DAVANGERE UNIVERSITY

DAVANGERE-577007

COURSE SCHEME

AND

SYLLABUS FOR

MASTER OF SCIENCE

DEPARTMENT OF STUDIES IN

BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

(2020-21 onwards)

SHIVAGANGOTRI

DAVANGERE UNIVERSITY

DAVANGERE-577007

The Chair Person
Board of Studies
Department of Biotechnology
Davangere University
DAVANGERE - 577 002

Registrar
Davangere University
Shivagangotri, Davangere.

Dr. Vadlapudi Kumar
Professor and Dean
Faculty of Science & Technology
Davangere University
Shivagangothri, Davangere-577007.

❖ PROGRAMME SPECIFIC OBJECTIVES:

Programme outcome of M.Sc. Biotechnology is to produce competent biotechnologist's who can employ and implement their knowledge base in premium processes and applications which will profoundly influence or utilized for existing paradigm of agriculture, industry, healthcare and restoration of degraded environment to provide sustainable competitive edge to present society. Students will exhibit contemporary knowledge in Biotechnology and students will be eligible for doing jobs in various sectors of pharmaceutical and biotechnological industry.

❖ PROGRAMME OUTCOMES:

Students will be able design, conduct experiments, analyse and interpret data for investigating

- Problems in Biotechnology and allied fields. Higher studies (M.Phil., Ph.D.) can be pursued in order to attain research positions. Various
- Examinations such as CSIR-NET, ARS-NET GATE, ICMR, DBT and many other opens channels for promising career in research. Students can become Junior Production Officer and Technical Assistant in biotechnology,
- Pharmaceutical Companies, bio fertilizer industry, aquaculture industries, environmental units, crop production units, food processing industries, national bio-resource development firms, banking and KPO. Entrepreneurship ventures such as consultancy and training centres can be opened.
- Some of the major pharmaceutical and drug companies' hiring biotechnological
- Professionals include Dabur, Ranbaxy, Hindustan Lever and Dr. Reddy's Labs, food processing industries, chemical industry and textile industry as well. Beside this industries also employ bio-technological professionals in their marketing divisions to boostup business in sectors where their products would be required. Beside industrial sector there are ample opportunities in academics as well.
- Students will be able to 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. Several career opportunities are available for students with biotechnology background abroad
- Especially in countries like Germany, Australia, Canada, USA and many more where biotechnology is a rapidly developing field.

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 & Genetics	4	4	70	30	**100**
	TheoryBT-1.2	Microbiology	4	4	70	30	**100**
	Theory BT-1.3	Biochemistry	4	4	70	30	**100**
Supportive	Theory BT-1.4	Bioanalytical Techniques	4	4	70	30	**100**
Core	Practical BT-1.5	Cell Biology & Genetics	4	2	40	10	**50**
	Practical BT-1.6	Microbiology	4	2	40	10	**50**
	Practical BT-1.7	Biochemistry	4	2	40	10	**50**
Supportive	Practical BT-1.8	Bioanalytical 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	Immunology &Immunotechniques	4	4	70	30	**100**
	Theory BT-2.3	Enzymology & Metabolism	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	Immunology & Immunotechniques	4	2	40	10	**50**
	Practical BT-2.7	Enzymology & Metabolism	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**

Internal assessments for papers

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

Total : 30Mark

III SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	Theory BT-3.1	Genetic Engineering	4	4	70	30	**100**
	Theory BT-3.2	Industrial Biotechnology	4	4	70	30	**100**
	Theory BT-3.3	Plant & Agricultural Biotechnology	4	4	70	30	**100**
Specialization (Choice)	Theory BT-3.4	A) Medical Biotechnology B) Genomics &Proteomics	4	4	70	30	**100**
Interdisciplinary elective (Choice)	Theory BT-3.5	Bio-entrepreneurship	2	2	40	10	**50**
Core	Practical BT-3.6	Genetic Engineering	4	2	35	15	**50**
	Practical BT-3.7	Industrial Biotechnology	4	2	35	15	**50**
	Practical BT-3.8	Plant & Agricultural Biotechnology	4	2	35	15	**50**
Specialization (Choice)	Practical BT-3.9	A) Medical Biotechnology B) Genomics & Proteomics	4	2	35	15	**50**
Total				26	Marks		**650**

