BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

M.Sc. BIOTECHNOLOGY: CHOICE BASED CREDIT SYSTEM -
LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

Sem.	Courses	Title	Ins. Hrs.	Credit	Exam. Hrs.	Marks		Total
						Int.	Ext.	
I	Core Course I (CC)	Cell and Molecular Biology	6	5	3	25	75	100
	Core Course II (CC)	Microbiology	6	5	3	25	75	100
	Core Choice Course I (CCC)	1. Biochemistry 2. Enzymes and Enzyme Technology	6	5	3	25	75	100
	Core Practical I (CP)	Cell and Molecular Biology, Microbiology, Biochemistry	6	3	3	40	60	100
	Elective Course I (EC)	1. Cancer Biology 2. Developmental Biology	6	4	3	25	75	100
	Value Added Course I (VAC)	Organic Farming	-	2*	3	25	75	100*
	Total		**30**	**22**	**-**	**-**	**-**	**500**
II	Core Course III (CC)	rDNA Technology	6	5	3	25	75	100
	Core Course IV (CC)	Microbial Biotechnology	5	5	3	25	75	100
	Core Choice Course II (CCC)	1. Immunology 2. Bioprocess Technology	5	5	3	25	75	100
	Core Practical II (CP)	rDNA Technology, Immunology and Bioprocess Technology	6	3	3	40	60	100
	Elective Course II (EC)	1. Bioanalytical Techniques 2. Pharmacology	5	4	3	25	75	100
	Non-Major Elective Course I	Agricultural Biotechnology	3	2	3	25	75	100
	Total		**30**	**24**	**-**	**-**	**-**	**600**
III	Core Course V (CC)	Plant Biotechnology	6	5	3	25	75	100
	Core Course VI (CC)	Animal Biotechnology	5	5	3	25	75	100
	Core Choice Course III (CCC)	1. Research Methodology 2. Genomics and Proteomics	5	5	3	25	75	100
	Core Practical III (CP)	Plant and Animal Biotechnology (P)	6	3	3	40	60	100
	Elective Course III (EC)	1. Biostatistics, Bioinformatics, Bioethics and IPR 2. Nanobiotechnology	5	4	3	25	75	100
	Non-Major Elective Course II	Bioenergy Technology	3	2	3	25	75	100
	Total		**30**	**24**	**-**	**-**	**-**	**600**
IV	Core Course VII (CC)	Environment Biotechnology	6	5	3	25	75	100
	Core Course VIII (CC)	Food Technology	6	5	3	25	75	100
	Entrepreneurship / Industry Based Course	Biotechnology for entrepreneurship	6	5	3	25	75	100
	Project	Project	12	5	-	20	80	100
	Value Added Course II (VAC)	Mushroom Cultivation	-	2*	3	25	75	100*
	Total		**30**	**20**	**-**	**-**	**-**	**400**
Grand Total			**120**	**90**	**-**	**-**	**-**	**2100**

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

Sl. No.	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	Core Courses	8	40	800
2.	Core Choice Courses	3	15	300
3.	Core Practicals	3	9	300
4.	Elective Courses	3	12	300
5.	Entrepreneurship/ Industry Based Course	1	5	100
6.	Project	1	5	100
7.	Non-Major Elective Courses	2	4	200
	Total	**21**	**90**	**2100**
	Value Added Courses *	2*	4*	200*

***The value added courses credit will not be included in the total CGPA.**
These courses are extra-credit courses.
Instruction hours for these courses is 30 hours.

PROGRAMME OBJECTIVES:

Graduate students from a diversity of life science disciplines make up the Masters in Biotechnology programme; as a result, the courses in this programme are designed to strongly emphasize on industry and research to

- Develop the advanced knowledge of the fundamentals of biotechnology for the day to day activities in both academia and industry.
- Prepare the students to recognise new issues and suggest research strategies to address them.

PROGRAMME OUTCOMES:

After successful completion of the programme, the students will be able to

- Address the research issues globally in the fields of biotechnology by using multidisciplinary methodologies.
- Build their scientific communication abilities for futuristic academic and research needs.
- Get the clear-cut understanding of how to proceed in the biotechnology sector, whether through biotechnology business or research.
- Utilize their expertise and knowledge of biotechnology's tools for environmentally beneficial and long-lasting answers to today's problems.
- Evolve their capabilities in research findings and research proposals in order to compete for research opportunities in national and international institutes.

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First Year **CORE COURSE I** **Semester I**

CELL AND MOLECULAR BIOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Familiarize the student in different areas of cell and molecular biology streams, including cellular organization and their interactions.
- Study the DNA replication, protein biosynthesis and translational regulation.
- Develop a comprehensive understanding of the complete cellular and molecular function of cell organelles in cell-to-cell interaction, gene regulation, and cellular signaling

UNIT – I THE STRUCTURE AND FUNCTION OF THE PLASMA MEMBRANE:

Chemical Composition of Membranes; Membrane Lipids, The Asymmetry of Membrane Lipids, Membrane Carbohydrates; Structure and Functions of Membrane Proteins; Integral Membrane Proteins, Peripheral Membrane Proteins, Lipid-Anchored Membrane Proteins; Membrane Lipids and Membrane Fluidity; Importance of Membrane Fluidity, Maintaining Membrane Fluidity, Lipid Rafts. Movement of Substances Across Cell Membranes; The Energetic of Solute Movement, Diffusion of Substances through Membranes, Facilitated Diffusion, Active Transport.

UNIT – II MOLECULAR STRUCTURE AND FUNCTIONS OF CELL ORGANELLE:

Mitochondria: structure, origin and evolution, organization of respiratory chain complexes, Mitochondrial Genome. Structure-functional relationship; Structure and function of peroxisome; Structure and function of microbodies, Golgi apparatus, lysosomes and Endoplasmic reticulum; Overview of cellular cytoskeleton: Organization and role of microtubules and microfilaments; Intermediate filaments; Cellular motility; Molecular motors. Nucleus: structure and function of nuclear envelope, lamina and nucleolus; Chromatin organization and packaging.

UNIT – III DNA REPLICATION, REPAIR AND RECOMBINATION:

Models of DNA replication: Semiconservative DNA replication, semidis continuous DNA Replication, unidirectional and bidirectional DNA replication – Mechanism of DNA replication in prokaryotes, DNA replication in eukaryotes - The structure and functions of DNA Polymerase, Replication in Eukaryotic cells. DNA Repair – Nucleotide excision repair, Base excision repair, Mismatch repair, Double strand Breakage Repair. Recombination: double strand break model or recombination.

UNIT – IV GENE EXPRESSION: FROM GENE TO PROTEIN:

An overview of the flow of Information through the cell – Overview of Transcription: Transcription in Bacteria, Transcription and RNA processing in Eukaryotic cells – Synthesis and processing of Ribosomal and Transfer RNA, Messenger RNA, Small noncoding RNAs and RNA interference, Translating Genetic information; Initiation, Elongation, Termination.

UNIT – V CANCER BIOLOGY:

Basic properties of a Cancer cell – Causes of cancer – Genetics of cancer – Tumor suppressor Genes and Oncogenes: Tumor viruses and oncogenes: Transformed cells, detection of integral viral DNA, structure of integral viral DNA. Protein kinase and transformation by retro viruses. Cellular counterpart of src. Carcinogens. Activation of oncogenes. Oncogenic proteins - protein kinases, growth factors, ras protein. Cancer Genome, New strategies for combating cancer – Immunotherapy, Inhibiting the activity of cancer promoting proteins.

Unit – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Freifelder D.2004. Molecular Biology, Narosa Publishing House. New Delhi.
2. Lewin B. 2018. Genes XII. Oxford University Press, London.
3. Ajoy Paul. 2014. Textbook of Cell and Molecular Biology**.** Books and Allied Ltd.
4. Karp, G., Iwasa, J., & Marshall, W. (2018). *Karp's Cell Biology*. John Wiley & Sons.
5. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., & Walter, P. (2019). *Essential cell biology*. Fifth edition, Garland Science.
6. Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P.0 &Matsudaira, P. (2008). *Molecular cell biology*. Macmillan.
7. Thomas D. Pollard & William C. Earnshaw & Graham T. Johnson. 2016. Cell Biology. 3rd
8. Edition. Elsevier Health Sciences
9. Watson JD, Gilman M, Witkowski J and Zoller M. 2010. Recombinant DNA. Scientific American Books. 4th Edition. New York.
10. Blackburn GM and Gait MJ. 2022. Nucleic Acids in Chemistry and Biology 4th edition. Oxford University Press.
11. Lodish H, Baltimore D, Beck A, Zipursky SL, Matsudaria P and Darnell J. 2007. Molecular Cell Biology. 4th Edition. Scientific American Books.
12. Cooper M. 2007. The Cell Molecular Approach. 2nd Edition. ASM Press.
13. Lewis J Kleinsmith and Valerie M Kish. 1995. Principle of Cell and Molecular Biology 2nd Edition. Benjamin-Cummings Publishing Company.
14. De Robertis, EDP and E.M.F Robertis. 1987. Cell and Molecular Biology. 8th Edition. Saunders Company.
15. Brown. T.A. 2011. Introduction to genetics: A molecular approach. 1st Edition. Garland Science.
16. J.D.Watson, Tania A. Baker, Stephen P. Bell, Michael Levine and Richard Losick. 2013. Molecular Biology of the Gene. 7th Edition. Benjamin/Cummings Publ. Co., Inc., California.
17. Benjamin Lewin. 2010. Genes XI. 11th Edition. Jones & Bartlett Learning.
18. Meyers. RA. 1996. Molecular Biology and Biotechnology. A comprehensive desk reference. (Ed) Wiley-Blackwell Publishers.

COURSE OUTCOMES:

- Extend the knowledge of the structure and functions of genetic materials.
- Focus on genome organization, transcription and translation process in prokaryotes.
- Acquire elaborate knowledge on nucleic acids and replication.
- Illustrate the reactions that comprise energy metabolism.
- Get thorough understanding of tumour viruses and oncogenes.

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First Year **CORE COURSE II MICROBIOLOGY (Theory)** **Semester I**

Code: **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Impart knowledge on classification of microbes and to provide understanding on metabolic function and biochemical reaction going on inside the microbial cell.
- Understand and predict the intermediate metabolism of any microbe used in industrial production processes.
- Acquire knowledge of microbial metabolism.

UNIT – I INTRODUCTION TO MICROBIOLOGY:

Discovery of microbial world, the experiment of Pasteur, the era of discovery of antibiotics and anaerobic life. Types and classification of microbes. Isolation, identification, characteristics and ultra structure of microbes – Viruses, Bacteria, Fungi and Algae. Various associations of microbes.

UNIT – II MICROBIAL BIODIVERSITY, GROWTH AND MOLECULAR SYSTEMATICS:

Origin and evolution of microorganisms. Concepts of species and hierarchical taxa.Bergy's system of classification – Viruses, Bacteria, Fungi. Biological nomenclature - Measurement of species richness and evenness. Simpson's diversity index – Multivariate analysis. **Microbial Nutrition and Growth:** Principles of microbial nutrition – carbon, nitrogen, sulphur, growth factors, nutritional requirements of Bacteria. Nutritional uptake and transport. Nutritional classification of Bacteria. Culture media preparation. Types of media - Selective media, Enrichment media and Differential media. **Molecular Systematics**: Techniques for the Identification and Genotyping of Microorganisms – Genotyping, 16S rRNA gene sequencing, 18SrRNA Sequencing, PFGE, ERIC, Ribotyping, RAPD, RFLP, MLST. Microbial Community analysis: DGGE, TGGE, SSCP, T-RFLP, FISH

UNIT – III MICROBIAL METABOLISM:

Influence of environment on microbial physiology. Physical factors – radiations, temperature, pH and pressure. Chemical factors – nutrients, water, C, H, O, N, P, S. Growth factors - amino acids, purines, pyrimidines, nucleosides, nucleotides, vitamins, lipids, inorganic nutrients. Antimicrobial compounds, metabolic inhibitors. Response to environment – growth and reproduction; growth inhibition and death, movement, differentiation. Modification to the environment – changes in chemical composition, changes in physical properties. Quantitative measurement of bacterial growth by cell mass, cell number and cell activity. Maintenance and preservation of cultures.

UNIT – IV METHODS IN MICROBIOLOGY:

Isolation of microbes fromvarious sources - serial dilution, pure culture and culture préservation techniques. Microbial culture collection centers. **Staining techniques** – Simple and differential - Gram, endospore, negative, flagellar staining. **Sterilization techniques:** 1. Concept of sterilization, disinfection, asepsis and sanitation. Moist heat; dry heat, pasteurization, Richards' rapid method - HTST (high temperature/short time) treatments; filter sterilization. 2. Sterilization methods - batch sterilization, continuous sterilization of medium and air. Physical methods of control - temperature, radiation,

desiccation, osmotic pressure and filtration. Chemical methods of control - phenol, alcohol, halogens, heavy metals, dyes, detergents, quaternary ammonium compounds, aldehydes and gaseous chemosterilizers. Evaluation of antimicrobial potency of disinfectants and antiseptics - tube dilution, agar diffusion. phenol coefficient.

