ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ ವಿಭಾಗ
ಶಿವಗಂಗೋತ್ರಿ, ದಾವಣಗೆರೆ–577007.

ಡಾ. ಸೀಮಾ ಜೆ ಪಟೇಲ್
ಅಧ್ಯಕ್ಷರು–BoS
ಫೋ. ನಂ. 9448223566

ಸಂಖ್ಯೆ:ದಾವಿವಿ:ಜೈತಅವಿ:2024–25–717
ದಿನಾಂಕ: 11.09.2024

ಗೆ,
ಕುಲಸಚಿವರು (ಆಡಳಿತ)
ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಶಿವಗಂಗೋತ್ರಿ
ದಾವಣಗೆರೆ–577007.

ಮಾನ್ಯರೆ,

ವಿಷಯ: ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಸ್ನಾತಕೋತ್ತರ ಪದವಿ ಅಧ್ಯಯನ ಮಂಡಳಿ ಸಭೆಯ ನಡಾವಳಿಯನ್ನು ಸಲ್ಲಿಸುತ್ತಿರುವ ಬಗ್ಗೆ.

ಮೇಲ್ಕಂಡ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ, ದಿನಾಂಕ:11.09.2024ರಂದು ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ ವಿಭಾಗದ ಸ್ನಾತಕೋತ್ತರ ಪದವಿ ಅಧ್ಯಯನ ಮಂಡಳಿ ಸಭೆನಡೆಸಿ ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಯ ನೂತನ ಪಠ್ಯಕ್ರಮ–2024. ಹಾಗೂ 2019–20ನೇ ಸಾಲಿನ ಪಿಹೆಚ್.ಡಿ. ಸಂಶೋಧನಾರ್ಥಿ ಮನೋಜ್ ಎಂ ಬಿ ಪಿಹೆಚ್.ಡಿ. ಸಂಶೋಧನಾ ಪರೀಕ್ಷಕರ ಪಟ್ಟಿ ಅನುಮೋದನೆ, ಮತ್ತು ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಯ ಪರೀಕ್ಷಕರ ಪಟ್ಟಿಯನ್ನು ಅಧ್ಯಯನ ಮಂಡಳಿಯಲ್ಲಿ ಅನುಮೋದಿಸಿ ಈ ಮೂಲಕ ತಮ್ಮ ಮುಂದಿನ ಸೂಕ್ತ ಕ್ರಮಕ್ಕಾಗಿ ಕಳುಹಿಸಲಾಗಿದೆ.

ವಂದನೆಗಳೊಂದಿಗೆ,

ತಮ್ಮ ವಿಶ್ವಾಸಿ,

ಅಧ್ಯಕ್ಷರು
ಅಧ್ಯಯನ ಮಂಡಳಿ
ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಅಧ್ಯಯನ ವಿಭಾಗ
ದಾವಣಗೆರೆ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಶಿವಗಂಗೋತ್ರಿ, ದಾವಣಗೆರೆ-577007

ಅಡಕ:
01. ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಸ್ನಾತಕೋತ್ತರ ಪದವಿ ನೂತನ ಪಠ್ಯಕ್ರಮ–2024ರ ಪ್ರತಿ.
02. 2019–20ನೇ ಸಾಲಿನ ಪಿಹೆಚ್.ಡಿ. ಸಂಶೋಧನಾರ್ಥಿ ಮನೋಜ್ ಎಂ ಬಿ ಪಿಹೆಚ್.ಡಿ. ಸಂಶೋಧನಾ ಪರೀಕ್ಷಕರ ಪಟ್ಟಿ.
03. ಜೈವಿಕ ತಂತ್ರಜ್ಞಾನ ಸ್ನಾತಕೋತ್ತರ ಪದವಿ ಪರೀಕ್ಷಕರ ಪಟ್ಟಿ.

DAVANGERE UNIVERSITY

Prof. Seema J Patel
Chairman, Board of Studies (BoS)
Department of Studies in Biotechnology
Mobile:9448223566

Date: 11-09-2024

Proceedings of PG Board of Studies (BoS) meeting of Biotechnology Davangere University (2024-25)

Board of Studies (BoS) meeting of PG Biotechnology board of Davangere University was held in the Department of Studies in Biotechnology, Davangere University, Shivagangothri, on 11-09-2024 at 11.00 a.m. Prof. Seema J Patel, Chairman, BoS welcomed the board members to the meeting. The chairman of the board briefed the agenda to the members and invited for discussion. The board has thoroughly discussed about each Topics in the curriculum. Proceedings have been recorded and provided hereunder.

- The board has approved the revised **PG Biotechnology syllabus** and suggested to implement same from the academic year 2024-25.
- The board has approved Ph.D. Panel of examiners for Research scholar Manoj MB
- The Board has approved panel of internal /external examiners for M.Sc., & Ph.D. Examination

Chairman and Members in the Board of Studies		Signature
Prof. Seema J Patel	Chairman	
Dr. Niranjan M H	Internal Member	
Dr. Navya H M	Internal Member	
Dr. Geetha N	External Member	

Chairman
Board of Studies
Department of Studies in Biotechnology
Davangere University
Shivagangotri, Davangere - 577 007.

DAVANGERE UNIVERSITY

DAVANGERE-577007

COURSE SCHEME

AND

SYLLABUS FOR

MASTER OF SCIENCE

DEPARTMENT OF STUDIES IN

BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

(2024-25 onwards)

DAVANGERE UNIVERSITY

SHIVAGANGOTRI

DAVANGERE-577007

Chairman
Board of Studies
Department of Studies in Biotechnology
Davangere University
Shivagangotri, Davangere - 577 007.

Dr. U.S. MAHABALESHWAR
M.Sc., M.Phil., Ph.D.
Professor & Dean, Science & Technology
Davangere University, Shivagangotri,
Davangere-577 007, Karnataka, India.

Registrar
Davangere University
Shivagangotri, Davangere

❖ PROGRAMME SPECIFIC OBJECTIVES:

Objective of M.Sc. Biotechnology is to develop competent biotechnologists who can employ and implement their knowledge base in premium processes and applications which will profoundly influence or be utilized for existing paradigm of agriculture, industry, healthcare and restoration of degraded environment to provide sustainable competitive edge to society.

PROGRAMME OUTCOMES:

Students will be able to

- Design, conduct experiments, analyse and interpret data for investigating problems in Biotechnology and allied fields.
- Pursue Higher studies like Ph.D. and Various examinations such as CSIR-NET, ARS-NET GATE, ICMR, DBT and many other open channels for promising career in research.
- Find opportunities in Pharmaceutical industries, bio fertilizer industries, aquaculture industries, environmental units, crop production units, food processing industries, national bio-resource development firms, banking and KPO.
- Achieve Entrepreneurship ventures and opportunities in academics as well.
- Understand the potentials and impact of biotechnological innovations on environment and their implementation for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.

M.Sc. in Biotechnology
Semester scheme with Choice-Based Credit System (CBCS) Course Structure

I SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	TheoryBT-1.1	Cell Biology & Advanced Genetics	4	4	70	30	100
	TheoryBT-1.2	Basic & Applied Microbiology	4	4	70	30	100
	Theory BT-1.3	Essentials of Biomolecules	4	4	70	30	100
Supportive	Theory BT-1.4	Bioanalytical & separation Techniques	4	4	70	30	100
Core	Practical BT-1.5	Cell Biology & Advanced Genetics	4	2	40	10	50
	Practical BT-1.6	Basic & Applied Microbiology	4	2	40	10	50
	Practical BT-1.7	Essentials of Biomolecules	4	2	40	10	50
Supportive	Practical BT-1.8	Bioanalytical & separation Techniques	4	2	40	10	50
Mandatory credits: English language Communication skills			2	2			
Total				26	Marks		600

II SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	TheoryBT-2.1	Molecular Biology	4	4	70	30	100
	TheoryBT-2.2	Immunotechnology	4	4	70	30	100
	Theory BT-2.3	Fundamentals of metabolism & Metabolic disorders	4	4	70	30	100
Supportive	Theory BT-2.4	Biostatistics & Bioinformatics	4	4	70	30	100
Core	Practical BT-2.5	Molecular Biology	4	2	40	10	50
	Practical BT-2.6	Immunotechnology	4	2	40	10	50
	Practical BT-2.7	Fundamentals of metabolism & Metabolic disorders	4	2	40	10	50
Supportive	Practical BT-2.8	Biostatistics & Bioinformatics	4	2	40	10	50
Mandatory credits: Computer skills			2	2			
Total				26	Marks		600

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III SEMESTER

Course	Paper Code	Paper Title	Hrs / Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-3.1	Genetic Engineering & gene therapy	4	4	70	30	**100**
	Theory BT-3.2	Bioprocess & Fermentation technology	4	4	70	30	**100**
	Theory BT-3.3	Plant Biotechnology	4	4	70	30	**100**
Specialization (Choice)	Theory BT-3.4	A) Medical Biotechnology & Health care B) Genomics & Proteomics	4	4	70	30	**100**
Interdisciplinary elective (Choice)	Theory BT-3.5	Bio innovation & Startups	2	2	40	10	**50**
Core	Practical BT-3.6	Genetic Engineering & gene therapy	4	2	40	10	**50**
	Practical BT-3.7	Bioprocess & Fermentation technology	4	2	40	10	**50**
	Practical BT-3.8	Plant Biotechnology	4	2	40	10	**50**
Specialization (Choice)	Practical BT-3.9	A) Medical Biotechnology & Health care B) Genomics & Proteomics	4	2	40	10	**50**
Total				26	Marks		**650**

IV SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-4.1	Environmental Biotechnology	4	4	70	30	**100**
	Theory BT-4.2	Animal Biotechnology, Biosafety & Bioethics	4	4	70	30	**100**
	Theory BT- 4.3	A) Research Methodology B) Pharmaceutical & Nano Biotechnology	4	4	70	30	**100**
Specialization	Theory BT-4.4	Dissertation	6	6	70	30	**100**
Core	Practical BT-4.5	Environmental Biotechnology	4	2	40	10	**50**
	Practical BT-4.6	Animal Biotechnology, Biosafety & Bioethics	4	2	40	10	**50**
Specialization	Practical BT-4.7	A) Research Methodology B) Pharmaceutical & Nano Biotechnology	4	2	40	10	**50**
Mandatory Credits : Personality Development			2	2			
Total				26	Marks		**550**

Total Marks for the Course :2400, Total Credits for the Course: 104 (including mandatory course)

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- Internal assessments for papers

1. Two sessional tests	: 10Marks
2. Seminar/Tutorial/group discussions	: 05Marks
3. Assignments/Field work/submission of specimens	: 05Marks
4. Attendance	: 10Marks
Total	: 30Marks

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

QUESTION PAPER PATTERN
I Semester M.Sc. Examination, February 2025
(2024-25 CBCS; New syllabus)
Department: BIOTECHNOLOGY

Paper …….. Paper Code……..