IV SEMESTER

Course	Paper Code	Paper Title	Hrs/ Week	Credits	Marks		Total
					Examination	Internal Assessment	
Core	TheoryBT-4.1	Environmental Biotechnology	4	4	70	30	**100**
	TheoryBT-4.2	Animal Biotechnology	4	4	70	30	**100**
	Theory BT- 4.3	A) Food Biotechnology B) Pharmaceutical & Nano Biotechnology	4	4	70	30	**100**
Specialization	Theory BT-4.4	Dissertation	6	6	70	Viva*30	**100**
Core	PracticalBT-4.5	Environmental Biotechnology	4	2	40	10	**50**
	PracticalBT-4.6	Animal Biotechnology	4	2	40	10	**50**
Specialization	Practical BT-4.7	A) Food Biotechnology B) Pharmaceutical & Nano Biotechnology	4	2	40	10	**50**
	BT 4.8	**Study Trip**	-	-	-	-	-
Mandatory Credits : Personality Development			2	2			
Total				26	Marks		**550**

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

1) Total Marks for the Course :2400
2) Total Credits for the Course: 104 (including mandatorycourse)

QUESTION PAPER PATTERN

Semester M.Sc. Degree Examination,

(CBCS Scheme-New Syllabus)

BIOTECHNOLOGY

Paper ……..

Paper Code……..

Time: 3 Hours Max. Marks; 70

Note: *All parts are compulsory*

PART-A

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

PART-B

Write short notes on **any four** of the following (5x4=20)

2.
3.
4.
5.
6.
7.

PART-C

Answer **any four** of the following (10x4=40)

8.
9.
10.
11.
12.
13.

I - SEMESTER

THEORY PAPER BT 1.1-CELLBIOLOGY AND GENETICS

Total: 64 Hrs

Course Objectives:

To understand,

- structural and functional aspects of the cell, cell cycle
- genomic structure of microbes, genetic disorders

Course Outcome:

Student will able to explain

- importance of cell and its organelles, signalling molecules and importance of cell cycle
- the basics of human genetics.

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

Prokaryotic and eukaryotic cellular organization, structural and functional features, macromolecules of the cell. Structure and models of plasma membrane-, transport across the membrane Active transport, Active transport of Na+ K+(sodium potassium ATPase) Ca2+ (Ca2+ - ATPase), passive transport, facilitated transfer, group transfer, extracellular structures, Transport across membrane, Cell to cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction- Tight and gap junctions, Desmosomes, plasmodesmata.

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

Nuclear organization, Chromosomes-structural organization; euchromatin and heterochromatin, nucleosome, nucleolus involvement of nucleolus in ribosome formation, polytene chromosome, lampbrush chromosomes, Nucleus structure – structural organization, nucleosome, specialized chromosomes, polytene and lamp brush chromosomes. overview of cell cycle, nuclear and cell division, stages in cell cycle- mitosis, meiosis and their significance, regulation of cell cycle, Cytoskeletal systems, major structural elements of cytoskeleton, microtubules, microfilaments; cellular movement, structure of cilia, flagella.

Unit 3: **Mendel laws, Chromosome and jumping genes:** **16Hrs**

Basic principles of Mendelian genetics- segregation and independent assortment, concept of dominance, multiple alleles, lethal alleles, Pedigree analysis, sex determination and sex-linked characteristics, structure of DNA, DNA as genetic material, Structure of eukaryotic chromosomes, chromatin structure, centromere and telomere structure, general characteristics of transposable elements, transposable elements in prokaryotes (Insertion sequences and complex transposons) and eukaryotes (Maize and humans).

Unit 4: Inheritance: **16Hrs**

Structural and numerical variations of chromosomes, fragile sites, karyotypes, genetic disorders: Mendelian Disorders and genetic disorders, Prenatal and postnatal genetic diagnosis, Genetic counseling; Linkage and crossing over, linkage maps, Inheritance of mitochondrial and chloroplast genes, maternal inheritance, genetic recombination, Homologous and non-homologous recombination, Transcription and translation in prokaryotes and eukaryotes.

❖ **Books Recommended:**

- 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.
- 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-CELLBIOLOGY AND GENETICS

❖ **List of Practicals**

1. Measuring the size of microorganisms using micrometry
2. Study of fixatives and preparation of stains
3. Study of polytene chromosome and lampbrush chromosome
4. Demonstration of Barr bodies in buccal cells
5. Demonstration of plasmolysis and deplasmolysis using peels of Rhoeo leaf
6. Study of Karyotyping in humans (normal and abnormal)
7. Study of *Drosophila* mutant type
8. Problems on (a) law of segregation (b) Independent assortment (c) Sex linked inheritance (d) population genetics
9. Preparation and observation of onion root tip squash for mitosis
10. Preparation and observation of onion flower buds for meiosis
11. Isolation of DNA by Rapid method

Spotters/ Scientific comments

THEORY PAPER BT1.2-MICROBIOLOGY

Total: 64 Hrs

Course Objectives:

- The objectives of this course to train students practically in basic and applied principles of microbiology.
- The course involves demonstration and on-hand training of various microbiological techniques.