UNIT – V MICROBIAL GENETICS:

Genetic system of bacteria – transformation, transduction, recombination. Extra cellular genetic material - plasmids and transposons. Genetic systems of viruses – Phage I, RNA viruses and retroviruses. Genetic system of fungi – Yeast and Neurospora. Genetic system of protozoa and mycoplasma. Gene regulation - prokaryotic gene regulation. Operon concept -lac operon and tryptophan operon. **Metagenomics - Culture Independent Studies:** Exploring and exploiting the microbial gene pool. Methods to detect and quantify bacteria in various ecological niches. Analysis of microbial communities in microhabitats using FISH. Functional characterization of microbial communities by mRNA analysis. Detection of active bacterial populations in soil.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Prescott, Harley, Klein. 2003. Microbiology. 5thEdition.McGraw Hill Publ.
2. Bernard R. Glick & Jack J. Pasternak. 2002. Molecular Biotechnology. Indian edition. Panima Publishing Corporation.
3. Pelzer, Chan and Kreig. 1986. Microbiology. 5th Edition. McGraw-Hill
4. Gerald J.Tortora, Berdell R, Funke, Christine L Case. 2013.
5. Microbiology: An Introduction (2018). Pearson Education.
6. Jeffrey C. Pommerville. 2011. Alcamo's Fundamentals of Microbiology. 9th Edition. Jones and Bartlett Publishers.
7. Jacquelyn G Black, Laura J Black. 2015. Microbiology: Principles and Explorations.
8. Stephen H. Gillespie, Peter M.Hawkey. 2006. Principles and practice of clinical Bacteriology. Wiley & Sons.
9. Sanjai Saxena. 2015. Applied Microbiology. Springer.
10. Kayser F.H, Bienz K.A, Eckert J, Zinkernagel RM.1998. Medical Microbiology. Thiemestuttgartz. New York.
11. Subha Chandra Pariga. 2014. Microbiology and Immunology. Elsevier.
12. Powar and Daginwala. 2010. General Microbiology. Vol. I. Himalaya Publishing House

COURSE OUTCOMES:

- Understand the History and classification of microbes.
- Outline the microbial diversity, growth and techniques of molecular characterization of microorganisms.
- Summarize the physical, chemical and environmental factors that influence microbial metabolism.
- Explain the different types of sterilization techniques.
- Demonstrate the Genetic system of bacteria, viruses, yeast and Neurospora.

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First Year **CORE CHOICE COURSE I** **Semester I**

1) BIOCHEMISTRY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study the structure, properties and metabolism of different biomolecules.
- Know the interrelationships between different metabolisms and their disorders.
- Acquire knowledge of biomolecules and their consequences for interpreting & solving clinical problems.

UNIT – I BIOENERGETICS:

Free energy and entropy. Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain–organization and role in electron capture. Electron transfer reactions in mitochondria. Oxidative phosphorylation- F1/F0 ATPase-structure and mechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and Oxidative phosphorylation – uncouplers, ionophores. Regulation of oxidative phosphorylation.

UNIT – II CARBOHYDRATE METABOLISM:

Classification, Structure and Isomerism.Monosaccharides, Oligosaccharides, Polysaccharides– Structure and Properties. Metabolism of Carbohydrates- Glycolysis, Mechanism of pyruvate Dehydrogenase, Citric acid cycle, HMP shunt, Glucuronic acid Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle. Metabolic disorders associated with carbohydrate metabolism. CSDB (Carbohydrate Structure Database, Glycome DB, Calvin cycle).

Unit – III Lipid Metabolism:

Biosynthesis of fatty acid and its regulation, biosynthesis of triacylglycerol, phospholipids and cholesterol. Metabolism of triacylglycerol during stress.α, β, γ, Oxidation of fatty acids– Role of carnitine cycle in the regulation of β -oxidation. Ketogenesis and its control. Lipoprotein types and its functions. Metabolic disorders associated with lipid metabolism, LMSD (Lipid Maps Structure Database), Lipid Bank.

UNIT – IV METABOLISM OF AMINO ACIDS, PROTEINS:

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid-transamination, deamination, ammonia formation, urea cycle and its significance. Catabolism of carbon skeletons of amino acids. Protein – classification, types, characteristics and structures, PDB (Protein Data Bank), Ramachandran plot, PROCHECK Solid state synthesis of peptides, Sequence determination.

UNIT – V METABOLISM OF PURINES AND PYRIMIDINES:

Digestion and absorption of nucleoproteins, Fractionation, sequencing and chemical synthesis of oligonucleotides. Metabolism of purines- de novo and salvage pathways for purine biosynthesis, regulation of biosynthesis of nucleotides. Purine catabolic pathway. Metabolism of pyrimidines - biosynthesis and catabolism. Disorders of purine and pyrimidine metabolism, intermediary metabolism and KEGG pathway.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

References:

1. L. Lehninger. 2021. Principles of Biochemistry, 8th Edition. W.H Freeman and Company.
2. Stryer. 2002. Biochemistry. 5th Edition. W.H. Freeman and Company.
3. G.L. Zubay., V.R. Rastogi., K.R. A. Geoffrey., V.B. Rastogi., K.R. Aneja 2017. Zubay's Principles of Biochemistry. Medtech Publisher
4. M.N. ChattergeaRanaShinde. 2011. Text book of Medical Biochemistry. 8th Edition. J.P. Medical Ltd.
5. J. L. Jain, Sunjay Jain, Nitin Jain. 2005. Fundamentals of Biochemistry. S. Chand and Company, New Delhi.
6. Allan Fershi. 1984. Enzyme structure and mechanism. 2nd Edition. W.H.Freeman& Co. Ltd., USA.
7. Trevor Palmer, 1985. Understanding Enzymes. 2nd Edition. Ellis, Horwood Limited.
8. Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly and Anthony P. Weli. 2015. Harper's Illustrated Biochemistry 30th Edition. McGraw Hill Lange Medical Books.
9. Donald Voet and Judith G.Voet, 2004. Biochemistry. 3rd Edition. John Wiley, New York.
10. https://nptel.ac.in/courses/102/105/102105034/https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/Week-1_06-Carbohydrate.pdf
11. https://csdb.glycoscience.ru/database/
12. http://www.glycome-db.org/
13. https://www.lipidmaps.org/data/structure/index.php
14. https://www.rcsb.org/
15. https://www.ebi.ac.uk/thornton-srv/software/PROCHECK/

COURSE OUTCOMES:

- Acquire knowledge about bioenergetics and its principles.
- Describe the metabolic pathways of carbohydrates and their regulatory mechanisms.
- Illustrate the structure, biological functions and metabolism of lipids.
- Intellectual about the structures of amino acids, their chemical properties and their metabolism.
- Assess the synthesis of purines and pyrimidines along with their regulation and explain.

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First Year **CORE CHOICE COURSE I** **Semester I**

2) ENZYMES AND ENZYME TECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the concepts and classes of enzymes.
- Study about enzyme kinetics and applications of enzymes.
- Give the knowledge on applications of various enzymes in industries.

UNIT – I HISTORICAL ASPECTS OF ENZYMOLOGY:

History, nomenclature and classification of enzymes, according to IUB-EC-1964.Intracellular localization of enzymes, isolation and fractionation of enzymes-classical methods of purification and crystallization, criteria of purity, units of enzyme activity. Turn over number, specific activity. Active site definition, organization and determination of active site residues, Isoenzymes.

UNIT – II KINETICS OF THE CATALYZED REACTION:

Single substrate reactions, bisubstrate reactions, Concept and derivation of Michaelis – Menten equation, Lineweaver Burk plot, Briggs Haldane relationship. Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics. Inhibition kinetics - competitive, non-competitive and uncompetitive. Allosteric inhibition, cooperative, cumulative, feedback inhibition.

UNIT – III MECHANISM OF ENZYME CATALYSIS:

Collision & transition state theories, specificity of enzymes. Proximity and orientation effects, general acid-base catalysis, covalent and electrostatic catalysis - nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Theories on the mechanism of catalysis. Coenzymes - structure and function, Mechanism of enzymes action: mechanism of action of lysozyme and chymotrypsin.

UNIT – IV ENZYME REGULATION:

General mechanisms of enzyme regulation, Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples. Allosteric enzymes, qualitative description of “concerted” & “sequential” models for allosteric enzymes.

UNIT V INDUSTRIAL APPLICATIONS OF ENZYMES:

Immobilization and Immobilized enzymes. Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Applications of immobilized enzymes.

Biosensors – glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors. Abzymes and Ribozymes. Enzymes of clinical importance - diagnostic significance and therapeutic effects. Enzyme Engineering.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. L. Lehninger. 2021. Principles of Biochemistry, 8th Edition. W.H Freeman and Company.
2. Stryer. 2002. Biochemistry. 5th Edition. W.H. Freeman and Company.
3. G.L. Zubay., V.R. Rastogi., K.R. A. Geoffrey., V.B. Rastogi., K.R. Aneja 2017. Zubay's Principles of Biochemistry. Medtech Publisher.
4. Allan Fershi. 1984. Enzyme structure and mechanism. 2nd Edition. W.H.Freeman& Co. Ltd., USA.
5. Trevor Palmer, 1985. Understanding Enzymes. 2nd Edition. Ellis, Horwood Limited.
6. Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly and Anthony P. Weli. 2015. Harper's Illustrated Biochemistry 30th Edition. McGraw Hill Lange Medical Books.
7. Donald Voet and Judith G.Voet, 2004. Biochemistry. 3rd Edition. John Wiley, New York.
8. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104105076/lec8.pdf

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Acquire the knowledge about history, classification, purification and separation of enzymes
- Intellectual about enzyme kinetics.
- Describe the mechanism of enzyme action.
- Construct the knowledge on enzyme regulation.
- Appraise the techniques of immobilization and application in enzymes in industries.

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First Year **CORE PRACTICAL I** **Semester I**

CELL AND MOLECULAR BIOLOGY MICROBIOLOGY, BIOCHEMISTRY

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study the physiology of the cells and their enumeration.
- Identify the specialized chromosomes.
- Perform the isolation, purification and quantification of nucleic acids.

EXPERIMENTS:

CELL AND MOLECULAR BIOLOGY

1. Cell Division – Mitosis and Meiosis
2. Barr body Identification in cells of Buccal smear.
3. Isolation and purification of Genomic DNA from prokaryotes.
4. Separation of DNA by AGE.
5. Separation of Protein by SDS – PAGE.
6. Conjugation, Transformation and Transduction (Demo)

MICROBIOLOGY

1. Isolation of microorganisms from air, soil & water - spread plate, pour plate, streak plate techniques
2. Staining methods – simple, differential, acid - fast & negative
3. Identification - Macroscopic, microscopic, biochemical, serological & generic level
4. Antibiotic sensitivity test – Kirby - Bauer method.

BIOCHEMISTRY

1. Extraction and Estimation of sugar from natural sources – glucose.
2. Estimation of protein by Lowry's method.
3. Estimation of amino acid by Ninhydrin method
4. Quantitative analysis of blood urea/ creatinine
5. Estimation of DNA by diphenylamine and RNA by orcinol method

REFERENCES:

1. David A. Thompson. 2011. Cell and Molecular Biology Lab Manual. CreateSpace Independent Publishing Platform'
2. Harley Presscot. 2002. Laboratory Exercises in Microbiology. 5th Edition. The McGraw Hill.
3. P.Gunasekaran. 2007. Laboratory Mannual in Microbiology. New Age International.

4. Alfred Brown, Heidi Smith. 2014. Benson's Microbiologica; Applications. Laboratory Manual in General Microbiology. John wiley& Sons.
5. Julio E Celis, David Shotton, Nigel Carter, Tony Hunter, Victor small J, Kai Simons. 2005. Cell Biology. Four Volume Set: Cell Biology. Vol. 1, 3rd Edition: A laboratory Handbook. Elsevier. Academic Press.

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Describe the basic instruments in cell biology
- Demonstrate the morphology of various types of cells and their enumeration
- Illustrate the different types of cell division
- Apply the various methods for the quantification of nucleic acids
- Acquire knowledge on protein quantification and separation.

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First Year **ELECTIVE COURSE I** **Semester I**

1) CANCER BIOLOGY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Provide the basic facts about cancer.
- Acquire the knowledge of molecular genetics of cancer.
- Provide the basic knowledge of cancer diseases and their treatment

UNIT – I CANCER:

Definition, Description of cancer, Basic facts about cancer, cancer is clonal in origin, Hallmarks of Cancer, general classification of human cancers, microscopic and macroscopic features of neoplasm's, Grade and stage of neoplasm – Histologic grade of malignancy and tumor staging.

UNIT – II CAUSES OF CANCER:

Theory of HITS, Chemical carcinogenesis – metabolic activation of chemical carcinogens (donors of simple alkyl group, cytochrome P-450 mediated activation), Mechanism of tumor initiation, promotion and progression.Irradiation carcinogenesis and viral carcinogenesis (Epstein Barr virus and Hepatitis virus).