Time: 3 Hours Max. Marks; 70

Note: *Answer Part **A**, **Four** questions from Part **B** and **four full** questions from Part **C***

PART-A

1. Answer any **Five** of the following (2x5=10)
   a)
   b)
   c)
   d)
   e)
   f)
   g)
   h)

PART-B

(5x4=20)

2.
3.
4.
5.
6.
7.
8.
9.

PART-C

(10x4=40)

10.
11.
12.
13.
14.
15.

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I – SEMESTER

Theory Paper BT 1.1 – Cell biology and Advanced Genetics

Total: 64 Hrs

Course Objectives:
The objective of this course is to understand,
- structural and functional aspects of the cell, cell cycle
- genomic structure of microbes, genetic disorders and inheritance patterns

Course Outcome:
At the end of the course Student will be able to explain
- importance of cell and its organelles, signalling molecules and importance of cell cycle
- the chromosome, jumping genes, inheritance of characteristics

*****

Unit 1: Cell and Cellular organelles: **16 Hrs**

Basic properties of cell, Major types of cell: Prokaryotic, plant, animal cell and their characteristics, macromolecules of the cell. Structure and models of plasma membrane, Cell permeability- Active transport: Active transport of Na+ K+(sodium potassium ATPase) Ca2+ (Ca2+ - ATPase), passive transport, facilitated transfer, group transfer, Cell adhesion- integrins, selectins, cadherins. Cellular interaction- Tight and gap junctions, Desmosomes, plasmodesmata, cell coat and cell recognition.

Unit 2: Nucleus, Cell Cycle and cytoskeleton **16 Hrs**

Nuclear organization: Nucleus – Structure and function of nuclear envelope, lamina nucleosome, nucleolus involvement in ribosome formation, Chromosomes-structural organization; euchromatin and heterochromatin, polytene and lamp brush chromosomes, overview of cell cycle, Cell division-mitosis, meiosis and their significance, regulation of cell cycle, Cytoskeletal systems-microtubules, microfilaments and intermediate filament; cellular movement, structure of cilia, flagella

Unit 3: Mendelian principles, Chromosome and Transposable elements **16 Hrs**

Principles of Mendelian genetics- law of dominance, segregation and independent assortment, multiple alleles, lethal alleles, Pedigree analysis, sex determination and sex-linked characteristics in humans, structure of DNA, DNA as genetic material- Griffith experiment, Hershey-Chase

experiment, Structure of eukaryotic chromosomes- chromatin, types, centromere, telomere and their importance. Transposable elements- general characteristics. Transposable elements in prokaryotes (Is elements and transposons) and their significance. Transposable elements in eukaryotes (Maize and humans).

Unit 4: Inheritance **16 Hrs**

Structural and numerical variations of chromosomes, karyotypes and idiogram, Genetic disorders: Mendelian Disorders and chromosomal disorders, Prenatal and postnatal genetic diagnosis, Genetic counseling – Stages and importance, Linkage and crossing over, genetic maps, genetic recombination- Homologous and non-homologous recombination, Recombination in bacteria- conjugation, transformation and transduction

❖ **Books Recommended:**

- Cell Biology, Thomas Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson. 2017. 3rd Edition. Elsevier. International Edition.
- Cell and Molecular Biology, Concept and Experiment, Gerald, K.
- The Cell - A Molecular Approach, Cooper. 2013. Sunderland (MA), Sinauer Associates, Inc. USA.
- Molecular Cell Biology, Lodish, H., Berk., A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh H., and Scott M.P.
- Cell and Molecular Biology, E.D.P De Robertis, M. D and E.M.F. De Robertis, Jr, Eighth Edition, 2001, Lippincott Williams & Wilkins,
- Molecular biology, Robert, F., Weaver, McGraw-Hill.
- Basic Genetics, Hartl, D.L. Jones and Bartlett Pub.
- Genes, Lewin B., Oxford Univ. Press.
- Molecular Genetics of Bacteria, J. W. Dale. John Wiley and sons.
- Principle of Genetics, Gardner *et al.,* John Wiley and sons Pub.
- Mobile Genetic Elements. Shapilo NY., Academic press.
- Microbial Genetics, Maloy SR. Friefelder, Jones and Bartlett Pub.
- Molecular Biology of Gene, Watson JD et al., Benjamin Cumming Pub.
- Molecular Genetics of Bacteria, JW Dale. John Wiley and sons

Practical Paper BT 1.5 – Cell biology and Advanced Genetics

❖ **List of Experiments**

1. Preparation and observation of onion root tip squash for mitosis
2. Preparation and observation of onion flower buds for meiosis
3. Measuring the size of microorganisms using micrometry
4. Study of polytene chromosome and lampbrush chromosome
5. Demonstration of Barr bodies in buccal cells
6. Demonstration of plasmolysis and deplasmolysis using peels of Rhoeo leaf
7. Study of Karyotyping in humans (normal and abnormal)
8. Karyotype analysis-idiogram-preparation of ideogram
9. Problems on linkages-two point and three point test crosses
10. Problems on (a) law of segregation (b) Independent assortment (c) Sex linked inheritance
11. Isolation of DNA by Rapid method from milk
12. Spotters/ Scientific comments

Theory Paper BT 1.2 – Basic and Applied Microbiology

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To get trained in basic and applied principles of microbiology.
- To learn various microbiological techniques.

Course Outcome:

At the end of the course Student will be able to

- Understand scope of microbiology, general characteristics of microbes and microbial classification
- Use microbiological techniques
- Apply knowledge of microbiology in various fields like environmental, food and medical.

*****

Unit 1: Microbes and microbial growth **16 Hrs**

History and scope of microbiology, Microbial Classification concepts, Chemotaxonomy, Numerical Taxonomy and Molecular approaches.

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

Viruses, viroids and prions

Growth curve, synchronous growth, continuous culture, factors affecting growth.

Unit 2: Microbiological techniques **18 Hrs**

Microscopy – principles and applications of light microscope (compound microscope, dark field, fluorescent, phase contrast microscope) and electron microscopes and advances in microscopy.

Principles and protocols of staining techniques (Differential staining and structural staining)

Sampling techniques for microorganisms, Culture Media, Sterilization methods, Pure culture techniques, Measurement of growth, Culture collection and maintenance of cultures.

Unit 3: Microorganisms in environment and food **18 Hrs**

Soil Microbiology: Soil microorganisms, Interactions, Biogeochemical cycles – Nitrogen and carbon cycles; Rhizobium, Mycorrhiza.

Aquatic microbiology: Marine micro flora, fresh water microflora, Microbiology of potable water, Purification, Sewage disposal.

Aero-microbiology: Aeromicroflora, Air sampling devices, significance of aerobiological studies.

Food and dairy microbiology: Microorganisms causing food spoilage, factors affecting

growth and survival of food microorganisms, food preservation techniques: canning, drying, freezing, pasteurization, vacuum packaging, smoking, chemical additives and irradiation. Food borne illness.
Useful microbes in milk and milk products, Fermented milk products

Unit 4: Microbial diseases **12 Hrs**

Important infectious diseases of humans - Tuberculosis, Typhoid, AIDS, rabies, Malaria, mycoses.
Important diseases of plants- Citrus Canker, Rust of Sorghum, Bean mosaic disease. Antibiotics: Types, mode of action, resistance to antibiotics.

❖ **Books Recommended:**

- General Microbiology, Roger Y Stanier, John L Ingraham, and Mark L Wheels, Macmillan press Ltd.
- Microbiology, Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co ltd.
- Microbiology, Prescott, Harley, Klein, McGraw Hill.
- General Microbiology, Sulia and Shantharam, Oxford and IBH Publishing.
- Text Book of Microbiology, Ananthanarayan and Jayaram Panicker, Universities Press.
- Food microbiology, WC Frazier, McGraw Hill Education Pvt. Ltd.
- Dairy microbiology, J B Prajapathi, and Pradip V Behare, Indian Council of Agricultural Research.

Practical Paper BT 1.6- Basic and Applied Microbiology

❖ List of Experiments

1. Rules and regulations of microbiology laboratory
2. Demonstration of lab equipments
3. Preparation of different types of Media
4. Preparation of Physiological saline and serial dilution using water, soil and food sample
5. Methods of obtaining pure culture of microorganisms - Streak plate method, Pour plate method, Spread plate method
6. Study of Colony Characteristics
7. Staining Techniques
   a. Simple staining and Negative staining
   b. Differential staining – Gram's staining
8. Study of bacterial motility by hanging drop technique
9. Microscopic observation of fungi
10. Study of Bacterial Growth by Turbidometry
11. Biochemical Characterization of Bacteria - Catalase test, IMViC Test, Starch hydrolysis test
12. Methylene blue test for milk

Theory Paper BT1.3- Essentials of Biomolecules

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To understand the basic principle on the structure/function of Biomolecules

Course outcome:

At the end of the course the student will be able to

- Get the knowledge regarding the structure and functions of carbohydrates, proteins, lipids and nucleic acids

*****

Unit- 1: Overview of Biomolecules **10 Hrs**

Introduction, composition in living matter, structure and properties of water: importance of water in biological system. Acid, Bases, pH and Buffers. Effects of pH on Biological process, buffer Solutions for Biological Investigation.

Unit 2: Carbohydrates and lipids **18 Hrs**

Carbohydrates: Classification, Structure, General Properties and biological importance of mono, oligo and polysaccharides. Monosaccharaides-configuration, conformation, cyclization, optical activity, stereoisomerism, epimers, anomers, mutarotation and reactions. Reducing and non reducing sugars. Disaccharides: Structural elucidation of Maltose, Lactose and Sucrose. Polysaccharides: structure and properties of homo and hetero polysaccharides; Storage and structural polysaccharides (Starch, Glycogen, cellulose, chitin); mucopolysaccharides-glycosaminoglycans, agarose and peptidoglycans; Derived sugars-Sugar acids and Amino sugars.

Lipids: General properties, Classification, Structure & functions of lipids. Fatty acid (saturated, unsaturated & polyunsaturated FA); Triacylglycerol (TAG), phospholipids, glycolipids, sphingolipids; Steroids-cholesterol, bile salts and steroid hormones. Structure and functions of Lipoproteins and lipopolysaccharides.

Unit 3: Amino acids, Proteins and enzymes **18 Hrs**

Amino acids: General characteristics, classification, structure and properties of amino acids, Structure of nonprotein amino acids, non-standard protein amino acids, peptide bond and synthesis of peptides.