Course Outcome:

Student will be able to

- Understand microbial classification
- Apply microbiological techniques

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Unit 1: History, Scope and Microbial Classification **16 Hrs**

Historical developments in microbiology, spontaneous generation theory, biogenesis theory, germ theory of diseases; scope of microbiology

Classification concepts, binomial nomenclature, taxonomic ranks, hierarchical organization; Linnaeus concepts of taxonomy; Haeckel's three-kingdom classification; Whittaker's five-kingdom classification; three-domain concept of Carl Woese

Microbial Classification: Identification and nomenclature; Criteria for microbial classification: Morphological, physiological, ecological, genetic analysis, molecular characteristics, phage typing, serotyping, G+C ratio, comparison of proteins, nucleic acid hybridization, nucleic acid sequence comparison, DNA and RNA homology, significance of rRNA in microbial taxonomy, Chemotaxonomy and Numerical Taxonomy.

General characteristics, classification and reproduction of bacteria, fungi, algae andprotozoa. Viruses, viroids and prions

Unit 2: Microbial growth and Microbiological techniques **20 Hrs**

Growth curve, measurement of growth, synchronous growth, continuous culture, factors affecting growth like temperature, acidity, alkalinity, water availability and oxygen; culture collection and maintenance of cultures

Microscopy – principles and applications of light, fluorescent, phase contrast and electron microscopes, principles and protocols of staining techniques, sampling techniques for microorganisms, preparation media, sterilization methods, pure culture techniques, microbial safety measures.

Unit3: Microorganisms and environment: **16Hrs**

Role of microorganisms in the environment

Soil Microbiology: Biogeochemical cycles; soil microorganisms, Interactions, Rhizobium, Mycorrhiza Aquatic microbiology: Marine micro flora, fresh water microflora, Microbiology of potablewater, Purification, Sewage disposal, Microbes in Bioremediation.

Aero-microbiology: Aeromicroflora, Aerobiology and allergy, Air sampling devices,

significance of aerobiological studies.

Unit 4: **Microbial diseases** **12 Hrs**

Important infectious diseases of humans - tuberculosis, Typhoid, AIDS, rabies, Malaria, mycoses, emerging and reemerging infectious diseases, Important diseases of plants-rusts, downy mildews, powdery mildews, smuts. Chemotherapy/antibiotics: Types, mode of action, resistancet antibiotics.

BOOKS RECOMMENDED:

- General Microbiology by Roger Y Stanier, John L Ingraham, and Mark L Wheels, Macmillanress Ltd.
- Microbiology by Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co ltd.
- Microbiology by Prescott, Harley, Klein, McGraw Hill.
- General Microbiology By Sulia And Shantharam, Oxford and IBH Publishing.
- Text Book of Microbiology by Anantahnarayan and Jayaram Panicker, Universities Press.

PRACTICAL PAPER BT1.6-MICROBIOLOGY

List of Practicals:

1. Rules and regulations of microbiology laboratory
2. Sterilization of glassware
3. Demonstration of lab equipments
    1. Autoclave
    2. Hot air oven
    3. Incubator
    4. Laminar Air Flow
    5. Inoculation Loop
    6. Colorimeter and Spectrophotometer
    7. Colony counter
4. Uses of Disinfectant
5. Preparation of different types of Media
6. Preparation of Physiological saline and serial dilution
7. Methods of obtaining pure culture of microorganisms
    1. Streak method
    2. Pour plate method
    3. Spread plate method
8. Study of Colony Characteristics
9. Staining Techniques
    1. Simple staining
    2. Negative staining
    3. Differential staining
10. Study of Bacterial Growth by Turbidometry
11. Biochemical Characterization of Bacteria

1. Catalase test
2. IMViC Test
3. Carbohydrate Fermentation Test
4. Starch hydrolysis test

12. Study of bacteria motility by hanging drop technique

THEORY PAPER BT1.3-BIOCHEMISTRY

Total: 64 Hrs

Course Objectives:

- To understand the fundamental biochemistry principles, such as structure/function of biomolecules, role of vitamins and enzyme activity

Course outcome:

- The student will be able to describe the biochemistry of carbohydrates, lipids, nucleic acids, vitamins, enzymes and structural organization of proteins.