UNIT – III MOLECULAR GENETICS OF CANCER:

Oncogenes, Oncogene families, cell transforming ability of onc gene, functional classes of oncogenes, Characteristics of individual oncogene (ras and erbA). Tumor suppressor genes – suppressor genes (rb and p53). Cancer diagnosis – categories of tumor markers (nucleic acid based markers and gene expression microarray).

UNIT – IV APOPTOSIS:

Bcl2 family proteins, Caspases, Apoptotic signaling pathway (Intrinsic and extrinsic pathway- Telomeres and immortality-Molecular mechanism of tumor metastasis.- WHOclassification- Tumor staging and grading- VEGF signaling, Angiogenesis.

UNIT – V DIAGNOSIS AND TREATMENT:

Methods in cancer cytogenetics (Karyotyping, FISH).Tumor markers, geneticmarkers of cancer predisposition (Tumor suppressor genes as diagnostic tool), Strategies of anticancer drug therapy: Chemotherapy (Cdk inhibitors as target of chemotherapeutic agents and ubiqutinizationincancer, classification of cytotoxic drugs: Alkylating agents, Platinum drugs, Topoisomerase inhibitors), gene therapy, Immunotherapy and Radiotherapy - Stem Cells and Cancer - Personalized medicine in cancer.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Raymond W. Ruddon, 2007. Cancer Biology. Oxford University Press, USA.
2. MomnaHejmadi, 2010. Introduction to cancer biology. MomnaHejmadi&Ventus Publishing ApS.
3. Bruce Alberts, Molecular Biology of the Cell (2015), Garland Science Publications, Newyork, USA.
4. S Pelengaries and M Khan, 2006. The molecular biology of Cancer. Ed. Blackwell Publishing.
5. Hanahan, Douglas et al., 2011. Hallmarks of Cancer: The Next Generation. Cell, Volume 144,646–674.
6. R. A. Weinberg, 2006. The Biology of Cancer: Garland Science.
7. R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G.BarryPierce, I. Damjanov, 2006.
8. The Biological Basis of Cancer. 2nd Edition (2006), Cambridge University Press.
9. https://nptel.ac.in/courses/104/105/104105102/
10. https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod1.pdf

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Gain a deep understanding of the fundamental processes related to cancer, growth, causes, and differentiation.
- Understand the multistep genetic alterations which enable the transformation of a normal cell into cancer.
- Describe the Molecular genetics of Oncogenes and Tumour Suppressor genes
- Acquire the knowledge of Apoptosis and its signalling
- Gain knowledge of cancer-related diseases and their treatment.

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First Year **ELECTIVE COURSE I** **Semester I**

2) DEVELOPMENTAL BIOLOGY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study the cellular basis of development.
- Study the early development process of humans.
- Provide knowledge on the medical implications of developmental biology.

UNIT – I BASIC CONCEPTS OF DEVELOPMENT:

The general concept of organisms development: Potency, commitment, specification, induction, competence, determination & differentiation; morphogenetic gradients; cell fate & cell lineages; genomic equivalence and cytoplasmic determinants; imprinting. Mutant and transgenic in analysis of development .General principles of cell-cell communication in development: cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, paracrine factors.

UNIT – II GAMETOGENESIS AND FERTILIZATION:

Gametogenesis and fertilization in animals, ultra structure of sperm and ovum, egg types, egg membrane. Fertilization, cleavage, Morula, Implantation, blastulation, gastrulation, formation of germ layers, axis formation - anterior and posterior. Sex determination - chromosomes and environment.Molecular events during fertilization, genetic regulations in embryonic development.Establishment of symmetry in plants, Seed formation and germination.

UNIT – III MORPHOGENESIS AND ORGANOGENESIS IN ANIMALS:

Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditiselegans; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination. Chromosomal sex determination in mammals and Drosophila.

UNIT – IV MORPHOGENESIS AND ORGANOGENESIS IN PLANTS:

Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and Antirrhinum.

UNIT – V IMPLICATIONS OF DEVELOPMENTAL BIOLOGY:

Medical implications of developmental biology - genetic disorders in human development, environmental assaults on human development, Future therapies, Environmental regulation of animal development - Environment as a part of normal development, Polyphenisms, plasticity and Learning. Development and Evolution.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Gilbert S.F. (2010) Developmental Biology, (Ed: 9) - Sinauer Associates Inc. Massachusetts, USA,
2. Berrill N.J, (1974).Developmental Biology, TMH Edition,
3. Diwan A.P., Dhakad N.K., (1996). Animal Regeneration-. Anmol Publications Ltd, India.
4. Browder L.W., Erickson C.A., and Jeffery W.R, Saunder. (1991). Developmental Biology-College Publishing House, Philadelphia, USA.
5. Strickberger, (2002). Genetics, 3rd edition- Prentice Hall of India.
6. Benjamin Lewin. (2000). Genes VII- Oxford University Press.
7. Sarin C. (1990). Genetics-, Tata McGraw–Hill Publishing Co., Ltd., New Delhi,
8. Gupta PK. (1996). Genetics- Rastogi Publications, Meerut, India.
9. Alberts B. (2002). Molecular Biology of the Cell, (Ed: 3) -, Garland Science, USA.
10. Brian K. Hall, Kluwer. (1999). Evolutionary Developmental Biology (2nd edition) - Academic Publishers.
11. T.Subramanium. (2013) Molecular Developmental Biology.
12. Leon W. Browder (2013). The Cellular Basis of Morphogenesis (Developmental Biology, 2) Springer Softcover reprint of the original 1st ed. 1986 Edition.
13. Blanche Capel. (2019). Sex Determination in Vertebrates (Volume 134) (Current Topics in Developmental Biology, Volume 134) Academic Press;1st Edition
14. Michael J.F. Barresi (Author), Scott F. Gilbert. (2019). Developmental Biology 12th Edition
15. http://www.sinauer.com/
16. https://www.amazon.com/dp/1493957341?tag=uuid10-20
17. https://www.textbooks.com/Developmental-Biology-10th-Edition/9780878939787/Gilbert.php?CSID=2MBWM2TBS3DS3CAAAMK2C2SMB

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Give the basic knowledge on organism development and determination
- Know about gametogenesis and fertilization in animals
- Understand the differentiation and regulation of normal.
- Learn about organogenesis in plant development
- Exhibit contemporary knowledge in Development and Evolution

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First Year **VALUE ADDED COURSE I ORGANIC FARMING** **Semester I**

Code: **(Theory)** **Credit: 2***

COURSE OBJECTIVES:

- To understand the concept of organic agriculture
- To know the importance of manures.
- To understand the various farming system.
- To know the importance of microbes and economic importance.

UNIT-I ORGANIC AGRICULTURE:

Organic Farming: Stages in Agricultural Development – History of Alternative Agricultural Development – III effects of Green Revolution Organic farming – Need, Concepts, Definition and Components – Essential characteristics – Key principles – Different concepts of organic farming – Natural farming, Biodynamic farming, Perma culture and Zero Budget Farming.

UNIT – II ORGANIC NUTRIENTS/MANURES:

Definition – Classification – Bulky Organic Manures (BOM) and Concentrated Organic Manures (COM) – Preparation of different types of compost including industrial waste, coir waste, press mud – Vermicompost – enriched FYM etc – Green manures (GM) and Green Leaf Manures(GLM) – their Benefits and significance . Bio - fertilizers and their types – Application of Bio - Fertilizers.

UNIT – III WATER AND SOIL TESTING AND FARMING SYSTEM:

Soil – Definition, Soil formation, Composition and characteristics. Types of soil and reclamation: Soil Fertility and Productivity; Method of Increasing productivity and fertility. System of farming: wet land, garden land and dry land farming system. Type of cropping system: mono cropping, multi cropping, inter cropping and sequential cropping.

UNIT – IV USES OF MICROORGANISMS IN FARMING:

Introduction - Need and benefits of Microorganism. Plant Protection Measures: Integrated pest & disease managements. Organic pesticides, bio-pesticides. Inorganic pesticides, disadvantages of their use.Seed, seedling and soil treatment measures.

UNIT – V SUSTAINABLE AGRICULTURE:

Concept of Sustainable Agriculture – Economic and Ecological aspects of Agriculture – Focus of conventional agricultural research and extension – using external inputs in low input farming – Common traits of Indigenous farming— Basic ecological principles of LEISA.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Sundaramari, M. (2006). Agriculture and Dairying- A Rural Development Perspective, NCBH, Chennai.
2. Tistale, S.L., W.I. Nelson and J.D. Beaton. 1990. Soil Fertility and Fertilizers, The McMillan Company, New York.
3. White H 1989. Introduction to the Principles and Practices of Soil Science, Oxfords Publishers, London.
4. IIRR (1996), Recording and using Indigenous Knowledge: A Manual International Institute of Rural Reconstruction, Silang, Cavite, Philippines.
5. Palaniappan.S.P. and K. Annadurai.(1999). Organic Farming Theory and Practice. Scientific Publishers (India), Jodhpur.
6. Sharma, Arun K. (2002). A Hand Book of Organic Farming Agrobios (India), Jodhpur.
7. P. L. Maliwal, (2021) Rinciples Of Organic Farming, Scientific Publishers
8. Mishra, Hariom& Gupta, Ankit&tripathi, ambikesh. (2022). A Text Book Of Modern Organic Farming. Book Rivers Publisheres.

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First Year **CORE COURSE III** **Semester II**

rDNA TECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study about principles of genetic engineering.
- Provide methodologies of rDNA technology
- Understand the applications of rDNA technology

UNIT – I BASICS CONCEPTS:

DNA structure and properties. Restriction enzymes, DNA ligase, klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase, cohesive and blunt end ligation, linkers, adaptors and homopolymeric tailing. Labeling of DNA - nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques - northern, southern and colony hybridization, fluorescence *in- situ* hybridization, chromatin immunoprecipitation, DNA - protein interactions, electromobility shift assay, DNeI foot printing and methyl interference assay.

UNIT – II CLONING VECTORS:

Plasmids, bacteriophages, M13 mp vectors, PUC19 and blue script vectors.Phagemids, lambda phage vectors, insertion and replacement vectors, EMBL, cosmids, artificial chromosome vectors (YAC, BAC), animal virus derived vectors - SV40, vaccinia/bacculo& retroviral vectors. Expression vectors – pMal, GST and pET based vectors. Protein purification. his-tag, GST-tag, MBPtag etc., intein-based vectors, inclusion bodies, methodologies to reduce formation of inclusion bodies, baculovirus and pichia vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors and shuttle vectors.

UNIT – III CLONING METHODOLOGIES:

Insertion of foreign DNA into host cells, transformation, construction of libraries, isolation of mRNA and total RNA. cDNA and genomic libraries, cDNA and genomic cloning, expression cloning and protein-protein interactive cloning. Yeast two hybrid system, phage display and principles in maximizing gene expression.

UNIT – IV PRINCIPLES OF POLYMERASE CHAIN REACTION:

Primer design, fidelity of thermos table enzymes, DNA polymerases, types of PCR - multiplex, nested, reverse transcriptase, real time, touchdown, hot start, and colony. Cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and site specific mutagenesis. PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis, mutation detection - SSCP, DGGE, RFLP, oligo ligation assay (OLA), Mismatch Chemical Cleavage (MCC), Allele-Specific Amplification (ASA) and Protein Truncation Test (PTT).

UNIT – V SEQUENCING METHODS:

DNA sequencing - Enzymatic, chemical & automated DNA sequencing and RNA sequencing.Chemical synthesis of oligonucleotides, introduction of DNA into mammalian cells, and transfection techniques. Gene silencing techniques, introduction to siRNA,

siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. Gene knockouts and gene therapy, creation of knockout mice, disease model, somatic and germ line therapy – *in-vivo* and *ex-vivo*, suicide gene therapy, gene replacement and gene targeting.Transgenics, cDNA and intragenic arrays, differential gene expression and protein array.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old. (2001). Principles of Gene Manipulation. 6th Edition. S.B.University Press.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. (2007). Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc.
3. Watson JD, Gilman M, Witkowski J, Zoller M. (1992). Recombinant DNA. Scientific American Books.
4.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. (2002). Molecular Biology of the Cell, 4th Edition. Garland Sciences.
6. Stanley Maloy (1994). Microbial genetics. 2nd Edition. Jones and Bartlett publisher.
7. Uldis N. Streips and Ronalad E. Yasbin. (2002). Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell.
8. Sandy B. Primrose, Richard M. Twyman, Robert W. Old. (2008). Principles of Gene Manipulation. 6th Edition. Blackwell Science.
9. Brown TA. (2008). Genomes. 3rd Edition. New York: Garland Publishing Co. New York: Garland Science.
10. https://www.ncbi.nlm.nih.gov/
11. https://www.amazon.com/Principles-Manipulation-Genomics-Sandy-Primrose-ebook/dp/B00D88OH7S?dchild=1&keywords=Principles+of+Gene+Manipulation+and+Genomics&qid=1618059356&s=digital-text&sr=1-1&linkCode=li3&tag=microbiologyn-20&linkId=ffbeea5b07e689ff62f2dd6bab07683c&language=en_US&ref_=as_li_ss_il
12. https://www.amazon.com/Gene-Cloning-DNA-Analysis-Introduction-ebook/dp/B08KR7W53N?dchild=1&keywords=Gene+Cloning+and+DNA+Analysis.&qid=1618059059&sr=8-2&linkCode=li3&tag=microbiologyn-20&linkId=c5db8e4b4711b286fb20e8b408efcc38&language=en_US&ref_=as_li_ss_il

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Explain the basic concepts of labelling and DNA-protein interactions
- Describe how the vectors can be used for the insertion of genetic material
- Know about methodologies involved in cloning
- Gain the ability to improve the knowledge of PCR amplification
- Understand various types of nucleic acid sequencing

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First Year **CORE COURSE IV** **Semester II**

MICROBIAL BIOTECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Teach the significance of microbes and their biotechnological applications in various sectors.
- Impart the knowledge about the genetic improvement of microbes for human welfare.

