitoring and its role in clinical trials • CRF and other source documents relevant to monitoring	**2**
7	Concept of Database and Clinical Data Management • Concept and designing of Database, • Data management & IT in clinical research • CRF designing • Query raising and query resolution • EDC System and 21 CFR Part 11 compliance • Practical for Protocol Design, CRF Design and source documentation	**10**
INTELLECTUAL PROPERTY RIGHTS		
8	**General Regime of Intellectual Property Rights:** Overview and Historical Perspectives; • Intellectual Property as an Instrument of Development; • Need for Protecting Intellectual Property- Policy Consideration- National Perspectives and International demands; • TRIPS (Trade Related Intellectual Property Rights) Agreement and International Treaties related to IPR	**6**
9	Patents: Criteria of Patentability; types of patent applications: provisional and complete specifications. • Procedure for Filing Patent Applications, Patent Granting Procedure; • Revocation, Patent Infringement and Remedies; • Relevant Provisions of the Biological Diversity Act, 2002; • Commercialization of patented innovations; licensing – outright sale, licensing, royalty;	**8**
10	Copyright and Neighboring Rights - Conceptual Framework, Copyright works, Ownership, transfer and duration of Copyright, Renewal and Termination of	**12**

	Copyright, Neighbouring Rights, Infringement of copyrights and remedies; Examples and Case study; • Protection of Plant Varieties and Plant Breeders' Rights - Protection of Plant Varieties and Farmers' Rights, Authority and Registry, Registration of Plant Varieties and Essentially derived variety, Duration, Effect of Registration and Benefit Sharing; Examples and Case study;	
11	Patent Specification Drafting Exercise	**4**

References:

1. Katzung, B.G. Basic and Clinical Pharmacology, (2010) Prentice hall International

2. National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (2017)

3. E6 Good Clinical Practice. Code, Document Title, Previously coded. E6(R2) Good Clinical Practice(GCP). Finalised Integrated Addendum: November 2016.

4. New Drugs and Clinical Trials Rules 2019

5. Website: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm

6. Karki, M S, Intellectual property rights: basic concepts (2009) M Atlantic Publishers & Distributors, New Delhi

7. Wadehra, B.L. Law Relating To Intellectual Property, (2011), Fifth Edition, Universal Law Publishing Co.Pvt. Ltd.

8. TIFAC 2002 Some questions and answers on Patents an d Copyrights

9. Das, H K ,Text book of Biotechnology,(2010), 4thedition, Wiley India Pvt. Ltd, New Delhi

10. Chawala, H .S., Introduction to Plant Biotechnology, 3rdedition, Science Publishers

11. Hirvani R, Patents in Plant Breeding: Guarding the Green Gold-,Biotech News, (2009),vol 4.

12. Ganguli Prabuddh, Intellectual Property Rights, (2001), Tata McGraw-Hill Publishing Company Ltd.

13. Narayanan P, Law of copyright and Industrial Designs,(2010), Eastern Law House, Delhi

14. Office of the Controller General Of Patents, Designs & Trade,(CGPDTM): Manual of Patents/Manual of Industrial Design/Draft Manual of Trademarks

Course Code and title: PSBTELE-125A Medical Biotechnology

Credits: 04 **Total Lectures: 60**

Course Outcomes:

1. to understand the cellular and molecular pathogenesis of the various diseases;

2. To understand molecular and cytological causes for various genetic disorders,

3. To understand various current diagnostics methods and therapies

Units	Topics	Number of Lectures
1	Introduction to medical biotechnology History and recent developments	2
2	Basis of diseases and disorders • Microbial diseases- Types of infections - primary, secondary, nosocomial, iatrogenic, zoonotic etc. Mechanisms of Bacterial and viral pathogenesis (bacterial toxins, capsules, enzymes, intracellular parasitism, antigenic variations etc. leading to establishment of infections. with any one example of each) • Genetic diseases- chromosomal disorders, single gene (cystic fibrosis, hemophilia, Sickle cell anemia) and polygenic disorders (Type 1 diabetes, Alzheimer Disease, breast cancer), mitochondrial disorders • Metabolic disorders- • Nutritional disorder: Kwashiorkor, Marasmus , Obesity, Diabetes, Inborn errors of metabolism- 1) Protein-PKU, Alkaptonuria and Maple syrupuria and Gauchers 2) Carbohydrates - glycogen storage disorders, Cori's disease and Pomes disease 3)Lipids- Atherosclerosis 4) Nucleic acids- Gout, Lesch-Nyhan syndrome	15
3	Diagnostic tools • Types- physical (overview) • Biochemical- Enzyme, protein based, antibody based, PCR based, microarrays based, cytogenetic methods including karyotyping, FISH, GISH), nano-based Principles of lab diagnosis of infectious diseases	18
4	Therapies- introduction to various therapeutic agents • Gene therapy • Proteins and enzymes in therapy	18

	• Chemotherapeutics - antibiotics and chemotherapeutic agents, viral agents, and antiviral drugs, chemotherapy for cancer treatment • Stem cell therapy, tissue engineering • Bioartificial organs • Nanotechnology in therapeutics	
5	Preventive measures- importance, overview of vaccines,	4
6	Societal, ethical, economical issues	3

References:

1. Medical Biotechnology. 2014. 1st edition. B.R. Glick, T.L. Delovitch, C. L. Patten. ASM Press

2. Molecular Diagnostics. For the clinical Laboratorian. 2nd Edition W. B Coleman, G. S. Tsongalis. Human Press

3. Molecular Diagnostics. 2005. 1st edition. G. P. Patrinos, W. Ansorge. Elsevier Pulblications.

4. Human Molecular genetics. (2019). 5th edition. T. Strachan, A. Read. Garland Science.

5. Human Molecular genetics – McConkey