Proteins: Classification and properties of proteins, Structural organization of proteins: primary, secondary, tertiary and quaternary structures. Secondary structure of proteins - alpha helix and Beta-pleated sheets. Tertiary structure of proteins– Myoglobin. Quaternary structure of proteins-

Hemoglobin; Denaturation and renaturation of proteins, biological roles of proteins. Ramachandran's plot and its significance.
Enzymes: Classification, nomenclature, general properties and specificity of enzymes, biological role of enzymes.

Unit 4: Nucleic acids and Blotting techniques **18 Hrs**

Nucleic acids: Structure and properties of Nitrogenous bases, Nucleosides, Nucleotides, Polynucleotides; Formation of phosphodiester bond. Properties of DNA- denaturation, renaturation and melting temperature. Different Structural forms of DNA: A, B and Z DNA, Structure of RNA- mRNA, rRNA and tRNA.
Sequencing methods- Maxam and Gilberts methods and Sangers dideoxy method.
Blotting techniques- Southern, Northern, Western blotting.

❖ **Books Recommended:**

- Principles of Biochemistry, Nelson, D.L., Cox, M.M. Lehninger. (2004). 4th edition Pub WH Freeman Co.
- Biochemistry and Molecular Biology, Elliott, W.H., Elliott, D.C. 3rd Indian edition, Pub. Oxford.
- Biochemistry, Mathews, Van Holde and Ahern, 3rd edition, Pub Pearson education
- Biochemistry, Stryer, L. 4th Edn. W.H. Freeman and Co. NY.
- Outlines of Biochemistry, Kuchel, P.W., Ralston Schaums, G.B. 2nd edition Pub: Tata.
- Biochemistry, Voet, D., Voet J.G. (2004). 2nd Edn.
- Biochemistry with clinical correlations, Devlin, T.M. (1997). Wiley-Liss Inc. NY
- Principles of Biochemistry, Zubey, G.L. Parson, W.W., Vance, D.E. (1994). WmC Brown publishers. Oxford.
- Biochemistry and Physiology of the cell , Edwards and Hassall.2nd Edn. McGraw Hill Co. UK. Ltd.
- Biochemistry, Satyanarayana U. And Chakrapani U. 3rd edition UBS publishers.
- Fundamentals of biochemistry, Jain JL. Multicolour illustrative edition.

Practical Paper BT 1.7-Essentials of Biomolecules

❖ **List of Experiments**

1. Estimation of Glucose by DNS method
2. Estimation of proteins by Biuret method
3. Estimation of proteins by Folin-Lowry method
4. Qualitative Analysis of Carbohydrates.
5. Isolation of starch from potato
6. Isolation of casein from Milk
7. Qualitative analysis of Proteins
8. Construction of maltose calibration curve
9. Determination of activity of human salivary alpha amylase
10. Spotters/ Scientific comments

Theory Paper BT1.4 - Bioanalytical and Separation Techniques

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To have comprehensive knowledge of the equipments used in Biotechnology will be offered in the course along with the applications.

Course Outcome:

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

- Confine the functioning, maintenance and safety aspects of the basic apparatus used in Biotechnology
- Understand the principles and applications of centrifuge, electrophoresis and chromatography in research and related experiments
- Use the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques

*****

UNIT 1: Scope of Analytical Techniques **16 Hrs**

Properties of Biomolecules- viscosity, diffusion, osmosis and donnan effect. Basic Techniques: Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultra filtration and other membrane techniques.
Electron microscopy – TEM and SEM, freeze fracture techniques, specific staining of biological materials.

UNIT 2: Chromatographic and Electrophoretic Techniques **16 Hrs**

Principle, instrumentation and applications of separation techniques for different biomolecules and applications: Chromatography - Paper, TLC, Gel filtration, ion exchange, affinity, HPLC and GC.
Electrophoretic Techniques: Principles and applications of Polyacrylamide and Agarose gel electrophoresis, IEF, 2D Electrophoresis; Gradient electrophoresis, Pulse field gel electrophoresis and immune electrophoresis.

UNIT 3: Centrifugation **16 Hrs**

Theory and Basic Principles of Centrifugation, Sedimentation velocity and Sedimentation Equilibrium; Types of Centrifugation and centrifuge machines:- Preparative and Analytical; Differential Centrifugation, Density Gradient Centrifugation; Ultracentrifugation (velocity and buoyant density).

UNIT 4: Advanced Techniques and Radioactivity **16 Hrs**

Protein crystallization and methods, Mass spectrometry, MALDI-TOF, Flow cytometry, Biosensors and Method of Detection and quantification of macromolecules on gel

Radioactivity: Radioactive compounds & types; units & measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Autoradiography; Radioimmunoassay and its clinical application.

❖ **Books Recommended:**

- Principles of instrumental analysis,, Skooge DA., Holler FJ., Crouch SR., Thompson Brooks Publ., 1988
- Methods in Enzymology, D. Holme& H. Peck,, Academic Press.
- Analytical Biochemistry, Longman, 3rd Edition, 1998
- Principles & Techniques of Biochemistry and Molecular Biology, K. Wilson & J. Walker Cambridge University Press, NY 2006
- Basic techniques in Molecular Biology, Surzycki S, Springer Verlag.
- Techniques in Microscopy and Cell Biology, A. K. Sharma, Tata MacGraw Hill Pub. Co., N Delhi 1991
- Light Microscopy in Biology, A. J. Lacey, IRL Press, Oxford Univ. Press, New York, 1989
- Molecular Biotechnology, S. B. Primrose, Blackwell Sci. Pub., Oxford 1994
- Recombinant DNA and Biotechnology, Krenzer & Massey, ASM Press, USA 2000
- Textbook of Biotechnology, H.K. Das, Wiley
- Protein Purification, - Principles & Practices, R. Scopes, 3rd Edition, Springer Verlag, 1994.
- Basic concepts of analytical chemistry. Khopkar SM. New Age International Publ. New Delhi, 1998

❖ **Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Group discussions, debates and seminars on case studies.
- AV presentation by students (on topics as per choice of the teacher).
- Surprise quizzes.
- Collection of case studies based on research findings.
- Poster presentations on specific case studies.

Practical Paper BT 1.8 - Bioanalytical and Separation Techniques

❖ **List of Experiments**

1. Validating Beer- Lambert's Law by using UV-Vis Spectrophotometer.
2. Bacterial cell disruption by Enzymatic methods
3. Preparation of Specimens for Scanning Electron Microscopy
4. Estimation of protein by FCR Method
5. Separation of amino acids by paper chromatography
6. Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography.
7. Extraction of Extracellular protein from bacterial cell
8. Extraction of Intracellular protein from bacterial cell
9. Protein precipitation by Ammonium sulphate method
10. Demonstration of Electrophoretic Techniques (Native, SDS-PAGE, Agarose gel)
11. Spotters/ Scientific comments

II– SEMESTER

Theory Paper BT 2.1- Molecular Biology

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To give an in-depth insight into the molecular aspects of life - the central dogma.
- To explain molecular aspects of genes and its regulation- genome- gene expressions heredity- recombination- protein synthesis- molecular basis of diseases- mutations genetic analysis etc.

Course Outcome:

At the end of the course, the student will

- Get an idea about the principles behind molecular biology which makes students to understand the basic molecular tools and its application in basic and applied research in various fields of life sciences.

*****

Unit 1: DNA Replication and Transcription **16 Hrs**

Models of replication, Meselson and Stahl's experiment, Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication. Prokaryotic and Eukaryotic transcription, General and specific transcription factors, Regulatory elements in mechanisms of transcription and post-transcriptional modifications

Unit 2: RNA synthesis, processing and translation **16 Hrs**

Transcription activators and repressors, promoters, RNA polymerases and transcription factors. RNA processing- capping, polyadenylation, splicing, alternative splicing, RNA editing, exon shuffling and RNA transport. Translation in Prokaryotes and Eukaryotes: Genetic code, initiation of translation, chain elongation and termination

Unit 3: Regulation of gene expression **16 Hrs**

Regulation of gene expression in Prokaryotes- Operon concept, regulation at transcription initiation- lac and trp operon , regulation of lytic and lysogenic cycles in lambda phage, ribosomal proteins as translational repressors.

Regulation of gene expression in eukaryotes- regulation after transcription initiation, translational control in ferritin and transferrin mRNA, RNA interference, role of chromatin in regulation of gene expression and gene silencing

Unit 4: Gene mutation and DNA repair **16 Hrs**

Mutation, types of mutations, phenotypic effects of mutations, suppressor mutations, mutation rates, spontaneous replication errors, induced mutations, analysis of reverse mutations, detecting mutations, Ames test; site directed mutagenesis, DNA repair mechanisms- mismatch

repair, direct repair, base-excision repair, nucleotide-excision repair and other types of DNA repair. Molecular genetic analysis: Molecular genetics revolution, Genetic model organisms – *Caenorhabditis elegans*, *Drosophila melanogaster* and *Arabidopsis thaliana*

❖ **Books Recommended:**

- Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
- Essential of Molecular Biology, Vol-I & 2, T.A. Brown, 2000. Oxford University Press.
- Genetics: analysis and principles, Robert brooker, 2011. 4 edition, McGraw-Hill.
- Genetic engineering, Rastogi Smita and Neelam Pathak., 2010. Oxford University press, New Delhi.
- The Cell. A molecular approach. Geoffrey M. Cooper, Robert E. Hausman.2003. 3rd edition
- Principles of Genetics. Gardner, Simmons and Snustad.2002. 8th edition
- Molecular biology: genes to proteins, Tropp BE., Jones &Bartlett , 2010

Practical BT 2.5 - Molecular Biology

❖ **List of Experiments**

Safety Rules in molecular biology laboratory experiments

Preparation of reagents for molecular biology experiments

1. Isolation of auxotrophs
2. Isolation of Genomic DNA by bacterial culture / plant source
3. Isolation of Plasmid DNA by bacterial culture
4. Isolation and Electrophoretic analysis of total RNA
5. Purification of isolated DNA
6. Estimation of DNA by Diphenyl amine method
7. Estimation of RNA by Orcinol method
8. Determination of Melting temperature (Tm) of DNA
9. Elution of DNA from Agarose gels
10. Agarose gel Electrophoresis and staining studies
11. Demonstration of Preparation of competent cells transformation by calcium chloride methods
12. Study of Conjugation in *E.coli*
13. Study of Transduction in *E.coli*
14. Spotters/ Scientific comment

Theory Paper BT 2.2 – Immunotechnology

Total: 64 Hrs

Course Objective:
The objective of this course is
- To know the concepts of immune response
- To learn the immunodiagnostic techniques

Course Outcome:
At the end of the course, the students will be able to
- Describe the immune system and Outline the mechanisms of Immune response
- Explain antibody production and purification
- Apply the major immunological laboratory techniques for clinical analysis and research

*****

Unit 1: Overview of the immune system **16 Hrs**

Types of immunity- innate immunity and acquired immunity, Cells and organs of immune system, Primary antibody response and secondary antibody response and immunological memory
Antigens: Immunological properties of antigens, factors influencing immunogenicity, epitope, hapten
Immunoglobulins: immunoglobulin classes, basic structure, antigenic determinants of immunoglobulins, diversity and specificity of antibodies, Regulation of immunoglobulin gene expression – Clonal selection theory, genetics of antibody diversity,
Immunohaematology: Overview, blood grouping, Rh factor determination, significance of blood cell based antigens.