UNIT – I SCREENING AND SELECTION OF INDUSTRIALLY IMPORTANT MICROBES:

Microbial Biotechnology- Introduction, scope and importance.Concept of screening - primary and secondary - Screening of organic acid, antibiotic, extracellular vitamins / amino acids, and enzyme inhibitors. Strain improvement methods- Mutation, protoplast fusion, metabolic rewiring, Recombination.

UNIT – II ADVANCES IN METHODOLOGIES FOR MICROBIAL BIOTECHNOLOGY:

General concepts of microbial biotechnology.Microbes as the single-cell factories for the production of commercially valuable compounds. Genetic transformation of microorganisms- Advanced genome editing tools- zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcriptional engineering for manipulating beneficial microorganisms/strains and their applications.

UNIT – III ENVIRONMENTAL APPLICATIONS OF MICROBIAL BIOTECHNOLOGY:

Important applications of microorganisms in environmental biotechnology. Biodegradation and biomass recycle; Bioremediation of toxic waste and soil remediation; Produciton of biofuel, biopolymers, bioplastics. Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); Role of microbial biotechnology in the circular economy.

UNIT – IV APPLICATIONS OF MICROBIAL BIOTECHNOLOGY IN THE FOOD SECTOR:

Application of microorganisms and microbial processes in food industries.Introduction to food processing and food preservation.Production of antibiotics and enzymes.Role of microorganisms in drugs and vaccines production. Methodologies of introducing desirable traits in Generally recognized as safe (GRAS) microbes.

UNIT – V GMOS FOR COMMERCIAL APPLICATIONS:

Genetic improvement of industrially important microbes (*Nannochloropsis*sp., and Yeast); Generation of microbial cell factories; Downstream processing approaches for large-scale production (*Nanncohloropsis*sp., Yeast). High-throughput screening of microbes.National and National guidelines for the application of GMOs in the environment, food and pharmaceutical sectors.Role of the Department of Biotechnology, India in regulating the processes of Genetic Engineering of microbes.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
2. Bernad R. Glick and Jack J. Pasternak. Molecular Biotechnology Principles and Applications of Recombinant DNA. WCB, 2002
3. Glazer, A.N. and Nikaido, H. (2008). Microbial Biotechnology. Cambridge University Press. 576 pp.
4. Baltz, R.H., Demain, A.L. and Davies,E. (2010). Manual of Industrial Microbiology and Biotechnology, Third Edition. American Society for Microbiology. 788 pp.
5. Harzevili, F.D. and Chen, H. (2017). Microbial Biotechnology: Progress and Trends. 379 pp. CRC Press. Taylor and Francis Group.
6. https://books.google.co.jp/books?hl=en&lr=&id=G51OoPDDZs0C&oi=fnd&pg=PR3&dq=+microbial+technology&ots=aR1C3ZgWDv&sig=wqS7-I5jQDfLg1rrBGhoR87gaTU#v=onepage&q=microbial%20technology&f=false
7. https://link.springer.com/content/pdf/10.1007/978-981-13-0053-0.pdf
8. https://sfamjournals.onlinelibrary.wiley.com/doi/full/10.1111/1751-7915.12818

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand the commercial importance of microbes.
- Gain knowledge about the physiological and metabolic properties of microbes.
- Demonstrate the genetic improvement of target microorganism by means of rDNA technology.
- Knowledge on guideline of GMO's application
- Describe the downstream processing techniques for large scale production

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First Year **CORE CHOICE COURSE II** **Semester II**

1) IMMUNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the basic elements of immunology.
- Increase knowledge about the basics of the immune system and immune responses.
- Acquire basic knowledge on immunoosupressin and modulation.

UNIT – I INTRODUCTION TO IMMUNE SYSTEM:

Organs and cells are involved in the immune system and response - Primary lymphoid organs, secondary lymphoid organs, lymphocytes, cytokines and lymphokines. Immune response (humoral and cell mediate).Types of immunity (innate and acquired).Terminology – Antigen, immunogen, hapten, allergen, tolarogen, super antigens, antibody, immunoglobulin, antigenicity, immunogenicity. Lymphatic system, lymphocyte circulation and lymphocyte homing. Mucosal and Gut-associated lymphoid tissue (MALT&GALT) and mucosal immunity.Principles of cell signalling.

UNIT – II REGULATION OF IMMUNE RESPONSE:

B-cell - development, maturation, activation and differentiation.B-cell receptor and determinants.B-cell subsets.Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, and antigenic determinants. T-cell development, maturation, activation and differentiation.T-cell receptor and determinants.T-cell subsets.Antigen processing and presentation - endogenous antigens, exogenous antigens, non-peptide bacterial antigens.Activation of B and T-lymphocytes, cytokines, their role in immune regulation, and immunological tolerance. Transplantation immunology - MHC, types of grafts, graft rejection and its mechanisms, GVH reactions, and prevention of graft rejection.

UNIT – III ANTIGEN-ANTIBODY REACTION:

Antigen-Antibody reaction by precipitation, agglutination and complement fixation. Non-specific immune mechanism - Surface defences, tissue defences, opsonization, inflammatory reaction, and hormone balance. Complement system - complement components, types, complement activation, regulation of complement system, biological consequences and pathways of complement activation, and complement deficiencies.

UNIT – IV VACCINOLOGY:

Immunization - Objectives of immunization, active, passive and combined immunization. Live, killed, attenuated, plasma derived, sub unit, recombinant DNA, protein based, plant-based, peptide, anti-idiotypic and conjugate vaccines. Role and properties of adjuvants & ISCOMS.Antibody genes and antibody engineering - chimeric and hybrid monoclonal antibodies, catalytic antibodies and generation of immunoglobulin gene libraries.

UNIT – V CLINICAL IMMUNOLOGY:

Immunity to infection, bacteria, viral, fungal and parasitic infections (with examples from each group).Hypersensitivity – Type I, II, III and IV.Autoimmunity and types of autoimmune diseases.Mechanism and role of $CD4^+$ T cells, MHC and TCR in autoimmunity.Treatment of autoimmune diseases. Transplantation – immunological basis of graft rejection, clinical transplantation and immunosuppressive therapy. Tumor immunology, tumor antigens, immune response to tumors and tumor evasion of the immune system.Cancer immunology and immunotherapy. Immunodeficiency - primary immuno-deficiencies, acquired or secondary immuno-deficiencies.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Kuby Immunology (8th Edition) 2019- Jenni Punt, Sharon Stranford, Patricia Jones.
2. Essentials of Immunology(2017) - Dr. S.K. Gupta.
3. Immunology and Immunotechnology(2010) - Dr. B. Annadurai.
4. Allergy and Immunology- Scott Jasmin RV.
5. Roitt's Essential Immunology (13th Edition) - Seamus J. Martin and Dennis R Burton-Iran M Roitt.
6. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt. 2011. Essential Immunology 12th Edition. Wiley - Blackwell.
7. Charles A Janeway, Jr. Paul Travers, Mark Walport, and Mark J Shlomchik. 1999. Immunobiology. 4th Edition. Journal of Current Biology publications.
8. D. M. Weir and John Stewart. 1997. Immunology. 8th Edition. Churchill Livingstone.
9. P.J.Delves, I S.J.Artin, I D.R.BurtonandI.M.Roitt. 2006. Essential Immunology. 11th Edition. Wiley - Blackwell.
10. Brostoff J, Seaddin JK, Male D and Roitt IM., 2002. Clinical Immunology.6th Edition.Gower Medical Publishing.
11. Ross, G.D. Ed Immuno biology of the Complement System.
12. Immunology - Understanding of Immune System by Claus D. Elgert. 1996. Wiley -Liss, New York.
13. Immunobiology: The Immune System in Health and Disease. 3rd Edition by Travers.
14. https://archive.nptel.ac.in/courses/102/105/102105058/

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand the basic concepts of the immune system, antigen-antibody interactions, and immune reactions.
- Elucidate the immune response of humans to foreign substances.
- Employ the modern techniques of immunology that helps to determine human protection.
- Get knowledge on the self-curing ability of the body

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First Year **CORE CHOICE COURSE II** **Semester II**

2) BIOPROCESS TECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Give an idea about the avenues of improving the trait of microbes and study the downstream processes for product recovery in fermentation.
- Create adequate industrial knowledge and skills.

UNIT – I BASIC PRINCIPLE OF BIOCHEMICAL ENGINEERING:

Isolation, screening and maintenance of industrially important microbes.Microbial growth and death kinetics (an example from each group, particularly regarding industrially beneficial microorganisms). Strain improvement for increased yield and other desirable characteristics. **Microbial Growth and Preservation:** Mathematical expression of bacterial growth, generation time and growth rate. Different phases of growth & growth curve and. Batch, continuous and synchronous cultures. Diauxic growth and factors affecting microbial growth. Stress response. Microbial death curve under adverse conditions.

UNIT – II CONCEPTS OF BASIC MODE OF FERMENTATION PROCESSES:

Bioreactor designs and types of fermentation and fermentors. Concepts & basic modes of fermentation - Batch, fed batch and continuous fermentation. Conventional fermentation versus biotransformation. Solid substrate, surface and submerged fermentation. Fermentation economics and fermentation media. Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. Large scale animal and plant cell cultivation and air sterilization. Upstream processing - media formulation, sterilization, aeration and agitation. Measurement and control of bioprocess parameters, scale up and scale down process.

UNIT – III DOWNSTREAM PROCESSING:

Bio separation - filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication.Cell disruption – enzymatic lysis and liquid-liquid extraction.Purification by precipitation (ammonium sulfate, solvent), electrophoresis and crystallization. Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques. Reverse osmosis and ultra filtration. Drying, crystallization, storage and packaging.Treatment of effluent and its disposal.

UNIT – IV APPLICATIONS OF ENZYMES IN FOOD PROCESSING:

Mechanism of enzyme function and reactions in food processing. Enzymic bioconversions e.g. starch and sugar conversion processes. High fructose corn

syrup, hydrolyzed protein and their downstream processing. Baking by amylases, deoxygenation and de-sugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

UNIT – V APPLICATIONS OF MICROBES IN FOOD PROCESSING AND PRODUCTION:

Fermented foods and beverages, food ingredients and additives used in fermentation and their purification. Fermentation as a method of preparing and preserving foods.Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products. Process wastes - whey, molasses, starch substrates and other food wastes for bioconversion to useful products. Bacteriocins from lactic acid bacteria – production and applications in food preservation.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Whittaker, Stanbury, P.F. Hall Whitaker, S. A.(1999). Fermentation Principles of Technology, Second Edition. Butterworth-Heinemann.
2. Michael Shuler and Fikret Kargi. (2002). Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ
3. Patel. A.H. (2004). Industrial Microbiology, Macmillan India Ltd., New Delhi.
4. Asenjo. J.A. (1990). Separation Processes in Biotechnology, Marcel Dekker, Inc, New York, USA.
5. Arnold L Demain and Julian E. Davies. (1999). Manual of Industrial Microbiology and Biotechnology, 3rd Edition, ASM press, Washington DC.
6. Crueger, W. and A. Crueger. (2000). Biotechnology: A Test Book of Industrial Microbiology, 2nd Edition. Panima Publishing Corporation, New Delhi.
7. Patel A.H. (2004). Industrial Microbiology. Macmillan India Ltd., New Delhi.
8. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton. G. (2001), Industrial Microbiology: An Introduction, Blackwell Science, London.
9. https://archive.nptel.ac.in/courses/102/105/102105058/

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Know the basic principle of biochemical engineering.
- Update the fundamentals of bioreactors.
- Understand the principles of product recovery.
- Know the application of enzymes and microbes in industries.
- Acquire knowledge ob food processing and production.

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First Year **CORE PRACTICALII** **Semester II**

rDNA TECHNOLOGY, IMMUNOLOGY AND BIOPROCESS TECHNOLOGY

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Update the hands-on training skills of students on the experiments of rDNA technology, immunology and industrial biotechnology.
- Get training in basic genetic engineering techniques which are essential for them to enrich their technical skills.
- Illustrate Antigen – antibody interaction.

EXPERIMENTS:

rDNA TECHNOLOGY:

1. Isolation of genomic DNA from plant and animal cells.
2. Isolation of plasmid DNA
3. Transformation and Transduction
4. RFLP & RAPD
5. PCR

IMMUNOLOGY:

1. Preparation of plasma and serum from the collected blood samples.
2. Precipitation techniques– Agar gel diffusion, counter immuno-electrophoresis, single radial immuno-diffusion, rocket immuno-electrophoresis (Hands on).
3. Agglutination techniques -Blood grouping and Rh factor; Latex agglutination – RF, HBsAg and CRP.
4. WIDAL test
5. Labelled Assays - Enzyme Linked Immunosorbent Assay (ELISA), Immunoflouresence (IF), and Immunohistochemistry (IH).