Unit 2: Immune response and immunization **16 Hrs**

Antigen processing and presentation, cytokines, major histocompatibility complex, complement pathways and its role in immune response, hypersensitivity-Type I, II, III and IV
Autoimmune disorders: General considerations, Classification of autoimmune diseases. representative auto immune disorders- Systemic Lupus Erythematosus, Myasthenia gravis
Transplantation immunology: graft rejection and acceptance, types of grafts, HLA typing, role of MHC proteins in transplantation;
Immunodeficiency disorder: Phagocytic cell defects, B-cell deficiency disorders, T-cell deficiency disorders, combined and Secondary immunodeficiency disorders
Immunization: types of vaccines –whole organism (attenuated and inactivated) and component vaccines (subunit vaccines, synthetic peptides, DNA vaccines). Representative vaccines – BCG, Polio vaccine, Hepatitis B vaccine, Covid19 vaccines.

Unit 3: Antibody production **16 Hrs**

Production of polyclonal antibodies: Preparation of immunogens, adjuvants, immunization procedures, bleeding procedures and collection of serum and antibodies.
Production of monoclonal antibodies: Strategies, methodology for production of hybridoma-cells, media, *in vitro* immunization, fusion, hybridma screening, selection and cloning. Ascites.
Purification of immunoglobulins: Purification of immunoglobulins from polyclonal sera, purifications of IgY from egg yolk, purification of monoclonal antibodies, assessment of purity and quality of immunoglobulins, preparation of Fab fragments- standard proteolytic cleavage methods.

Unit 4: Antibody-antigen interactions **16 Hrs**

Nature of antibody-antigen interactions: Physico-chemical basis of antibody-antigen interaction, In vitro techniques based on antigen-antibody interaction: principles, methodology and applications of agglutination, precipitation reactions – Radial and Ouchterlony immunodiffusion, immunoelectrophoresis, complement fixation, immunofluorescence, FACS, chemiluminescence assay, Radio Immuno Assay and ELISA.
Enzyme immunoassays (EIA): Properties of enzymes used in EIA, chromogenic substrates, immobilization of immunoreactants on solid phases, preparation of enzyme-antibody conjugates.

❖ **Books Recommended:**

- Immunology – An Introduction, Tizard, Thomson.
- Kuby Immunology, Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby, WH Freeman.
- Immunology &Immunotechnology, Ashim K Chakravarthy, Oxford University Press.
- Immunodiagnostics, S C Rastogi, New Age International.
- Essential Immunology, Roitt I. Blackwell Scientific Publications, Oxford.
- Practice and theory of immunoassays, P Tijssen, Elsevier

Practical BT 2.6 - Immunotechnology

❖ List of Experiments

1. Serum and plasma separation from whole blood
2. Partial purification of Immunoglobulins by ammonium sulphate fractionation
3. Differential Leukocyte count
4. Serological reactions - Agglutination
5. Precipitation – VDRL test
6. Single radial immune diffusion
7. Ouchterlony double diffusion
8. Rocket immunoelectrophoresis
9. Enzyme linked immunosorbant assay
10. Serum protein electrophoresis
11. Extraction of IgY from egg yolk
12. Spotters/ Scientific comments

Theory Paper BT - 2.3 Metabolism and Metabolic Disorders

Total: 64 Hrs

Course objective:

The objective of this course is

- To know the fundamental concepts of metabolic pathways, importance and their regulatory mechanism and major diseases associated with impairment in metabolism

Course Outcome:

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

- Understand the fundamental concepts of metabolic pathways, energy yield/utilization during metabolic pathways,
- Explain the causes for human disorders associated with metabolism

*****

Unit 1: Introduction to Metabolism **16 Hrs**

Metabolism- catabolism and anabolism, importance of enzymes, coenzymes and cofactors in metabolism, High energy compounds - ATP, NAD, FAD, FMN, quinines. Organization of electron carriers and enzymes in mitochondria, mitochondrial respiratory chain, Classes of electron transferring enzyme, inhibitors of electron transport, oxidative phosphorylation, Mechanism of oxidative phosphorylation, Regulation of Oxidative phosphorylation, Photorespiration and Photophosporylation- cyclic and non – cyclic reactions; anaerobic respiration

Unit 2: Metabolism of Carbohydrates and lipids **18 Hrs**

Glycolysis – Reactions, energy yield and regulation of glycolysis. TCA cycle-Reactions, Energetics and Regulation. Glyoxylate cycle, pentose phosphate pathway-regulation and significance, Entner-Doudoroff pathway. Glucoronic acid cycle, Glycogen synthesis, Breakdown of glycogen (Glycogenolysis) and its regulation, Biosynthesis of glucose (gluconeogenesis), and its regulation.

Lipid metabolism:

Beta oxidation of fatty acids, Ketone bodies, Fatty acid biosynthesis- control of fatty acid synthesis. Biosynthesis of cholesterol, triacylglycerols and phospholipids. Lipoproteins and their types, importance of lipoproteins, biosynthesis of lipoproteins, degradation of lipoproteins

Unit 3 : Metabolism of Amino acids and nucleic acids **14 Hrs**

Amino acids-general structure, classification and functions. Catabolism of amino acids-transamination, oxidative deamination, and decarboxylation, urea cycle- steps involved and

regulation. Biosynthesis of amino acids (Glutamate family, aspartate family, serine family and aromatic amino acids), Regulation of amino acid biosynthesis.
Nucleic acid metabolism structure and functions of nucleotides- purines and pyrimidines, De Novo synthesis of purines – pathway, key enzymes and regulation and Salvage pathway, De Novo synthesis of pyrimidine nucleotides- pathway, key enzymes and regulation and Salvage pathway, degradation of purine and pyrimidine nucleotides.

Unit 4: Metabolic disorders **16 Hrs**

Disorders of carbohydrate metabolism- Lactose Intolerance, glycogen storage disease, diabetes mellitus, Hereditary fructose intolerance, galactosemia. **Disorders of lipid metabolism-** hypercholesterolemia, hyperglyceridemia, familial hyperlipidemia, acquired hyperlipidemia. **Human genetic disorders of amino acid metabolism-** Phenylketonuria, Tyrosinemia, Maple syrup urine disease, Hartnup disease, albinism. **Disorders of Nucleic acid metabolism**-Adenosine deaminase deficiency, gout, Lesch-Nyhan syndrome, orotic aciduria, Von Gierke's Disease

❖ **Books Recommended:**

- Fundamentals of Biotechnology, P. Prave, Uwe Faust, Wolfgang Sittinger, and Dieter A. Sukatsch. Publisher: Wiley-VCH, Weinheim.
- Principles of Fermentation Technology. Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall. Publisher: Pergamon Press.
- Principles of Biochemistry, Lehninger A.L. Publisher: Worth Publishers.
- Text of Biochemistry, West and Todd. Publisher: Macmillan.
- Metabolic Pathways, Greenberg. Publisher: Academic Press.
- Biochemistry, G. Zubay, 2nd Ed. Publisher: Wm. C. Brown Publishers
- Inborn Metabolic Diseases, Diagnosis and Treatment, Jean-Marie Saudubray, Matthias R. Baumgartner, Ángeles García-Cazorla, John Walter. Publisher: Springer, 2022.

Practical Paper BT 2.7- Metabolism and Metabolic Disorders

❖ **List of Experiments**

1. Effect of sugar type on yeast metabolism
2. Estimation of urea by DAMO method
3. Effect of temperature on yeast metabolism
4. Estimation of carbohydrates by phenol sulphuric acid method
5. Estimation of pyruvate by 2,4-dinitrophenyl hydrazine method
6. Estimation of tryptophan by $FeCl_3$ method
7. Assay of catalase from potato/apple
8. Effect of temperature on activity of catalase
9. Fermentation of sugars by lactic acid bacteria
10. Estimation of ketone bodies in urine
11. Spotters/ Scientific comments

Theory Paper BT 2.4 - Biostatistics and Bioinformatics

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To encompass the methodology and theory of statistics as applied to problems in the field of life sciences
- To comprehend the fundamentals and applications of Bioinformatics in biotechnology research.
- To impart knowledge of various software tools used in Bioinformatics studies.

Course Outcome:

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

- Understand and perform structured query and analyse the results in biologically significant way.
- Detail the basic concepts in Bioinformatics.
- Demonstrate the applications of Bioinformatics in biotechnology research.
- Apply various software tools used in Bioinformatics for specific case studies.

*****

Biostatistics

Unit 1: Statistical concepts **16 Hrs**

Introduction to Bio-statistics, basic concepts, data types, sampling methods, data collection, tabulation of data, graphical representation of data- Histogram, bar graphs, pie chart, pictogram, frequency polygon, frequency curve. Frequency distribution, Measures of central tendency: Arithmetic mean, median, mode. Measures of dispersion: Range, quartile deviation, mean deviation, standard deviation, standard error, coefficient of variation.

Unit2: Probability and hypothesis testing **16 Hrs**

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Types of distribution of data: Normal, Binomial, Poisson. Hypothesis testing: Z-test, t-test, F-test, chi square test; ANOVA.

Bioinformatics

UNIT 3: Introduction to Bioinformatics **16 Hrs**

Definition-Importance and uses of Bioinformatics, concepts, History; Scope / Research Areas of Bioinformatics; Bioinformatics - Online tools and offline tools

Biological databases and search tools: Database browsing and Data retrieval; Types of data bases - NCBI, Gen bank, DDBJ, Swiss port, EMBL and PDB; Various specialized databases,

BLAST and its different types; FASTA; Primer design – need for tools, Primer design programs and software (PRIME3).

UNIT 4: Sequence analysis and *In-Silico* applications **16 Hrs**

Submission of DNA sequences to the database; Sequence alignment; Pair wise and Multiple sequence alignment; use of CLUSTAL W and CLUSTAL X for the multiple sequence alignment; SEQUIN; Phylogenetic analysis: Alignment, Tree Building, and Tree Evaluation, Tree-Building Methods-Distance based and character-based methods, Evaluating Trees and Data- Bootstrapping (parametric and nonparametric), Phylogenetic softwares (CLUSTAL-omega, PHYLIP etc); Protein Identity based on composition, Physical properties Based on sequence, secondary structure and tertiary structure. Protein folds prediction tools. 3D Structure Modeling in drug discovery, molecular docking, quantitative structure activity relationship (QSAR).

❖ **Books Recommended**

- Biostatistics, Daniel. (Wiley).
- Statistics, S.C.Gupta.
- Statistical Methods, G.W.Snedecor&W.G.Cochran.
- Fundamentals of Biostatistics, Khan &Khanum.
- Let us C, Kanetkar.
- Fundamentals of Biostatistics, U.B.Rastogi (Ame Books Ltd).
- Bioinformatics, D.Mount.
- Introduction to Bioinformatics, Arthur Lesk, III edition, Oxford Publications. 2004
- Structural Bioinformatics, Philip E Bourne, John Wiley & Sons. 2009.
- Fundamental Concepts of Bioinformatics, D E Krane & M L Raymer, Pearson, 2002

❖ Web links and Video Lectures (e-Resources):

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://acrobat.adobe.com/id/urn:aaid:sc:AP:122a2f83-9c58-446e-9ee5-887d89e420ee
- https://acrobat.adobe.com/id/urn:aaid:sc:AP:ad7ad0d2-e85d-45bf-85e3-c6a88735eabc
- https://www.coursera.org/courses?query=bioinformatics
- https://www.edx.org/learn/bioinformatics
- https://bioinfotraining.bio.cam.ac.uk/
- https://onlinecourses.nptel.ac.in/noc19_bt25/preview
- https://pll.harvard.edu/course/introduction-proteomics?delta=0
- https://www.coursera.org/courses?query=genomics
- https://www.classcentral.com/subject/genomics
- https://online.stanford.edu/programs/genetics-and-genomics-program

Practical Paper BT 2.8 Biostatistics & Bioinformatics

❖ **List of Experiments**

1. Problems on central tendencies (Arithmetic mean, median and mode) and measures of dispersion (Range, Mean deviation, standard deviation)
2. Graphical representation of data (Bar diagram, Pie chart, Pictogram)
3. Anova/F-test/Z test
4. Chi square test
5. Knowledge of different Biological databases
6. Retrieving sequence Data from Entrez
7. Protein Identification and Analysis using EXPASY tool
8. Conduction sequence similarity using BLAST and FASTA
9. Protein Validation- Ramachandra Plot using Precheck
10. Homology Modelling and Protein structure Analysis
11. Multiple Sequence alignment- Dynamic, Global alignment and Clustal W
12. Phylogenetic analysis using online software - Clustal W, NCBI and Phylotree
13. Primer Designing using NCBI and PCR Primer Design Tool by Eurofins
14. Molecular Docking using Swiss Dock
15. Docking Visualization using Protein-Ligand Interaction Profilier

III – SEMESTER

Theory Paper BT 3.1- Genetic Engineering and Gene Therapy

Total: 64 Hrs

Course objectives:

The objective of this course is

- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.

Course outcome:

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

- achieve good knowledge on methodological repertoire which allows them to innovatively apply these techniques in basic and applied fields of life science researches.

*****

Unit- 1: Molecular tools in genetic engineering **16 Hrs**

Extraction and purification of genomic and plasmid DNA from biological sources, isolation of RNA, Quantification of Nucleic acids. Restriction-modification systems: restriction endonuclease- Types and Nomenclature, recognition of sequences- cleavage patterns and their modifications. Application of restriction enzymes. Enzymes used in cloning- ligase, methylases, Polymerase, Phosphatase, Polynucleotide Kinase, topoisomerases and Nucleases.

Unit 2: Plasmid, Phage & Viral Vectors & their application in rDNA **16 Hrs**

Properties of good vectors, cloning and expression vectors – Plasmids –pBR322, pUC18 and pET, Phage vectors – lambda phage, M13. Plant based vectors Ti and Ri, binary and shuttle vectors. Hybrid vectors: Cosmids vectors. Artificial chromosomes vectors - Yeast artificial chromosomal vectors- YAC and BAC, Vectors for animals – SV40, (BPV), Retrovirus. Pichia vector system.

Unit 3: Gene manipulation **14 Hrs**

Restriction mapping, cloning in plasmid, methods of insertion of foreign DNA into host cells-transient-transfection, transformation etc. and screening methods for transformants. Construction and screening of genomic, cDNA and BAC libraries and applications. Chromosome walking and Chromosome Jumping. Gene expression in prokaryotes and eukaryotes. Protein purification by affinity tags-His-tags, GST-tags, MBP-tags etc. Mutagenesis: Site direct mutagenesis; deletion mutagenesis.

Unit 4: Gene analysis techniques and Gene therapy **18 Hrs**

Hybridization techniques- Colony hybridization, fluorescence in situ hybridization. Molecular probes- Preparation, labelling, amplification and applications. Polymerase chain reaction- Principle, primer designing, Types- RT-PCR, Real-time PCR. Advanced Sequencing methods- Automated DNA sequencing, Pyrosequencing and Next generation sequencing; Microarray, Dnase foot printing.

Gene therapy:

Types of gene therapy (somatic and germ line), methods of gene therapy (*Ex vivo* and *in vivo* methods); vectors for gene therapy- viral vectors (adenoviral, retro viral vectors & other viral vectors) and non-viral vectors (Microinjection, electroporation, particle bombardment, liposomes mediated etc.); gene therapy for genetic diseases (SCID, Cystic fibrosis etc.) Production of Recombinant pharmaceuticals (Human insulin and somatostatin),

Genome editing: Gene targeting, knock-out mice, genome editing by CRISPR-CAS technology.

❖ **Books Recommended**

- Gene cloning and DNA analysis-An Introduction. T.A. Brown. 5thedition. Blackwell Publishing.
- Molecular Cloning -A laboratory Manual Vol: 1, 2 & 3. 3rdEdition. J. Sambrook and D.W. Russell.
- Principles of Gene Manipulation. S.B. Primrose, R.M. Twyman and R.W. Old. 6th edition. Blackwell Science.
- Principles of Gene Manipulation and Genomics, 7th Edition. S. B. Primrose & R. M. Twyman. Blackwell Publishing.
- Introduction to Proteomics-Tools for the New Biology. Daniel C. Liebler, Humana Press.
- Bioinformatics and Functional Genomics. Jonathan Pevsner. 3rd Edition. Wiley-Blackwell Publishers.
- Proteomics. Timothy Palzkill, Kluwer Academic Publishers

Practical Paper BT 3.6- Genetic Engineering and gene therapy

❖ **List of Experiments**

1. Isolation of DNA from Plant source
2. Isolation of DNA from Animal source
3. Isolation of RNA from plant source
4. Isolation of RNA from Animal source
5. Isolation of plasmids and purification.
6. Electrophoretic separation of DNA/plasmid by agarose gel electrophoresis
7. Quantification of DNA by UV spectrophotometry
8. Preparation of competent *E.coli* cells, (Demonstration)
9. Genetic Transformation of *E.coli* with a recombinant plasmid. (Demonstration)
10. Screening transformed cells for the presence of recombinant plasmid and gene (Demonstration)
11. Transformation frequency and cloning efficiency. (Demonstration)
12. Spotters/Scientific comments

Theory Paper BT 3.2- Bioprocess and Fermentation Technology

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To know microbial growth and application of microbes in industrial product formation
- To learn significance of fermentation processes and overview of the Upstream and downstream process from raw material to product in industry.

Course Outcome:

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

- Explain various cell culture methods, strain improvement, design and development of medium for inoculum development.
- Understand the techniques of sterilization and explain various aspects of fermenter for an industrial fermentation process.

*****

Unit 1: Principles of Bioprocess Technology **16 Hrs**

Introduction to concepts of bioprocess engineering, Overview of bioprocesses with their various components; Isolation, selection and improvement of industrially important microorganisms; Screening of microorganisms for primary and secondary metabolites. Strain improvement for increased yield and other desirable characteristics. Problems associated with strain improvement; Preservation of improved strains. Optimization of bioprocesses, yield coefficient, doubling time, specific growth rate, metabolic and biomass productivities, effect of temperature, pH and salt concentration on product formation.

Unit 2: Basic concepts of fermentation processes **18 Hrs**

Typical structure of advanced Bioreactor and their working mechanism; Design features; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Solid substrate, surface and submerged fermentation; Fermentation media; Design and types of culture/production vessels- Batch, Fed batch, CSTBR, airlift, packed bed and bubble column fermentor; Impeller, Baffles, Sparger.

Upstream and downstream processing:

Media formulation; Inocula development and Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process. **Downstream Processing:** Introduction, Cell disruption methods; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra-filtration, drying, crystallization, storage and packaging; Treatment of effluent and its disposal.

Unit 3: Enzyme Biotechnology **16 Hrs**

Sources of enzymes; isolation and purification of enzymes, immobilized enzymes (or whole cells) and their industrial application; Industrial Applications of enzymes- in food, baking and beverage industry- Amylases, lipases, proteases. Enzymes in textile, detergent industry- catalases, cellulases and proteases. Enzymes used in drug design, delivery and enzyme replacement therapy.

Unit 4: Industrial Biotechnology **14 Hrs**

Industrial production of Alcohol- Ethanol, Industrial production of Alcoholic beverages – Wine, Beer and Whisky, Organic acids – Citric acid, lactic acid, Amino acids–Glutamic acid, lysine. Microbial Production of Therapeutic Compounds: Antibiotics: penicillin, and streptomycin and tetracyclines. Recombinant protein- Insulin, hepatitis-B vaccine. Fermented foods: Bread, cheese, olives, sausages.

Books Recommended

- Biotechnology – Volumes 1 to 5,Rehem. Publisher: Wiley-VCH. 1981 onwards.
- Industrial Microbiology- LE Casida Jr. New Age International Private Limited. 2019.
- Industrial Microbiology (2nd Edition), Prescott, Samuel Cate. Publisher: McGraw-Hill Book Company, Inc.
- Immobilized enzymes. R. Messing. Publisher: CRC Press
- Biochemical engineering fundamentals, Bailey and Ollis. Publisher: McGraw-Hill
- Biotechnology, BD Singh. Publisher: Kalyani Publisher, 2021.
- Industrial Biotechnology, Cruger & Cruger. Publisher: Sinauer Associates. 2004
- Industrial Biotechnology, Arnold and Demain. Publisher: ASM Press. 1999.
- Microbial Biotechnology, Alexander, G, WH Freeman and Company. Publisher: W.H. Freeman and Company. 2007.
- Microbial Technology, Peppler, Volumes 1 & 2. Publisher: Academic Press.
- Industrial Enzymes and their Applications, Uhlig H. John Wiley and sons. Publisher: John Wiley & Sons. 1998.
- Industrial Microbiology, Patel A H. 1st edition, Macmillan India Limited.
- Bioprocess Engineering in Biotechnology, Jackson AT, Prentice Hall, Engelwood Cliffs.1991.