BIOPROCESS TECHNOLOGY:

1. Isolation and characterization of industrially important microorganisms
2. Production of beverages (beer, wine, and ethanol) by using microorganisms
3. Production of antibiotics (penicillin, streptomycin & erythromycin) by using microorganisms
4. Mass cultivation of Single Cell Protein (SCP)
5. Separation of amino acids (amylase and protease) from the microbial culture.

REFERENCES:

1. A Practical Text book genetic engineering in bacteria (2021) - P V G K Sharma

2. Competency Based practical manual for microbiology (2021) - UpasanaBhumbla, Jaypee.
3. Text and Practical microbiology for MLT(2021) - Dr.C.P.Baveja& Dr. V. Baveja
4. Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby. 2003. Immunology. 5th Edition, W. H. Freeman & Company.
5. Topley and Wilson. G. Wilson, A.Miles, M.T.Paker. Arnold, Heineman, 1984. Principles of Bacteriology, Virology and immunology. Willy – Blackwell.
6. Brenda D. Spangler. 2002. Methods in Molecular Biology and protein chemistry. John Wiley & sons, Ltd.
7. Bruce Rirren/Eric. D. Green. 1997. Genome Analysis – A laboratory manual – vol I Analyzing DNA. Cold spring Harbor Laboratory press.
8. Frederick M. Ausbel, Roger Breut. 2002. Short protocols in Molecular Biology. Vol I & II, 5th Edition. John Wiley & Sons Inc

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand the basics of crucial experiments in rDNA technology, immunology and bioprocess/industrial biotechnology.
- Gain knowledge about the steps and operations involved in these experiments.
- Acquire knowledge on qualitative and quantitative methods on antigen – antibody interaction
- Perform primary and secondary metabolites production.
- Demonstrate DNA amplification methods

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First Year **ELECTIVE COURSE II** **Semester II**

1) BIOANALYTICAL TECHNIQUES

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the range and uses of analytical methods in Biology.
- Understand the broad role of the Biologist in measurement and problem solving for analytical tasks.
- Observe the structure of the biological samples

UNIT – I BASIC INSTRUMENTATION:

Principles, operation protocol & applications of the following instruments: Weighing balance, laminar clean air flow bench, autoclave, incubators, weighing balances, pH meter, water bath, hot air oven, colony counter and microtome – Laboratory safety measures.

UNIT – II MICROSCOPY:

Observation of different microbes. Light – Bright & Dark field; Phase contrast, Inverted Phase contrast; Fluorescent, Electron – TEM, SEM and STEM; Confocal.

UNIT – III SPECTROSCOPY:

Colorimeter, Spectrometer, UV visible spectrometer, X – ray spectrometer, ELISA reader, Atomic absorption spectrometer, Flame photometer, Flourometer & Spectroflourometer. FTIR and (ICPOET) Inductively coupled Plasma optical emission transmission.

UNIT – IV SEPARATION TECHNIQUES:

Centrifugation - Principle, operation, types & applications. Chromatography - Principle, operation & applications - Paper – ascending, descending & Circular, TLC, HPLC, HPTLC, GC, Column Chromatography, Ion Exchange & Affinity Chromatography, GC-MS and LC – MS.

UNIT – V ELECTROPHORESIS:

Gel electrophoresis; AGE and PAGE–Pulse field gel electrophoresis (PFGE) – 2D gel electrophoresis – MALDI- TOF (Matrix-Assisted Laser Desorption/Ionization Time-of Flight), MALDI-TOF- MS (Matrix-Assisted Laser Desorption/Ionization Time-of-Flight /time of Flight Mass spectrometry).

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Chatwal, G.R and Anand, S.K. (2009). Instrumental methods of Chemical Analysis, Himalaya Publishing House, New Delhi.
2. Plummer, D.T. (2008). An Introduction to Practical Biochemistry, Tata McGraw- Hill Publication, New Delhi.
3. Boyer, R.F. (2011). Biochemistry Laboratory: Modern theory and techniques, 2nd Edition, Prentice Hall Publishers.
4. Wilson, K. and Walker, J. (2000). Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press Publishers.
5. Okotore, R.O. (2008). Basic Separation Techniques in Biochemistry. New Age International Pvt Ltd Publishers.
6. Palanivel, P. (2000). Laboratory Manual for Analytical Biochemistry & Separation Techniques, School of Biotechnology, Madurai Kamaraj University, Madurai.
7. Sawhney, S.K. and Singh, R. (2005). Introductory practical Biochemistry, (2nd Edition). Narosa Publishing House, New Delhi.
8. Lee, S.Y., Nielsen, J. and Stephanopoulos, G., "Industrial Biotechnology: Products and
9. Processes", John Wiley & Sons, 2016.
10. Cruger, W., Cruger, A., "A Textbook of Industrial Microbiology", Panima Publishing
11. Corporation, 2nd Edition, 2005.
12. Pandey, A., Negi, S., Soccol, C.R., "Current Developments in Biotechnology and
13. Bioengineering: Production, isolation and purification of industrial products", Elsevier, 2016.
14. Okafor, N., "Modern Industrial Microbiology and Biotechnology", CRC Press, 2007
15. CasidaJr, L. E., "Industrial Microbiology", Wiley, 1968.
16. https://nptel.ac.in/courses/102/107/102107028/
17. http://epgp.inflibnet.ac.in/
18. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=944

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand the working principles, construction and applications of the instruments often used in the studies related to various disciplines of Biological Sciences.
- Understand the principle, Instrumentation of different types of microscopy and its applications in various research fields.
- Acquire knowledge about the basics and latest developments in instrumentation techniques and their applications in various research fields
- Understand the importance and applicationsof electrophoretic techniques
- Demonstrate the applications of centrifugation and spectroscopy techniques like FTIR, AAS, and NMR.

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First Year **ELECTIVE COURSE II** **Semester II**

2) PHARMACOLOGY

Code: **(Theory)** **Credit: 4**

Course Objectives:

The objectives of this course are to:

- Explain the mechanism of drug action
- Apply the basic pharmacological knowledge for prevention and treatment
- Understand the drugs development process and regulations

UNIT – I GENERAL PHARMACOLOGY:

Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists, addiction, tolerance. Pharmacokinetics-Membrane transport, absorption, distribution, metabolism and excretion of drugs.Enzyme induction, enzyme inhibition, kinetics of elimination.

UNIT – II PRINCIPLES OF TOXICOLOGY:

Definition and basic knowledge of acute, subacute and chronic toxicity.Definition and basic knowledge of genotoxicity, carcinogenicity, teratogenicity and mutagenicity.Chronopharmacology-Definition of rhythm and cycles, Biological clock and their significance leading to chronotherapy.

UNIT– III PHARMACODYNAMICS:

Principles and mechanisms of drug action.Receptor theories and classification of receptors, regulation of receptors.drug receptors interactions signal transduction mechanisms, G-protein–coupled receptors, ion channel receptor, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.

UNIT – IV DRUG DEVELOPMENT PROCESS:

Methods involved in the development of new drugs. Preclinical toxicological studies.Calculation of LD50 & ED 50.Acute, subacute and chronic toxicity studies.Pre-clinical pharmacokinetic and dynamic studies.High throughput screening (*in vitro* and *in vivo*) for pre-clinical pharmacokinetic and pharmacodynamic studies.

UNIT – V DRUG REGULATIONS:

Drug and Cosmetics Act, Drug Price Control order, Application for Investigational New Drug (IND), Application for New drug Discovery (NDD) according to Indian Control Authority & USFDA guidelines. Conducting bio-equivalence studies.Ethical considerations in utilizing human subjects for drug discovery process.Helsinki's declaration.ICH-GCP Guidelines.Ethical guidelines in utilizing animals for experimental purposes.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Rang H. P., Dale M. M., Ritter J. M., Flower R. J., Rang and Dale's Pharmacology, Churchil Livingstone Elsevier (2020)
2. Katzung B. G., Masters S. B., Trevor A. J., Basic and clinical pharmacology, Tata McGraw-Hill 11th edition (2010)
3. W.C.Evans, Trease and Evans Pharmacognosy, 16th edition, W.B. Sounders & Co., London, 2009.
4. Mohammad Ali. Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, New Delhi.
5. Text book of Pharmacognosy by C.K. Kokate, Purohit, Gokhlae (2007), 37th Edition, NiraliPrakashan, New Delhi.
6. Herbal drug industry by R.D. Choudhary (1996), IstEdn, Eastern Publisher, New Delhi.
7. K.D.Tripathi. Essentials of Medical Pharmacology (2016), JAYPEE Brothers Medical Publishers (P) Ltd, New Delhi
8. Sharma H. L., Sharma K. K., Principles of Pharmacology (2017), Paras medical publisher
9. Modern Pharmacology with clinical Applications, by Charles R.Craig& Robert.
10. Ghosh MN. Fundamentals of Experimental Pharmacology. Hilton & Company, Kolkata.
11. Kulkarni SK. Handbook of experimental pharmacology. VallabhPrakashan.
12. R Endress, Plant cell Biotechnology, Springer-Verlag, Berlin, 1994.
13. Tara V Shanbhag. 2020. Pharamacology for Medical Graduates. 1st Edition, Elsevier India.
14. Dr.HazaifShaikh. 2021. Pharmacology. 1st Edition, Clever Pen Publishing LLP.

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Understand the pharmacological actions of different categories of drugs
- Know the concept of pharmaco-toxicology
- Apply the basic knowledge in pharmacodynamics
- Know drug development procedures
- Know the drug regulation act and ethics

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First Year **NON-MAJOR ELECTIVE COURSE** **Semester II**

AGRICULTURAL BIOTECHNOLOGY

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

The objectives of this course are to:

- Introduce the basics, civilization and development of agriculture
- Explain the concepts of agricultural crop improvement
- Understand the importance of agricultural biotechnology and laws

UNIT – I GENERAL INTRODUCTION:

Civilization and development of agriculture- Evolution of modern agricultural approaches- Domestication and trans domestication- Centres of origin and diversification of agriculturally important crops. Agro biodiversity and evolution of land races, tradition rice varieties Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists, addiction, tolerance. Pharmacokinetics-Membrane transport, absorption, distribution, metabolism and excretion of drugs.Enzyme induction, enzyme inhibition, kinetics of elimination.

UNIT – II AGRICULTURAL CROP IMPROVEMENT:

Traditional methods of Crop improvement – Clonal selection – mass selection – inbreeding – out breeding introgressive hybridization – vegetative propagation methods - Grafting – Rapid multiplication techniques.

UNIT– III MODERN METHODS FOR CROP IMPROVEMENT:

Micropropagation – parasexual hybridization – haploid production – Transgenic crops – Induction of haploidy - Experimental polyembryony – Apomixis and its biotechnological exploitation for crop improvement.

UNIT – IV PESTS AND MANAGEMENT:

Major pests of Agricultural Crops (elementary account) - Developing pest resistant species – Biopesticides.

UNIT – V AGRICULTURAL BIOTECHNOLOGY LAWS:

Agricultural biotechnology and Law – plant variety certification and protection. Farmers rights – UPOV convention – patenting – IPR – Ethical aspects – Public acceptance of bioengineered GM foods and organisms.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Jones L. 1991. Biotechnological innovation in Crop improvement, ButterworthHiemann, London
2. Arie Altman. 1998. Agricultural Biotechnology, Marcel Dekker, Inc.
3. Forbes JC and Watson RD. 1992. Plants in Agriculture, Cambridge Univ. Press, Great Britain
4. Erbish FH and Maredia M. 1998. Intellectual Property Rights in Agricultural Biotechnology. Universities Press, India
5. Maarten J. Chrispeels and David E. Sadava. 1994. Plants, Genes and Agriculture, Jones &Barleft Publishers, London.

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Understand the importance of agricultural biotechnology at the basic level
- Get introduced to terms related to crop improvement
- Critically think about the role of pests and their management
- Know the agricultural biotechnology act and ethics
- Apply modern agricultural methods

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Second Year **CORE COURSE V** **Semester III**

PLANT BIOTECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The objectives of this course are to:

- Provide the basic principles and techniques involved in plant tissue culture
- Understand the fundamental aspects of plant tissue culture and molecular biology of plants
- Understand the concepts of modern technology about large-scale production of target metabolites

UNIT – I BASICS OF PLANT TISSUE CULTURE:

Plant tissue culture techniques.*In-vitro* pollination and fertilization.Embryo culture and its applications.Embryogenesis and organogenesis.Micropropagation, haploids and their applications.Somaclonal variations and applications.Endosperm culture and production of triploids.

UNIT – II PROTOPLAST – CULTURE & GENETIC MANIPULATION:

Introduction to protoplast isolation, culture and regeneration, methods of fusing protoplasts, somatic hybridization.Protoplast and tissue culture manipulation for genetic manipulation of plants.

UNIT– III PLANT TRANSGENESIS:

Agrobacterium mediated gene transfer,*Agrobacterium*based vectors (Ti plasmids and Ri plasmids), viral vectors and their applications. Direct gene transfer methods - electroporation, microinjection and particle bombardment. Characterization of transgenics, screenable and selectable markers.Marker free methodologies and gene targeting.

UNIT – IV TRANSGENIC PLANTS:

Transgenic rice with Vitamin A, transgenic plants with stress tolerance for drought and salinity, crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Genetically modified foods - application, future applications, ecological impact of transgenic plants. Organic food, types of organic food, identifying organic food, organic food & preservatives. Genetic modification in food industry – background, history, controversies over risks, application, future applications.

UNIT – V PLANT MOLECULAR BIOLOGY TECHNIQUES:

Quantitative Real time PCR, Southern blotting, Northern blotting, Western blotting, DNA sequencing methods and their applications. DNA finger printing in plants. Marker assisted selection (MAS) for crop improvement.

Unit – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Gamborg O.L and Philips, G.C. (1995). Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.
2. Slater A., Scott N.W. and Fowler, M.R. (2008). Plant Biotechnology - the genetic manipulation of plants. (2nd) Edition. Oxford University press, USA.
3. Chawla H.S., (2002). Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. (1999). Plant Molecular Genetics. Pearson Education limited, England
5. Phundan Singh. (2013). Principles of Plant Biotechnology. Kalyani Publishers, India.
6. V. Kumaresan. (2015). Applied Plant Biotechnology. Saras Publication, India.
7. Singh. (2014). Plant Biotechnology, (2nd) Revised Edition, Kalyani Publishers, India.
8. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. (2000). Molecular cell Biology. (4th Edition), W.H. Freeman & Company
9. https://nptel.ac.in/courses/102/103/102103016/
10. https://www.mooc-list.com/tags/biotechnology
11. https://www.coursera.org/courses?query=biotechnology
12. http://www.intechopen.com/books/genetic-transformation
13. https://link.springer.com/book/10.1007% 2F978-3-662-07424-4
14. https://link.springer.com/book/10.1007%2F978-81-322-1026
15. http://www.ebook777.com/plant- tissue-cultre-development-biotechnology/

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Understand the techniques involved in plant tissue culture.
- Gain knowledge on the protoplast culture and genetic manipulation of plants.
- Understand the fundamental aspects of the molecular biology of plant transgenesis.
- Describe the application of molecular markers and marker-aided breeding.
- Enrich the knowledge concerning different applications of transgenic technology.

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Second Year **CORE COURSE VI** **Semester III**

ANIMAL BIOTECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The objectives of this course are to:

- Understand the essential facts of animal cell culture
- Get knowledge on transgenic animals, pest and animal management
- Understand the concepts of molecular markers and their significance

UNIT – I CELL AND ORGAN CULTURE:

History – Definitions – steps for preparation of cell culture room, culture Environment (Substrate and Media) – Techniques for establishing of cell lines –insect cell culture – organ and embryo culture – cryopreservation – valuable products. Artificial insemination (IUI, ICSI) – Embryo transfer.Nuclear transplantation, *invitro*fertilization technology. Genetic Engineering in animals: Transformation of animal cells – Cloning vectors – Restriction Endonucleases, expression vectors – RTPCR - animal viral vectors and yeast vectors.

UNIT – II PEST AND ANIMAL MANAGEMENT:

Juvenile hormone analogues – pheromones and genetic manipulation.Biotechnology of silkworms. Transgenic silk production – Baculoviruses vector and foreign gene expression. Biotechnological approach to the production of live feed. Animal management: cat, dog, pig, horse using appeasing pheromones and their products.

UNIT – III MOLECULAR MARKERS:

Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing.Mapping of human genome – HGP (Human genome project), RFLP, RAPD and its applications. Genetic engineering approaches for the correction of genetic disorders. Human cloning, Gene silencing. Animal right activities Blue cross in India – Society for prevention of cruelty against animals. Ethical limits of Animal use – Human Rights and Responsibilities. Proteomics in disease biomarkers identification.

UNIT – IV TRANSGENIC ANIMALS:

Development and uses - mice, cattle, goat, fish and sheep and transgenic pets.Cloning (DOLLY, MOLLY and POLLY)Tendered meat production. Transgenic breeding strategies – Molecular farming (products with strategic importance).Insulin production using GMO.Embryonic stem cell preservation and its uses in endangered animals.

UNIT – V REGULATORY NODES IN ANIMAL BIOTECHNOLOGY:

Regulating DNA technology – DNA barcoding.Regulating food and food ingredients.Human gene therapy. Initial public concerns – accumulation of defective genes in the future generation. Future of gene therapy.Patenting Biotechnology inventions – patenting multi-cellular organisms – patenting fundamental research.Indian and USA patents.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. B Singh, SK Gautam and MS Chauhan. (2015). Textbook of Animal biotechnology. Teri Publication.
2. M.K. Sateesh. (2010). Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2nd Edition. New Age International Pvt. Ltd. Publishers.
3. Harrison, M.S. and Bal, I.R. (1997). General techniques of all culture Cambridge University press.
4. Prasash M. and Arora. C.K. (1998). Plant tissue culture, Ammol publication Pvt. Ltd.
5. Darling D.C. and Morgan S.J. (1994). Animal cells, culture Media. Wiley, New York.
6. In-vitro cultivation of animal cells. (1994). I. ed., Butter worth – Heinemann Ltd.
7. R. Ian Freshney. (2010). Culture of Animal cells & Manual of basic technique. 6th Edition. Wiley – Blakwell publication.
8. Bernard B. Glick, Jack J. Pastunak. (2009). Molecular Biotechnology principles and application of Recombinant – DNA
9. R. Sasidhara. (2006). Animal Biotechnology. MJP publishers
10. Duhcy R.C. (2007). Text book of biotechnology. S.Chand& Company Ltd.
11. Bobert C. Tait. (1997). An Introduction to Molecular Biology. 1st Edition. Horizon Scientific Press.
12. Bobert Matheson. (1994). Entomology- an introductory course. 2nd Edition. Comstock Publishing Company.
13. https://books.google.co.in/books?id=DYRrngEACAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0
14. https://books.google.co.in/books?id=DKM_k7M8dAUC&source=gbs_book_other_versions
15. https://books.google.co.in/books?id=1qacDwAAQBAJ&printsec=frontcover

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Understand the basic concepts of animal cell culture and genetic engineering.
- Know how the transgenic animals are developed.
- Update the basic knowledge on genetic manipulation and production of live feed.
- Know about the uses of markers to diagnose genetic disorders.
- Understand the patent basics on biotechnology,

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Second Year **CORE CHOICE COURSE III** **Semester III**

1. RESEARCH METHODOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The objectives of this course are to:

- Impart the essential components of research and tools involved in data analysis
- Discuss the importance of IPR and patenting
- Understand the ways to present the research in readable form.

UNIT – I BASICS OF RESEARCH:

Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem, Research Design, Sampling Design, Methods of Data Collection, Processing and Analysis of Data, Sampling Fundamentals, Testing of Hypothesis.

UNIT – II COLLECTION OF RESEARCH DATA:

Journals -standard of research journals - impact factor - citation index. Data retrieval - access to archives and databases, search engines – google scholar, PubMed - national informatics center network services. Online data base library. Web Search - Introduction to Internet, Use of Internet and WWW. Using search engine like Google, Yahoo etc, and using advanced search techniques.

UNIT– III RESEARCH WRITING:

Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography. Pictures and Graphs; Research proposal/Grant- definition, structure, budget allocation, specific aims, background and significance. Hierarchy of funding agencies in India and their operations.

UNIT – IV ANALYSIS OF RESEARCH DATA:

Spreadsheet Tool - Introduction to spreadsheet application, features and functions, using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Introduction to SPSS and GraphPad Prism software.

UNIT – V STATISTICAL ANALYSIS:

Measures of dispersion - sampling methods: random sampling - types of variables: qualitative and quantitative variables - continuous and discontinuous

variables - scaling method – mean - standard deviation- standard error - coefficient of variation: elucidation with model sums.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Research Methodology - Methods and techniques - C R Kothari &GauravGarg
2. Fundamentals of Research Methodology and Statistics - Yogesh Kumar Singh.
3. Research Methodology and applied statistics - D.N. Sansanwal
4. Writing the doctoral dissertation. Barrons Educational series, 2nd edition, Davis, G.B. and C.A. Parker, 1997. pp 160.
5. Authoring a PhD, thesis: how to plan, draft, write and finish a doctoral dissertation, Duncary, P. 2003. Macmillan, pp 256.
6. Basic Computer Science and Communication Engineering ñ R.Rajaram (SCITECH).
7. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
8. The complete reference Office Xpn Stephan L. Nelson, Gujulia Kelly (TMH).
9. MS office, Sexena, S. 2001. Vikas Publishing House Pvt. Ltd., New Delhi.

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Perform the research framework towards research problem
- Apply basic principles of different analytical techniques
- Analyze sequence and structure of bio-macromolecule data
- Classify various types of data and apply basic statistical concepts such as measures of central tendencies, measures of dispersion and sampling.
- Acquire knowledge on publishing research data

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Second Year **CORE CHOICE COURSE III** **Semester III**

2. GENOMICS AND PROTEOMICS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The objectives of this course are to:

- Provide an overview of the fundamental technical concepts of genomics, and proteomics
- Lay a firm basis on genomics and proteomics, specifically on experimental design, data analysis and data processing

UNIT – I INTRODUCTION TO GENOMICS:

Methods involved in DNA sequencing– manual & automated methods: Maxam and Gilbert sequencing and Sangers sequencing method. Metagenomics; Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical approaches. Genome sequence assembly software.

UNIT – II DATABASES AND GENOME DATA TOOLS:

Handling Genome Data: Web based servers and softwares for analysing the genome: Genome Browser, NCBI genome. Genomes and databases of the representative model organisms. Databases for nucleic acids and protein sequences.

UNIT – III INTRODUCITON TO PROTEOMICS:

Introduction to protein structure- Chemical properties of proteins. Physical interactions determine the property of proteins. Short-range interactions, electrostatic forces, van der Waal interactions, hydrogen bonds, Hydrophobic interactions. Methods to determine protein sizes- SDS-PAGE; Native PAGE, Determination of covalent structures – Edman degradation.

UNIT – IV ANALYSIS OF PROTEOME:

Introduction to Proteomics and proteomes analysis. 2D-PAGE. Sample preparation, Gel-based proteomics - two-dimensional gel electrophoresis (2-DGE), two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Staining methods, PF-2D, Tandem FPLC, Mass spectroscopy: basic principle, ionization sources, mass analyzers, different types of mass spectrometers (MALDI-TOF Q-TOF, LC-MS) Multidimensional proteomics.

UNIT– V TOOLS AND APPLICATIONS:

Proteome analysis – Algorithms for proteomics – Protein expression profiling – protein arrays – ProteinProtein interactions – Protein microarrays.Advantages and disadvantages of DNA and protein microarrays.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Westermeier, Reiner. Proteomics in Practices. 3rd edition, Weinheim, Wiley, 2002.
2. Simpson RJ. Purifying Proteins for Proteomics / A Laboratory Manual, First edition. Cold Spring Harbor Laboratory Press, 2004.
3. Brown TA. Introduction to Genetics: A Molecular Approach. First Edition, Garland Science, Taylor & Francis group. 2012.
4. Veenstra, TW and Tates III, JR, 2006. Proteomics for biological discovery(2nd edition), Wiley Publications(2019).
5. Durbin R, Eddy SR, Krogh A, Mitchison G. Biological Sequence Analysis, Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, 2000.
6. Biomolecules: Structure, function in Health and Disease-CEC

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Retrieve and manipulate genome and proteome data from public repositories
- Manage, interpret, and analyze large data sets
- Analyze functional genetic and genomic data and expertise in bioinformatic tools

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Second Year **CORE PRACTICAL III** **Semester III**

PLANT AND ANIMAL BIOTECHNOLOGY

Code: **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Provide hands on training on plant and animal tissue culture technology.
- Acquire knowledge on DNA isolation from animal cell
- Understand about the establishment and maintenance of cultures.

EXPERIMENTS:

Plant Biotechnology

1. Introduction to the laboratory and general Safety Practices for plant cell, Plant growth and development. Laboratory Report Guidelines (Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures.
3. Tissue culture media preparation – Seedling and Callus culture
4. Protoplast isolation – 1. Mechanical and 2. Enzymatic method.
5. Protoplast culture
6. Isolation of plant genomic DNA
7. Size analysis of DNA by Agarose Electrophoresis
8. Transformation of leaf discs with Agrobacterium
9. Regeneration abilities of the Shoot Apical Meristem (SAM).
10. Preparation of chloroplast from pea

Animal Biotechnology

1. Preparation of animal tissue culture media
2. Isolation of DNA from Animal liver
3. Cytotoxicity Assay
4. Stem Cell Isolation
5. Human PBMC isolation
6. Isolation of primary cell culture.