Practical Paper BT 3.7- Bioprocess and Fermentation Technology

❖ **List of Experiments**

1. Estimation of Lactic acid by titrimetric method
2. Estimation of citric acid by titrimetric method
3. Production of citric acid by *A.niger*
4. Assay of antibiotics and demonstration of antibiotic resistance
5. Strain improvement by random mutagenesis using UV light
6. Production of red wine from grapes and estimation of percentage of alcohol by specific gravity method
7. Immobilization of yeast by calcium alginate gel entrapment and assay for enzymes- invertase
8. Effect of media supplements on growth curve of microorganisms
9. Visit to industry/Biotech park-report to be submitted along with the record
10. Spotters/ Scientific comments

Theory Paper BT 3.3- Plant Biotechnology

Total: 64 Hrs

Course objective:

The objective of this course is

- To understand modern plant tissue culture, genetic engineering
- To know breeding to improve plants for various reasons such as increasing yield and quality, heat and drought resistance, resistance to phytopathogens, herbicide and insect resistance
- To get the idea of cloning and its related field.
- To understand a wide range of useful and valuable traits in cultural biotechnology

Course outcome:

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

- Understand Mass multiplication and conservation of rarer and endangered medicinal plants.
- Understand the methods for obtaining and application of genetically modified plants.
- Know the application of plants as bioreactors for production of secondary metabolites.
- Apply Crop improvement through hybrid varieties.

*****

Unit 1: Plant tissue culture **16 Hrs**

Milestones in history of plant cell and tissue culture and its scope, culture media; Media composition and types, plant growth regulators (auxins, cytokinins and gibberellins), cellular totipotency, explants preparation and surface sterilization for organogenesis; micropropagation, somatic embryogenesis, Protoplast isolation and purification; Protoplast viability test; Protoplast culture and regeneration; somatic hybridization, cybrids and applications

Unit 2: Gene transformation techniques **16 Hrs**

Mechanism of DNA transfer – Direct gene transfer methods-particle bombardment, electroporation and microinjection. *Agrobacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; Development of transgenic for abiotic & biotic stress tolerance Tools and techniques used in agriculture biotechnology, Herbicide resistance, viral resistance, bacterial resistance, fungal resistance ; Transgenic crops- Golden rice, Bt cotton, Bt brinjal and sweet potato.

Unit 3: Germplasm conservation and metabolic engineering of plants **16 Hrs**

Germplasm preservation: Germplasm collection, cryopreservation, cryoprotectant and storage; Synthetic seed production and its applications; suspension cultures and plant cell reactors, Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavonoids, alkaloids; Immobilization of cells, terminator gene technology

Practical Paper BT 3.8- Plant Biotechnology

❖ List of Experiments

1. Laboratory organisation for plant tissue culture
2. Preparation of Murashige and Skoog's medium and sterilization
3. Preparation of explant
4. Induction of callus from various explants
5. Organ/meristem culture
6. Preparation of synthetic seeds
7. Micropropagation of Plants through shoot tip culture
8. Study of Hairy root culture
9. Anther culture – To obtain haploid plants
10. Protoplast isolation, viability test and culture
11. Spotters/ Scientific comments

Theory Paper BT 3.4 (A) - Medical Biotechnology and healthcare

Total: 64 Hrs

Course Objective:

The objective of this course is

- To understand the human disease diagnostics and organ function tests
- To know the applications of DNA vaccines, Monoclonal antibodies, Antisense technology and Stem cell therapy.
- To describe the tumour biology and therapies

Course outcome:

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

- Apply the diagnostic and organ function tests for detection of diseases and disorders
- Comprehend the DNA vaccines, Monoclonal antibodies, Antisense technology and enzymes, hormones, stem cells in therapy
- Understand the biotechnological approaches for cancer therapy

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Unit 1: Diagnosis of Microbial diseases and Organ function **20 Hrs**

Diagnosis of Microbial Diseases of Humans: Mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Bacteria (Typhoid, TB), Viruses (AIDS, Dengue, Covid 19), Fungi (Histoplasmosis, Candidiasis), Protozoa (Malaraia).
Evaluation of organ functions: Organ function tests - liver, kidney, pancreatic, thyroid and cardiac function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase.

Unit2: Modern therapeutic and prophylactic approaches **20 Hrs**

DNA-based Vaccines, RNA based vaccines, Recombinant DNA (rDNA) vaccines – Attenuated, subunit, Vector vaccines, Edible vaccines.
Monoclonal Antibodies in therapy : Generations of MAbs, Antibody Engineering/Recombinant MAbs, Humanized MAbs, Immunotherapy using MAbs, Immunomodulation.
Gene therapy: Gene therapeutic strategies against diseases - AIDS; Mechanism of HIV-1 Entry into cells, therapeutic strategies against HIV, clinical trials. Cystic Fibrosis (CF); Molecular mechanism of CF pathogenesis, CFTR Gene Transfer in animal Models, clinical trials.
RNA therapeutics: Antisense RNA, Ribozymes, Phosphorothioate oligonucleotides, Mechanism of RNAi, siRNA synthesis and delivery strategies. Micro RNA. Applications of RNAi

Unit 3:Enzymes, Hormones, cytokines and stem cells in therapy **12 Hrs**

Enzyme in therapy: Introduction, DNase1, Adenosine Deaminase, Asparginase, Streptokinase, digestive enzymes.

Hormones in Therapy: Introduction, uses of Insulin (Humulin), Human growth hormone and Erythropoietin hormones.

Cytokines in therapy: Features and physiological Roles, Cytokines as Therapeutics agents,

Stem cells in therapy: Properties, types and applications of stem cells. Tissue engineering.

Unit 4: Cancer therapy **12 Hrs**

Tumor biology: Introduction, properties of tumor cell, causes of tumors, tumor antigens, Proto-oncogenes, oncogenes, tumour suppressor genes (p53). Culturing of tumor cells, tumor cell lines and their applications

Major types of cancers : Carcinoma, sarcoma, melanoma, lymphoma and leukemia.

Different biotechnological approaches for cancer diagnosis and therapy: Cancer biomarkers, Molecular diagnosis, Monoclonal antibodies, Immunotherapy, cell therapy and gene therapy.

❖ **Books Recommended**

- Text Book of Microbiology, Ananthanarayan and Jayaram Panicker, Universities Press.
- Medical Biotechnology, Pratibha Nallari and V Venugopal Rao, Oxford University Press
- Essentials of Medical Biochemistry, R C Gupta, CBS Publication
- Medical Biotechnology, Jogdand, Himalaya Publishing
- Clinical Biochemistry, Eds Jaroslav Racek, Daniel Rajdl, Charles University Publication
- Applications of Biotechnology in oncology, Kewal Krishan Jain, Springer Nature.

Practical Paper BT 3.9(A) - Medical Biotechnology and healthcare

❖ **List of Experiments**

1. Determination of total cholesterol in serum by Zak's method
2. Determination of calcium in serum
3. Estimation of Blood sugar
4. Estimation of serum creatinine by Jaffe's method.
5. Determination of Hemoglobin content by Sahli-hellige method.
6. Preparation of Selective and Differential media used in Diagnostic Microbiology
7. Study of normal micro flora of skin on blood agar/nutrient agar
8. Enumeration of erythrocytes in human blood
9. Enumeration of WBC in human blood
10. Erythrocytes sedimentation rate
11. Laboratory Diagnosis of Diseases; WIDAL test
12. Case study on cancer
13. Spotters/ Scientific comments

Theory Paper BT 3.4(B)- Genomics & Proteomics

Total: 64 Hrs

Course Objectives:

The objective of this course is

- To learn important concepts of technologies relevant to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course Outcome:

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

- Discern the crucial concepts and techniques applied in genomics, transcriptomics and proteomics.
- Classify the complexity of genome/ proteome structural and functional organization.
- Formulate and assess experimental design for solving theoretical and experimental problems in Genomics and Proteomics fields.

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UNIT-1: Introduction **10 Hrs**

Concept of genomics, Structural genomics, Functional Genomics, Transcriptomics, proteomics, and metabolomics

UNIT 2: Genomics **18 Hrs**

Genome Sequencing; Genome sequencing projects of *E.coli*, yeast, and human genome project.Structural genomics: Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole-genome shotgun sequencing Understanding a genome sequence: locating the genes in a genome sequence; identification and classification using molecular markers- 16S rRNA typing/sequencing, EST's and SNP's.

UNIT 3: Genome Analysis **18 Hrs**

Genome Organization and Structure: C-Values of genomes, Repetitive and coding sequences, Genetic and physical maps, Methods of physical mapping. Molecular markers, Hybridization based markers restriction fragment length polymorphism (RFLP's), random amplification of polymorphic DNA (RAPD's) and amplified fragment length polymorphisms (AFLP). Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR).

Approaches to mapping, fluorescence *in-situ* hybridization (FISH) - DNA amplification markers; Telomerase as molecular markers.

UNIT 4: Principles of proteomics **18 Hrs**

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Micro scale solution; isoelectric focusing; peptide fingerprinting; LCMS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-Protein interactions, Yeast two hybrid system.

Functional genomics and proteomics: Analysis of microarray data; protein and peptide microarray-based technology; PCR-directed protein in-situ arrays; structural proteomics.

❖ **Books Recommended**

- Plant Genome Analysis, Peter M Gresshoff, (1st Ed.), CRC Press.UK.1994
- Genetic Analysis – Principles, Scope and Objectives, John R S Finchman. (1st Ed.). Blackwell Science. Singapore.1994.
- Biocomputing Informatics and the Genome Projects, Smith D.W. (1st Ed.) Academic
- Press.USA.1993.
- Benjamin Lewis. Genes VIII (7th Ed.). Oxford University & Cell Press.UK.1999
- Benjamin Lewis. Genes IX (9 th Ed.). Jones and Bartlett publishers. USA. 2007
- Principles of Gene manipulation and Genomics, SB Primrose and RM. Twyman,7th Ed.). Blackwell publishers.UK.2007
- Liebler D C. Introduction to Proteomics-Tools for the New Biology (2nd Ed.).John R. Humana Press Totowa. NJ. 2002

Practical Paper BT 3.9(B)- Genomics & Proteomics

❖ List of Experiments

1. Isolation of Genomic DNA by bacterial culture / plant source
2. Isolation of Plasmid DNA by bacterial culture
3. Isolation and Electrophoretic analysis of total RNA
4. Purification of isolated DNA
5. Southern Blotting technique
6. Retrieving Genomic database - case study
7. Molecular weight determination of protein by SDS-PAGE
8. Study/retrieving of 3-Dimensional protein structure
9. Western Blotting technique
10. Spotters/Scientific comment

Theory Paper BT-3.5 Bio-Innovation and Start-Ups

Total: 32 Hrs

Course Objective:

The objective of this course is

- To learn the principles of bio-innovation
- To know the start-up schemes and innovative government programmes to draft project proposal to funding agencies.
- To assess a project activity with a work plan, budget and schedule, along with its feasibility.

Course Outcome:

At the end of the course the student will be able to:

- Prepare project report for biotechnology entrepreneurship.
- Address the market challenges for a new enterprise.
- Setup enterprise for new biotechnology product.
- Assess the global market scenario of their product.

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Unit 1: Introduction **6 Hrs**

Concept of entrepreneurship, Entrepreneurship in Biotechnology; Nature and importance of Entrepreneurs; Government schemes for commercialization of technology (eg. Biotech Consortium India Limited).

Unit 2: Entrepreneurship in Biotechnology **10 Hrs**

Biotechnology: emerging industries with examples from Transgenics, recombinant therapeutic products for human health care, release of genetically engineered organisms, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization.

Unit 3: Start-up **6 Hrs**

Setting of a small industry, location of an enterprise, steps of starting small industry, Incentive & subsidies for industry, factors necessary for entrepreneurship, promoting bio-entrepreneurship.

Unit 4: Project Management and Business Plan **10 Hrs**

Project and project management; Steps of project-Project Identification; Project Selection; Project Formulation and Project Appraisal; Project Report- Need and significance; contents; Errors of project report; Writing effective business plan; Feasibility study- Market, Social, Financial and Technical.

❖ **Books Recommended**

- Entrepreneurship Development, S.S. Khanka S. Chand &Co, 2006.
- Practical Approach to IPR, Rachana Singh Puri, IK Intl. Ltd. 2009.
- Bioethics & Biosafety, R Rallapalli & Geetha Bali, APH Publication, 2007.
- Bioethics & Biosafety, Sateesh M K, IK Publishers, 2008.

❖ **Web links and Video Lectures (e-Resources):**

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.coursera.org/courses?query=regulatory%20affairs
- https://www.ilearngira.com/courses/free-regulatory-affairs-e-learning/
- https://www.coursera.org/courses?query=startup
- https://www.digitalindia.gov.in/
- https://www.makeinindia.com/

❖ **Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Group discussions, debates and seminars on case studies.
- AV presentation by students (on topics as per choice of the teacher).
- Surprise quizzes.
- Collection of case studies based on research findings.
- Poster presentations on specific case studies.

IV SEMESTER

Theory Paper BT 4.1-Environmental Biotechnology

Total:64 Hrs

Course Objectives:

The objective of this course is

- To learn the application of biotechnology in environment.
- To understand the basic principles involved in waste water management
- To know about the principles and techniques underpinning the application of biosciences to the environment

Course Outcome:

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

- Obtain knowledge on basic principles and technologies of decontamination of persistent organic pollutants mainly by means of biotechnological approaches.
- Summarize waste water management strategies and solid waste management methods

Unit 1: Basic concepts and issues related to Environment **16 Hrs**

Environmental pollution, major types of wastes and pollutants. Global environmental problems: Ozone depletion, greenhouse effect, and acid rain, their impact and management.

Biotechnological methods of pollution detection: General bioassay, cell biological methods, immunoassays, DNA-based methods. Biosensors

Unit 2: Biotechnological methods of pollution abatement **16 Hrs**

Reduction of CO_2 emission. Microbiology of Waste Water Treatments- Aerobic Process; activated sludge, Oxidation ponds, trickling filter, rotating biological contactor, and fluidized beds. Environmental significance of genetically modified microbes, Eutrophication, heavy metal pollution and its abatement, phytoremediation Bioleaching and its types.

Biodegradation of Xenobiotic Compounds: Introduction to xenobiotic compounds, general features of biodegradation of xenobiotic, Factors affecting process of biodegradation, Biodegradation of toxic chemicals- Polycyclic aromatic hydrocarbons, Polychlorinated biphenyls, Synthetic detergents, Organo-nitro-compounds.

Unit 3: Heavy metal pollution and remedial mechanisms of industrial wastes **16 Hrs**

Sources of heavy metal pollution; Microbial interactions with inorganic pollutants - Microbial metal resistance, Microbial transformation, Accumulation and concentration of metals; Biosorption, Oil degradation, creation of superbug; Hydrocarbon degradation.

Treatment of wastes: Solid wastes; sources and management. Biomedical wastes, Types of biomedical wastes; Hazards caused by biomedical wastes; Treatment strategies for biomedical wastes. Sewage water treatments systems; Primary, secondary and tertiary treatments. Treatment schemes for waste waters of, Dairy, pulp and paper, dye, leather.

Unit 4: Biotechnological Applications in Environmental Management **16 Hrs**

Role of environmental biotechnology in management of resources; Reclamation of wasteland; Production of Biogas and biofuel-Biodiesel, Biofilms and its applications, biopesticides, Bioplastics- PHB, PLA, cellulose and protein based plastics. Biocomposting; vermiculture; organic farming; biomineralization, Green composite – starch based. Concept of green patent, Biological indicators, bioremediation.

❖ **Books Recommended**

- Environmental Biotechnology-Theory and Applications, G M Evans, J C Furlong, John Wiley &Sons, e-book, 2003.
- Environmental Biotechnology: Concepts and Applications, Hans-Joachim Jordening, Josef Winter, John –Wiley and Sons, 2006.
- Environmental Biotechnology: Basic concepts and Applications, InduShekhar Thakur, I K Internationals Pvt Ltd., 2006
- Environmental Biotechnology, A H Scragg, Longman, 1999,
- Recent reviews from scientific journals.
- Environmental Biotechnology, Christopher. F Forster, D.A. JohnWase, 1987 Ellis Harwood.
- Comprehensive Biotechnology. Second edition, Elsevier, 2011, Murray Mor. Young (Editor in chief). ISBN-978-0-08-088504-9
- Waste water Microbiology, Gabriel Bitton, 2005, John Wiley and Sons, Wiley series in Ecological and Applied Microbiology.
- Microbial Ecology. Fundamentals and Applications, Ronald M Atlas. Pearson Education India.

Practical Paper BT 4.5 Environmental Biotechnology

❖ **List Of Experiments**

1. Analysis of sewage water for COD
2. Analysis of sewage water for BOD
3. Estimates of total organic carbon in the given sample
4. Analysis of sewage water for Toxic chemicals for Hydrogen sulphide
5. Analysis of sewage water for Toxic chemicals for chloride
6. Analysis of sewage water for Toxic chemicals for residual chloride
7. Analysis of sewage water for Toxic chemicals for CO_2
8. Estimation of Co^{2+} and Ni^{2+} by colorimetry/spectrophotometry
9. Analysis of sewage water for Microbial flora
10. Spotters/Scientific Comment

Theory Paper BT 4.2- Animal Biotechnology, Biosafety & Bioethics

Total: 64 Hrs

Course Objective:

The objective of this course is

- To Understand the principles of animal cell culture and its application.
- To Understand the latest developments in cell culture techniques and the techniques of animal cell culture and its industrial and medical applications.
- To introduce basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.

Course outcome:

At the end of the course student

- Comprehend the fundamental concepts of animal cell culture, and its importance.
- Discuss the significance of transgenesis with reference to animal models.
- Students will gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas.

*****

Unit 1:Introduction **12 Hrs**

History and developments of animal cell culture, laboratory facilities required for animal cell culture, aseptic handling; Advantages and disadvantages of cell culture methods, Applications and Importance of cell culture.

Animal cell culture media: Physical, Chemical properties and metabolic functions of different constituents of culture medium. Balanced salt solution and their importance in animal cell culture. Types of media: Natural media -serum, plasma and tissue extract, advantages and disadvantages of natural media. Artificial media, chemically defined media. Serum containing media and Serum free media and their applications.

Unit 2: Primary culture **20 Hrs**

Preparation of animal materials; Isolation of the tissue- mouse embryo, chick embryos and human biopsy material. Types of Primary culture: Primary explantation techniques- single coverslip cultures, double coverslip cultures and flask culture method. Tissue disaggregation methods- Mechanical and enzymatic (Trypsinization and Collagenase); Characteristics of cells in culture: contact inhibition; anchorage dependence and suspension cells; cell-cell communication etc. Nomenclature of cell lines, Primary and established cell lines, culture and propagation, immortalization of cell lines, selection of cell line and routine maintenance. Cell senescence; cell and tissue response to trophic factors; Measurement of viability and cytotoxicity; Cell separation techniques.

Culturing of specialized cells: Epithelial, mesenchymal, hematopoietic cells, Lymphocyte preparation.
Cloning of Animals: Methods and uses. Introduction, nuclear transfer for cloning, cloning from- embryonic cells, adult and fetal cells. Cloning efficiency, cloning for production of transgenic animals.

Unit 3: Commercial applications of cell culture **16 Hrs**

Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies; Tissue culture as a screening system; Mass production of biologically important compounds. Livestock improvement: Manipulation of reproduction in animals (Artificial insemination, multiple ovulations, *in vitro* fertilization, Embryo transfer technology). Potential application of transgenic animals: models for various diseases/disorders, production of peptides and proteins of biopharmaceutical interest (molecular farming).
Cell and Tissue engineering: Growth factors for *in situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering, 3D bioprinting.

Unit 4: Biosafety and Bioethics **16 Hrs**

Introduction, biosafety issues, Biological Safety Cabinets & their types; Primary Containment for Biohazards. Biosafety Guidelines: Biosafety guidelines and regulations GMOs/LMOs-Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture.
Bioethics: Introduction, Applications of Bioethics, Ethical issues in genetically modified organisms, Ethical issues related to stem cell research. Intellectual Property Rights: Introduction; Forms of IP; Patents and its types, Trademark, Copyright & Related Rights.