REFERENCES:

1. M. S. Clark. (1997). Plant Molecular Biology: A Laboratory Manual. Springer-Verlag.
2. Slater A., Scott N.W. and Fowler, M.R. (2008). Plant Biotechnology - the genetic manipulation of plants.2nd Edition. Oxford University press, USA.
3. H.S. Chawla, (2002). Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. (1999). Plant Molecular Genetics. Pearson Education limited, England.
5. Harrison, M.S. and Bal, I.R. (1997). General techniques of all culture Cambridge University press.

6. Prasash M. and Arora. C.K.. (1998). Plant tissue culture, Ammol publication Pvt. Ltd.
7. Darling D.C. and Morgan S.J. (1994). Animal cells, culture Media. Wiley, New York.
8. https://www.wileyindia.com/catalog/product/view/_ignore_category/1/id/7653/s/plant-biotechnology-practical-manual/#:~:text=Protoplast%20Isolation%2C%20Culture%20and%20Fusion
9. https://books.google.co.in/books?id=wmnFGjPFStwC&pg=PA27&source=gbs_toc_r&cad=4
10. https://www.academia.edu/attachments/42546185/download_file?st=MTY1NTQ1MTIyOCwxNTcuNDYuNzUuMTU0&s=swp-splash-paper-cover

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Gain the techniques for media preparation and micro propagation
- Develop the skill of genomic DNA isolation and identification from plants
- Have the capability to perform the techniques for protoplast isolation and culture
- Perform transformation of *Agrobacterium*
- Use the techniques for isolation of DNA from animal and its size analysis by agarose gel electrophoresis.

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Second Year **ELECTIVE COURSE III** **Semester III**

1. BIOSTATISTICS, BIOINFORMATICS, BIOETHICS AND IPR

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The objectives of this course are to:

- Acquire knowledge of database generation and data mining
- Discuss the importance of IPR and bioethics
- Learn the methods for interpretation of results

UNIT – I BIOSTATISTICS:

Introduction to Biostatistics – sample, population and statistical inference.Interval data - construction of histogram; interpretation of histogram, the normal distribution.Count data - examples of count data (bacterial cell count, radio activity count, colony and plaque counts) statistical treatment to count data. Statistical methods – Measures of Mean, Median and Mode: Standard Deviation and Standard Error. Regression and Correlation coefficient analysis, Student's t-test, Analysis of Variance (ANOVA), Chi-Square test, Duncan's multiple range test, Tukey's post hoc assay.

UNIT – II INTRODUCTION TO BIOINFORMATICS:

Introduction to Bioinformatics; Uses of Computers in biological research; Introduction to genomic research and data generation and analysis. Genome projects, Importance of computational biology and bioinformatics, the contribution of bioinformatics in biotechnology. Basic programming in bioinformatics.

UNIT – III DATABASES AND TOOLS:

Databases for nucleic acids and protein sequences; data retrieval tools for sequence identification and analysis; *in silico*search tools for sequences; motif analysis. Molecular databases- Collection, accessibility, compatibility. Systems Biology: Definition, and Introduction Hypothesis-driven research in systems biology, Wet-lab and Dry-lab experiments. Reductionist and Integrative approach.

UNIT– IV BIOETHICS:

Definition – moral, values, and ethics in biology; Role and importance of ethics in biology; Basic Approaches to Ethics, Bioethics: legal and regulatory issues; Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research, Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse Future 'Bioethical Conflicts' in Biotechnology - Changing perception of Nature, Human Genetic Engineering, GMOs.

UNIT – V INTRODUCTION TO IPR & PATENTS:

Definition, patentable and non-patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition; Concept of Prior Art; Precautions while patenting - disclosure / non- disclosure; Time frame and cost; Patent licensing and agreement. Introduction to IPR; Types of Intellectual property – Patents, Trademarks, Trade secrets, Copyrights and related rights; Traditional vs. Novelty; Importance of intellectual property rights in the modern global economic environment, Importance of intellectual property rights in India; IPR and its relevance in biology and environmental sciences; Case studies and agreements -Evolution of GATT and WTO and IPR provisions under TRIPS; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970).

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Principles and practices of Biostatistics - BelavendraAntonisamy - PrasannasSoloman Christopher (2017)
2. Intellectual Property - Elizabeth verkey and JithinSaji Isaac.(2015)
3. IPR, Biosafety and Bioethics (2013) - Goel Pearson
4. Bioethics - by Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul, Fred Dycus Miller Cambridge University Press, 2002.
5. Bioethics & Science, John A. Bryant, Linda Baggott la Velle, John F. Searle – 2002.
6. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
7. Law of Intellectual Property Rights (2016)-Shiv Sahai Singh
8. WTO And Intellectual Property Rights (2007)-TalwarSabanna
9. IPR: Unleashing the Knowledge Economy(2017)- PrabuddhaGanguli
10. https://books.google.co.in/books?id=DYRrngEACAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0
11. https://books.google.co.in/books?id=DKM_k7M8dAUC&source=gbs_book_other_versions
12. https://books.google.co.in/books?id=1qacDwAAQBAJ&printsec=frontcover

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Capture the essentials of bioethics, biosafety, and IPR
- Understand the biosafety and bioethics measurements
- Combine and relate the concepts of IPR and patenting in biology
- Generate alignments of gene and protein sequences
- Explore the use of technology to understand genome and protein biology

Second Year **ELECTIVE COURSE III** **Semester III**

2. NANOBIOTECHNOLOGY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The objectives of this course are to:

- Introduce the basics of nanoparticles and their applications
- Provide an insight into the fundamentals of nanotechnology in biological and biomedical research
- Understand the mechanistic role of nanoparticles in biological systems

UNIT – I INTRODUCTION TO NANOMATERIALS:

Introduction to Nanotechnology- History, scope and concepts of nanobiotechnology.Introduction and applications of nanomaterials- nanoclusters, nanotubes, nanowires, nanoparticles, engineered nano particles, nanocapsules and nanospheres.Applications of biological macromolecules such as proteins, lipids, polysaccharides, nucleic acid in nanotechnology.

UNIT – II ROLE OF NANOTECHNOLOGY IN BIOLOGY:

Synthetic methods of nanomaterials and their drawbacks; Biological synthesis of nanomaterials using plants, fungi and bacterial systems.Intra- and extra-cellular synthesis of nanomaterials by biological systems.Generation of hybrid nano-conjugates, DNA-oligomers and aptamers. Critical parameters involved in the biological synthesis of efficient nanoparticles.

UNIT – III IMPACT OF NANOMATERIALS IN BIOLOGICAL SYSTEMS:

Impact of emitted nanomaterials in physiological and metabolic properties of the aquatic organisms.Mechanisms of cellular uptake of nanomaterials; Impact of nanomaterials in regulating key signaling pathways.In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.Nanomedicines.

UNIT – IV PROTEIN AND DNA BASED NANOSTRUCTURE:

Chemical and physical properties of S-layers. Generation of DNA-protein nanostructure- methodology; Self-assembly of DNA Nanoparticles- Applications of DNA and proteins/peptides as the biomolecular templates; Formation of regularly arranged Nano-particles; Cells as the Nanobio-machine, link between the signaling pathways; Concepts in nanobio-machines for information processing and cell-cell communications.

UNIT – V APPLICATIONS OF NANOBIOTECHNOLOGY:

Applications of nanobiotechnology in agriculture, environment, drug designing and precise delivery; Advanced polymeric and metallic nanoparticles for drug

delivery. Applications of nanobiotechnology in cancer diagnosis and treatment.Applications in agriculture- Nanofertilizers, Nanopigments, Nanopesticides, Food processing and Anti-freezing. Ethical issues and patent issues associated with nanobiotechnology. Health and environment risk assessments.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Jones L. 1. Claudio Nicolini, Nanobiotechnology&Nanobiosciences Pan Stanford Publishing Pvt. Ltd, 2009.
2. C.M. Niemeyer and C.A. Mirkin, Nanobiotechnology, Concepts, Applications and perspectives, WILEY-VCH, VerlagGmbH&Co, 2004.
3. S. David Goodsell, Bionanotechnology, Lessons from Nature, Wiley-Liss, Inc, 2004.
4. D. E. Reisner, Joseph D. Bronzino. Bionanotechnology: Global Prospects. CRC Press (2008).
5. Erbish FH and Maredia M. 1998. Intellectual Property Rights in Agricultural Biotechnology. Universities Press, India
6. Maarten J. Chrispeels and David E. Sadava. 1994. Plants, Genes and Agriculture, Jones &Barleft Publishers, London.
7. Shyam S Mohaptra, ShivenduRanjan, NanditaDasgupta, Raghavendrakumar Mishra, Sabu Thomas. 2018. Applications of targeted Nano drugs and Delivery systems.
8. https://doi.org/10.1016/j.biotechadv.2011.06.007
9. https://books.google.co.jp/books?hl=en&lr=&id=FPCbDwAAQBAJ&oi=fnd&pg=PA1&dq=nanobiotechnology&ots=q4GWOot49C&sig=S5IPXDMQCZZ-NN3KDElN0NU5csk
10. https://academic.oup.com/clinchem/article-abstract/53/11/2002/5627223
11. https://pubs.acs.org/doi/abs/10.1021/acs.jafc.9b06615?casa_token=YLVEHbfx98EAAAAA:oMGCErPnLCHouLoaTHrfP74xoFsK36-PsvWZKyfVQcqAgdGFNtNpypiOqR2-SmKBiWWorvvAXLdLxrgldMU

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Describe the importance of nanotechnology in the biotechnology sector at basic level
- Demonstrate the biomedical applications of nanotechnology
- Employ nanomaterials and engineered nanoparticles for agricultural and biomedical applications
- Acquire knowledge on the role of nanoparticles in cell signaling
- Learn about the ethical issues related to Nano biotechnology.

Second Year **NON MAJOR ELECTIVE II** **Semester III**

BIOENERGY TECHNOLOGY

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Introduce the basics of biological systems necessary to understand the bioenergy concepts.
- Introduce the basics of sustainable biomass and sustainable renewable energy resources
- Gain the information about different types of bioenergy conversion systems

UNIT – I INTRODUCTION TO ENERGY:

Introduction to energy- Energy, environment and sustainable development. Renewable and Non-renewable energy- Definition, resources, applications and ecological and economic consequences. Natural energy resources. Fossil fuel resources- National and international scenario. Circular economy.

UNIT – II RENEWABLE ENERGY SOURCES:

Introduction to renewable energy resources- Solar energy, Geothermal Energy, Wind energy, Ocean energy, and Bioenergy.

UNIT – III BIOENERGY:

Energy from biological feedstocks. Introduction to different types of biomass. Bioenergy- Definition, resources, applications and challenges. Various types of biofuels- First-generation biofuel; second-generation biofuel; third-generation biofuels; fourth-generation biofuels- introduction and applications.

UNIT – IV BIOENERGY PRODUCTION:

Conversion of biomass products into biofuels- Introduction, processes involved and applications.Lipids production from biomass. Transesterification for biodiesel production. Fermentation for bioethanol and biobutanol production. Anaerobic digestion for biogas/biomethane production. Microbial fuel cell for bioenergy production. Biorefinery.

UNIT – V BIOLOGICAL CONVERSION:

Biological Conversion: Biodegradation substrate; Anaerobic digestion, process parameters of biomethanation; chemical kinetics and biomethanation process, biogas plant types, biogas plant design, biogas purification and utilisation; environmental and social impacts; bioconversion of substrates into bioethanol. Concept of Biorefinery and Circular Economy

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Duffie, J. A., & Beckman, W. A. (2013). Solar engineering of thermal processes, fourth edition, Wiley.
2. Mukherjee, D., &Chakrabarti, S. (2004). Fundamentals of renewable energy systems. New Age International.
3. Sukhatme, S. P. (2005). Solar Energy Principles of Thermal Collection and storage Tata McGraw Hill Publishing Company Ltd. New Delhi.
4. Kothari, D. P., Singal, K. C., &Ranjan, R. (2011). Renewable energy sources and emerging technologies. PHI Learning Pvt. Ltd.
5. Tiwari, G. N., &Ghosal, M. K. (2007). Fundamentals of renewable energy sources. Alpha Science International Limited.
6. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York, 1980
7. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood, Chichester, 1984
8. R. C. Maheswari, Bio Energy for Rural Energisation , Concepts Publication, 1997
9. Capareda S, Introduction to biomass energy conversion, CRC Press. ISBN: 978-1-466-51333-4.
10. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons. ISBN: 978-0-470-72111-7
11. Vaughn C. Nelson, Kenneth L. Starcher, Introduction to Bioenergy (Energy and the Environment), CRC Press. ISBN: 978-1-498-71698-7
12. Yebo Li and Samir Kumar Khanal, Bioenergy: Principles and Applications, Wiley-Blackwell. ISBN: 978-1-118-56831-6
13. Ted Weyland, Bioenergy: Sustainable Perspectives, Callisto Reference. ISBN: 978-1-632-39633-4
14. https://nptel.ac.in/noc/individual_course.php?id=noc18-bt15
15. https://doi.org/10.1016/j.rser.2013.12.035
16. https://doi.org/10.1016/j.scitotenv.2021.148751
17. https://books.google.co.jp/books?hl=en&lr=&id=_oEe3J8GnC0C&oi=fnd&pg=PP1&dq=biodiesel+ashok+pandey&ots=8mmWE0O3M3&sig=tKvClrta2_kp1lyTTZ5BWfl6g1w#v=onepage&q=biodiesel%20ashok%20pandey&f=false
18. https://doi.org/10.1016/j.biortech.2011.08.030
19. https://doi.org/10.1016/j.scitotenv.2020.137116

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Obtain an in-depth knowledge of various energy resources.
- Understand the importance of sustainable energy generation.
- Acquire complete knowledge about the concept of biorefinery and circular bioeconomy.
- Explain the chemical and biological methodologies involved in biodiesel production

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Second Year **CORE COURSE VII** **Semester IV**

ENVIRONMENT BIOTECHNOLOGY

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The objectives of this course are to:

- Impart adequate information about the environmental systems
- Recognize the lethal impact of environmental pollution and methods to control
- Understand the environmental pollution and remediation using biotechnology

UNIT – I BIOGEOCHEMISTRY:

Microbial flora of soil – Interactions among soil microorganisms – Nitrogen cycle – Carbon cycle – Sulfur cycle – Phosphorous cycle – Nitrogen fixation by photosynthetic bacteria, cyanobacteria and methanogenic bacteria – Biotechnology in the reduction of carbon dioxide emission.