❖ **Books Recommended**

- Gene Cloning and DNA Analysis (6th Edition), T.A. Brown. John Willey & Sons Inc, USA, 2010.
- Lewin's Gene XI (11th Edition), Krebs JE, Kilpatrick ST and Goldstein ES. Jones and Bartlett Publishers, Inc, 2013.
- Animal Cell and Tissue Culture (1st Edition), Shivangi Mathur. Publisher: Agrobios (India), 2009.
- Animal Biotechnology, Varun Mehta. Publisher: Campus Book International, 2011.
- Culture of Animal Cells: A Manual of Basic Technique & Specialized Applications (6th Edition), R. Ian Freshney. John Willey & Sons
- Molecular Cloning: A Laboratory Manual (4th Edition), Michael R. Green and Joseph Sambrook. Cold Spring Harbor Laboratory

- Animal Cell Culture-A Practical Approach (3rd Edition), John R. Masters. Publishers: Oxford University Press, 2000.
- Animal Biotechnology-Models in Discovery and Translation (1st Edition), Editors: Ashish S. Verma and Anchal Singh, Elsevier 2014.
- Bioethics and Biosafety, Sateesh, M.K., IK International Publishers (2008)
- Patent law and Entrepreneurship, Singh I. and Kaur, B., Kalyani Publishers (2006).
- Law of Patents, Srinivasan, K. and Awasthi, H.K., Jain Book Agency (1997)
- Patent Law, Narayan, P., Eastern Law House (1975).
- Anthology of Biosafety (Vols. 1-4), Jonathan, Y.R., American Biological Safety Association (2005).
- Encyclopaedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

Practical Paper BT 4.6- Animal Biotechnology, Biosafety & Bioethics

❖ List of Experiments

1. Preparation of Balanced Salt Solutions
2. Preparation of artificial media
3. Culture and maintenance of cell lines, trypsinization
4. Quantification of cells by trypan blue exclusion dye
5. Preparation of serum and plasma from Blood
6. Isolation of chick embryo
7. Preparation of primary culture from Mechanical and enzymatic methods
8. Preparation of animal material by hanging drop method
9. Study of Growth kinetics of cells in culture
10. Spotters/Scientific comment

Theory Paper BT- 4.3 (A) Research Methodology

Total: 64 Hrs

Course objectives:

The objective of this course is

- To develop the research aptitude among the students
- To make them familiar with different research methods and techniques
- To introduce research paper writing and induce paper publication skills.

Course outcomes:

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

- Understand the meaning and importance of research
- Understand the concept of research design and survey methodology
- Write and publish a technical research paper
- Review papers effectively

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UNIT - 1 Introduction **16 Hrs**

Objective of Research; Types of Research; Research Formulation- Research Approaches, Steps in Research Process; Criteria of Good Research; Ethics in Research. Literature Review: concept and importance, Characteristics of Good Research. Importance of interdisciplinary research in biotechnology.

UNIT – 2 Data collection, Analysis and Interpretation of Data **16 Hrs**

Data Collection- Primary and Secondary Data Sources; Data Collection Methods; Data Processing; Classification of Data. Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

UNIT 3: Research Design **14 Hrs**

Concept and Importance of Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT 4: Use of tools for Research and Paper writing **18 Hrs**

Reference Formats and Styles (APA, Chicago, MLA, ASA), Software for Reference Management like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Paper Writing – Layout of a Research Paper, Journals in Biotechnology, Impact factor of

Journals, Publication of research article, Ethical issues related to publishing, Plagiarism and Self-Plagiarism plagiarism, Software for detection of Plagiarism.

❖ **Books Recommended:**

- ❖ Research Methodology, S.S Vinod Chandra, S Anand Hareendran, Pearson
- ❖ Statistical Methods, Y.P. Agarwal. Sterling Publishers Pvt. Ltd.
- ❖ Methods of Statistical Analysis, P.S Grewal. Sterling Publishers Pvt. Ltd.
- ❖ Fundamentals of Statistics, S.C. Gupta, V.K. Kapoor. Publisher: Sultan Chand & Sons.
- ❖ An introduction to Research Methodology, Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, RBSA Publishers , U.K., 2002.
- ❖ Research Methodology. Methods & Technique (2^{nd} Edition). Kothari. C.R. Second Edition. New Age International Publishers, New Delhi.
- ❖ Research Methodology, Sinha, S.C. and Dhiman, A.K., 2002. Ess Ess Publications. 2 volumes.

Practical Paper BT- 4.7 (A) Research Methodology

❖ **List of Experiments**

1. Experimental design and hypothesis testing
2. Literature review and meta analysis
3. Data collection and statistical analysis using SPSS
4. Ethical consideration- plagiarism detection using software tools
5. Application of ANOVA in biological experiments
6. Formatting of references
7. Writing and publishing a research article
8. Preparation of project report using Latex tool
9. Spotters/ Scientific comments

Theory Paper BT 4.3(B) - Pharmaceutical and Nanobiotechnology

Total: 64 Hrs

Course Objective:

The objective of this course is

- To know the drug design and quality assurance
- To understand Nanobiotechnology and applications in field of medicine

Course Outcome:

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

- Comprehend natural drug extraction and drug design
- Explain the analysis and quality control of the drugs
- Describe applications of nanotechnology

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Unit 1: Drug discovery, drug design, development and delivery **16 Hrs**

Drug Development: Pharmaceutical industry – current status and future prospects, Drug development Process, Role of molecular recognition in drug design, enzymes and receptors as drug targets, prodrug design and applications, computer aided drug design, preclinical and clinical trials. Drug delivery System, Biopolymers for drug delivery. Animal models and their purpose.

Drug sources: Plants, Microbes and animals. Use of natural products in traditional medicines, Marine natural products. Plant Primary and secondary metabolites: Characteristics and medicinal importance of alkaloids, sterols, flavonoids, glycosides, saponins, quinones, tanins and volatile oils.

Extraction and Isolation techniques: Introduction, Principle and Applications of different extraction & isolation methods - hot extraction and cold extraction methods.

Unit 2: Drug analysis, Quality assurance and validation **16Hrs**

Qualitative analysis of phytochemicals. Evaluation methods: In vitro methods- Antioxidant properties and antimicrobial activities. In vivo methods: Evaluation of acute toxicity; Animal models for -anti-inflammatory, wound healing, anti diabetic, and anticancerous activities of the drugs. Final product analytical methods and tests for various biopharmaceuticals. Quality control in pharmaceuticals in- process and final product control. sterilization control : physical, chemical & biological indicators ; sterility testing (sampling & methods), regulation and pharmacopoeia, GLP & GMP in pharmaceuticals, quality control through WHO, ICH process, design of sterile product manufacturing unit.

Unit 3: Nanomaterials and Their Characterization **16 Hrs**

A Brief History, Definition of Nanotechnology, Nanoscale materials: Definition and properties; Different formats of nanomaterial and applications; Bottom-Up versus Top-Down approaches; Methods of synthesis of Nanoparticles – Physical (bead mill, laser ablation), Chemical (sol-gel, precipitation, chemical reduction) and Biological (use of microbes, enzymes, plant materials), Parameters affecting nanoparticle growth, shape, size and structure; Characterization of Nanomaterials- UV, FTIR, SEM, TEM, Atomic force microscopy, Dynamic light scattering (DLS), XRD etc.

Unit 4: Biomedical and Life Science Applications of nanomaterials **16 Hrs**

Introduction to Nanomedicine; Nanobiocatalysts - characterization and applications in the production of drugs; Nanopore technology; Nanoparticles for drug delivery; Nanoparticles for diagnostic applications and diagnostic imaging; Pathogen detection by magnetic nanoparticle-based techniques; Nanotechnology products and applications in ocular, oncology, neurology and cardiology; Nanobiosensors and Case studies. Environmental effects, public perceptions, Guidelines and regulatory aspects and evaluation of Nanopharmaceuticals in India, Europe and USA, challenges and risks associated with Markets for Nano medicine. Trends in Research and education.

❖ **Books Recommended**

- Biopharmaceuticals, Biochemistry and Biotechnology, Gary Walsh, Wiley Pub.
- Synthesis of Medicinal Agents from Plants, AshishTewari, Elsevier
- The Theory & Practice of Industrial Pharmacy, Leon Lachman, Herbert A. Lieberman & Joseph &Kanig, Vergese Publishing House Bombay
- Text book of pharmacognosy and phytochemistry, Biren shah and AK Seth. CBS pub.
- Nanoparticle technology handbook, Masuo Hosokawa, Elsvier, 2012.
- Nanotechnology in biology and medicine, Tuvan ho Dhin, CRC press, 2006.
- The handbook of nanomedicine, Kewal K. Jain, Humana press, 2008.
- Essential of nanotechnology, Jereme Ramsden, Ventus publishing, 2006.
- Nano Biotechnology Protocols, Sandra J. Rosenthal and David W. Wright, Humana press, 2005
- Nano biotechnology Human Health and the Environment, Alok Dhawan, Sanjay Singh, Ashutosh Kumar Rishi Shanker, CRC Oress, 2018.
- The nanobiotechnology handbook , Yubing Xie, CRC press, 2013.

❖ **Web Links And Video Lectures (E-Resources) :**

VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

- https://www.udemy.com/course/nanotechnology
- https://www.coursera.org/courses?query=nanotechnology
- https://stores.biotecnika.org/products/nanobiotechnology-certification-course
- https://www.edx.org/learn/nanotechnology
- https://www.classcentral.com/subject/nanotechnology
- https://www.youtube.com/watch?v=ebO38bbq0_4
- https://www.coursera.org/lecture/nanotechnology/welcome-to-the-course-apP2j
- https://www.digimat.in/nptel/courses/video/102107058/L03.html

❖ **Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Group discussions and seminars on case studies.
- Presentation by students (on topics given by teacher).
- Surprise quizzes.
- Collection of case studies based on research findings.
- Poster presentations on case studies as per choice of students

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Practical Paper BT 4.7 (B)-Pharmaceutical and Nanobiotechnology

❖ **List of Experiments**

1. Regulations for Working in a regulated environment and Validation of equipment
2. Extraction of phytochemicals – Soxhlet extraction
3. Qualitative analysis of secondary metabolites in the given plant extract - Alkaloids, Flavonoids, Steroids, Saponins, Glycosides
4. Estimation of total phenolic content in the given plant extract
5. Determination of Antioxidant activity of the Plant metabolites
6. Antibiotic sensitivity test using disc diffusion method
7. Study of sterilization indicators
8. Chemical synthesis of nanoparticles
9. Green synthesis of nanoparticles
10. Characterization of nanoparticles - UV vis spectroscopy
11. Study of Antimicrobial activity of nanoparticles by agar diffusion method
12. Cyclic voltametric studies of nanoparticles
13. Spotters/Scientific Comment

BT 4.4 -Project Work/Dissertation

Project Outcome:

This course will include allotment of an individual research work to each student to be carried out in fourth semester. This will not only enhance knowledge base of students but also provide them exposure as to how to conduct and carry out a research based task. Students will also learn how to compile and interpret results. The candidate should submit four copies of dissertation/project report to the chairman of the Department one week before the commencement of fourth semester theory examinations and reports will be evaluated by external and internal examiners.

The assignment of marks for Project is as follows:

Project dissertation & Viva-voce	:	70 marks
Internal assessment	:	30 marks
Total	:	100 marks

Chairman
Board of Studies
Department of Studies in Biotechnology
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