UNIT – II BIODEGRADATION AND BIOREMEDIATION:

Aerobic degradation of aliphatic and aromatic compounds – Co-metabolic degradation of organopollutants – Anaerobic degradation of aromatic compounds, halogenated organics and sulfonates – Biodegradation of herbicides and pesticides – Remediation technologies – Bioventing, biosparging and bioslurping, phytoremediation – Biodesulphurization of coal and oil – Microbial transformation of heavy metals, bioleaching, bioaccumulation, biosorption, and bioprecipitation of heavy metals.

UNIT– III ECOFRIENDLY BIOPRODUCTS FROM RENEWABLE SOURCES:

Fundamentals of composting process – Composting technologies, composting systems, compost quality – Biofertilizers – Biopesticides – Scientific aspects and prospects of biofuel production – Bioethanol, biohydrogen, biodiesel – Bioplastics and biopolymers.

UNIT – IV BIOLOGICAL TREATMENT OF WASTEWATER:

Physico-chemical characteristics of wastewater – Activated sludge process – Trickling Filter – Rotating biological contactors – Fluidized bed reactor – Up-flow anaerobic sludge blanket reactor (UASB) – High-rate anaerobic wastewater treatment – Comparison between aerobic and anaerobic treatment processes – Algal photosynthesis in wastewater treatment.

UNIT – V STOICHIOMETRY, KINETICS AND BIOREACTORS DESIGN:

Basic mass balance – Oxidation-reduction reactions – Degree of reduction and mass balance – Design kinetics, mass balance and application of kinetics – Design of activated sludge process and anaerobic digestion system.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Introduction to Environmental Biotechnology by A. K Chatterji, PHI Learning publishers, 2011
2. Environmental Biotechnology by Alan Scragg. Pearson Education Limited, England
3. Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press
4. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter. Winter-VCH. 2005
5. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall of India. 2001
6. Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Acquire a complete knowledge about ecosystems and their significance.
- Familiarize the various strategies to mitigate environmental pollution using biotechnological approaches.
- Get a comprehensive knowledge about emerging pollutants and environmental problems.
- Know the significance of renewable sources.
- Learn the material balance on product development.

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Second Year	**CORE COURSE VIII FOOD TECHNOLOGY**	**Semester IV**
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

The objectives of this course are to:

- Understand the chemical nature and associated microbes in food
- Quality control and laws of Indian and international standards
- Understand the principles of fermentation techniques and food processing

UNIT – I FOOD CHEMISTRY AND NUTRITION:

Food constituents – Classification, structure and functions of carbohydrates in food, Classification, structure and functions of proteins in food, Classification, structure and functions of lipids in food. Metabolic Pathways - Glycolysis, Gluconeogenesis, Transamination, Fatty Acid Oxidation, Browning Reactions in Food, Enzymes and nutrition in food and food product.

UNIT – II FOOD MICROBIOLOGY AND FERMENTATION:

Microorganisms in foods- microscopic, macroscopic and biochemical.Microbial growth on food material.Food spoilage, toxins from microbes.Physical and chemical methods of controlling microbes; Methods of disinfection, sanitation and asepsis. Microbial cultures in food fermentation and their maintenance; Traditional fermented foods of India and other Asian countries -fermented foods based on milk, meat, and vegetables; fermented beverages. Probiotics and Prebiotics.

UNIT– III FOOD PROCESSING AND PRESERVATION:

Definition Food Processing and Food Preservation; Functions, Benefits and Drawbacks of Food Processing. Processing Techniques – dicing, slicing, mincing, macerating, liquefaction, emulsification. Performance Parameters for Food Processing – hygiene, energy efficiency, minimization of waste, labour. Preservation techniques.

UNIT – IV PACKING AND SHELF LIFE:

Definition and principles of Packaging - methods of packaging various food products, factors affecting packaging. Define shelf life of industrial products, factors affecting shelf life. Methods to improve shelf life.Shelf life duration of various food products.

UNIT – V FOOD SAFETY AND QUALITY:

Concept of food safety and quality; Quality Control & Assurance –GMP, GHP, GLP, GAP, HACCP; Food Sampling Techniques; Rapid Detection of Microorganisms.FDA - Structure and Function, FSSAI – Structure and Function,

Licensing and Registration of Food Units – Central and State Licensing Authorities.Codex India.FAO & WHO – Role and Functions.COPANT and ASEAN.ISO – special emphasis on ISO 9001:2000/2008; ISO 22000:2005; ISO 45001; ISO 14000.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Hazel King. 2002. Trends in food technology. 1st Edition- Raintree Publications.
2. David, S. Robinson. 1997. Food Chemistry and nutritive value. Longman group, UK.
3. Frazier, W.C. and Westhoff, D.C. 1988. Food Microbiology, 4th Edition. McGram-Hill, New York.
4. Pyke, M. 1981. Food Science and Technology, 4th Edition. John Murray, London.
5. Chandra S. 2010. Food Processing and Technology. 1st Edition- Jain Brothers-Newdelhi.
6. Sivasankar, B. 2002. Food processing and preservation. Prentice Hall, New Delhi
7. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. 1979. Food engineering operations, 2nd Edition. Applied Sciences Pub. Ltd., London.
8. Victoria Emerton and Eugenia Choi. 2008. Essential Guide to Food Additives. 3rd Edition-Royal Society of Chemistry.
9. Fennema, O.R. 1976. Principles of food science: Part I, Food chemistry, Marcel Dekker, New York.
10. David E. Bender and Arnold E. Bender. 2015. Dictionary of Nutrition and Food Technology. 7th Edition-Woodhead Publishing.
11. Norman N. Portter and Joseph H. Hotchkiss. 2007. Food Science. 5ht Edition-CBS Publishers & Distributors.
12. Shakuntala, N. and Shadaksharaswamy, M. 1997. Foods; Facts and Principles. 2ndEdition.New Age International Publishers, New Delhi.

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Understand the nutritional content of food and metabolism.
- Update the knowledge of the fermentation process and food microorganisms.
- Describe the techniques related to food processing and preservation.
- Understand food safety and quality and standards.
- Gain knowledge on shelf life of food products.

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Second Year	ENTREPRENEURSHIP / INDUSTRY BASED COURSE BIOTECHNOLOGY FOR ENTREPRENEURSHIP	Semester IV
Code:	(Theory)	Credit: 5

COURSE OBJECTIVES:

The objectives of this course are to:

- Introduce the concept of entrepreneurship, method of project conceptualization
- Assessment strategies for projects and generating funds from agencies
- Understand the biotechnology-based entrepreneurship resources

UNIT – I INTRODUCTION TO ENTREPRENEURSHIP:

Introduction to bio-business, Indian context, SWOT analysis of bio-business.Ownership, Development of Entrepreneurship; Stages in the entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its barriers. Small scale industries: Definition; Characteristics; Need and rationale.

UNIT – II IDENTIFICATION OF A PROJECT:

Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report, project appraisal.

UNIT– III ASSESSMENT OF A PROJECT:

Financial analysis: Ratio analysis, Investment process, Break-even analysis, Profitability analysis, Budget and planning process. Sources of finance: Source of development finance, Project financing, Role of consultancy organizations.

UNIT – IV GENERATION OF FUND:

Funding of biotechnology business, support mechanisms for entrepreneurship, funding agencies in India- CSIR, DBT, DST, ICMR, MoEF and TNSCST , biotech policy initiatives, Role of knowledge centers and R&D (knowledge centers like universities and research institutions, role of technology up gradation). MSME.

UNIT – V BIOTECHNOLOGY ENTERPRISES:

Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, Incubation centers. Etc.,), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Startup schemes in Indian government, Business incubation support schemes, Successful start-ups-case study.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars

REFERENCES:

1. D. Hyne& John Kapeleris. 2006. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases.
2. Richard Dana Ono. 1991. The Business of Biotechnology: From the Bench of the Street. Butterworth- Heinemann.
3. Sibi. G. 2021. Intellectual Property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology. 1st Edition-Dreamtech Press.
4. Martin Grossmann. 2003. Entrepreneurship in Biotechnology: Managing for growth from start-up to Initial Public Offering
5. Yali Friedman. 2008. Best Practices in Biotechnology Education. Logos Press.
6. Robert Nicholas Trigiano and Dennis John Gray. 2004. Plant Development and Biotechnology CRC Press. 358 pages.
7. Vasant Desai. 2005. Dynamics of Entrepreneurial Development and Management. 6th Edition. Himalaya Publishing House, 2005.
8. Prasannan. Projects: Planning Analysis, Selection, Implementation& Review. 7th Edition. HolgerPatzelt and Thomas Brenner. 2010. Handbook of Bioentrepreneurship. 2nd Edition- Springer.
9. Craig D. Shimaskai. 2014. Biotechnology Enterprenurship. 1st Edition- Academic Press.

COURSE OUTCOMES:

On the Successful Completion of the course, the students will be able to:

- Understand the concept of bio-entrepreneurship.
- Gain the knowledge of writing projects and fund generation.
- Design projects independently and understand the importance of bio-enterprises
- Learn the support of government for entrepreneurship
- Face the challenges related to start ups

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Second Year **PROJECT** **Semester-IV**

Code: **Credit: 5**

Each candidate shall be required to take up a Project Work and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the student in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT /EVALUATION /VIVA-VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External):

I. Plan of the Project - 20 marks

II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc and presentation of the report. - 45 marks

III. Individual initiative - 15 marks

2. VIVA-VOCE / INTERNAL& EXTERNAL - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate shall be declared to have passed in the Project work if he/she gets not less than 40% in each of the Project Report and Viva-voce but not less than 50% in the aggregate of both the marks for Project Report and Viva-voce.

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Second Year	VALUE ADDED COURSE II MUSHROOM CULTIVATION	Semester IV
Code:	(Theory)	Credit: 2*

COURSE OBJECTIVES:

- To know the nutrient value of mushroom.
- To study the morphology and types of Mushrooms.
- To differentiate edible and non-edible Mushrooms.
- To learn the prospects and scope of mushroom cultivation in small scale industry

UNIT – I INTRODUCTION:

History of mushroom - Morphology of Mushroom -Nutritional and medicinal properties - Types of edible and Properties of mushroom – Current scenario - Economic importance.

UNIT – II REQUIREMENTS FOR MUSHROOM CULTIVATION:

Agro-climate requirements – Selection of Location – Composting platform, Equipment & facilities, pasteurization room & growing rooms. Facilities required for spawn preparation, Preparation of spawn substrate, preparation of pure culture, media used for pure culture, culture maintenance, storage of spawn. Casting materials & Case running: Importance of casing mixture, Quality parameters of casing soil, different types of casing mixtures, commonly used materials.

UNIT III CULTIVATION OF ECONOMICALLY IMPORTANT MUSHROOOM:

Cultivation of Button, Oyster and Straw Mushrooms: Collection of raw materials, compost & composting, spawn & spawning, casing & case run, cropping& crop management, picking & packing.

UNIT – IV POST HARVEST MANAGEMENT:

Post-harvest packaging and Management, Disease and Pest: Pest and pathogens of mushroom; control measures; Integrated Pest Management (IPM).

UNIT – V MARKETING:

Marketing of mushroom: market demand; market channels; direct marketing and wholesale marketing.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars

REFERENCES:

1. Tripathi, D.P. Mushroom Cultivation. 2005. Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi.
2. Acharya, K., Roy, A. and Sarkar, J.2020.Mushroom cultivation technology. Techno world.
3. Pathak Y. G. 2010. Mushroom production and processing technology (2010), Agrobios (India).

COURSE OUTCOMES:

- Cultivation of different edible mushrooms.
- Acquaintance with climatic requirements of mushroom cultivation.
- Acquire building knowledge for mushroom cultivation and pest management.
- Learn Harvesting and post harvesting processes of mushroom.
- Entrepreneur for mushroom and its value added products.

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