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Unit- 1: Concepts in Biochemistry 10Hrs

An overview of Macromolecules, composition of 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 and General Properties of mono, oligo and polysaccharides. Monosaccharaides-configuration, conformation, cyclization, optical activity, Stereoisomerism, mutarotation and reactions. 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, Glycosaminoglycans and glycoproteins). Derived sugars-Sugar acids and Amino sugars.

Lipids: General properties, Classification, Structure & function of lipids. Triacylglycerol (TAG), Phospholipids, Sphingolipids, glycolipids, Steroids-cholesterol, bile salts, 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. Protein structure - Primary, Secondary, Tertiary and Quaternary structure of proteins. Ramachandran's plot and its significance. Secondary structure of proteins-alpha helix and Beta pleated sheet. Tertiary structure of proteins– Myoglobin. Quaternary structure of proteins- Hemoglobin; Denaturation and renaturation of proteins, biological roles of proteins

Enzymes: Classification, nomenclature, general properties and specificity of enzymes, biological role of enzymes, enzyme denaturation.

Unit 4: Nucleic acids, Vitamins and Porphyrins **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

Vitamins: General characteristics, classification, structure and importance of vitamins; Biological functions of fat-soluble vitamins (A, D, E and K) and Water soluble vitamins.

Porphyrins: Definition, structure, properties and importance of chlorophyll, cytochrome, haemoglobin, myoblobin and vitamin-B_{12}.

❖ **Books Recommended:**

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

PRACTICAL PAPER BT1.7-BIOCHEMISTRY

❖ LIST OF PRACTICALS:

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. Separation of amino acids by circular paper chromatography
6. Separation of plant pigment by paper chromatography
7. Isolation of starch from potato
8. Isolation of casein from Milk
9. Qualitative analysis of Proteins
9. Construction of maltose calibration curve
10. Determination of activity of human salivary alpha amylase

Spotters/ Scientific comments

THEORY PAPER BT1.4-BIOANALYTICAL TECHNIQUES

Total: 64 Hrs

Course Objectives:

- A comprehensive knowledge of the equipment 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

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

Interaction of living and non-living matter; haracterization of biological macromolecules, hydrodynamic properties of biomolecules- viscosity, diffusion, osmosis and donnan effect. Microscopic techniques- Light Phase contrast, fluorescence, Scanning and Transmission electron microscopy and confocal microscopy.

Basic Techniques: Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques.

UNIT 2: Chromatographic Techniques **16Hrs**

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

UNIT 3:Spectroscopy Techniques **16Hrs**

Principle, instrumentation and application of UV-visible, fluorescent, Circular Dichroism (CD), NMR, ESR spectroscopy, Atomic absorption spectroscopy, Plasma emission spectroscopy, X-ray diffraction, Mass spectroscopy.

Advanced Techniques: Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis. Method of Detection and quantification of macromolecules on gel, staining procedure for proteins, Nucleic acid etc. zymograms and transilluminator, Flow cytometry and Biosensors.

UNIT 4: Centrifugation: 16Hrs

Basic Principles and application; RCF, Sedimentation co-efficient etc; Types of centrifuge – Micro-centrifuge, High speed & Ultracentrifuge; Preparative centrifugation; Differential & density gradient centrifugation; Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

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

❖ BOOKS RECOMMENDED:

- Principles of instrumental analysis. Skooge DA., Holler FJ., Crouch SR., Thompson Brooks Publ., 1988
- Selected readings from Methods in Enzymology, Academic Press.
  D. Holme& H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
- Basic concepts of analytical chemistry. Khopkar SM. New Age International Publ. New Delhi, 1998
- Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker (Eds.) 6th Ed., Cambridge Univ. Press, 2005.
- D. Holme& H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
- R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.

PRACTICAL PAPER BT1.8-BIOANALYTICAL TECHNIQUES

❖ LIST OF PRACTICALS:

1. Validating Beer- Lambert's Law by using UV-Vis Spectrophotometer.
2. Bacterial cell disruption by Ultra sonication method and Enzymatic methods
3. Preparation of Scanning Electron Microscopy slides
4. Separation of amino acids by paper chromatography
5. Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography.
6. Extraction of protein from bacterial cell(intracellular/ extracellular)
   a. Protein precipitation by Ammonium sulphate method
   b. Dialysis
   c. Estimation of protein by FCR Method
7. Chromatographic Techniques
8. Electrophoretic Techniques (Native, SDS-PAGE, Agarose gel)

Spotters/ Scientific comments

II– SEMESTER
THEORY PAPER BT 2.1- MOLECULAR BIOLOGY

Total: 64 Hrs

Course Objectives:

- The course gives an in-depth insight into the molecular aspects of life - the central dogma.
- It explains 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.

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

Overview of cell cycle,Structure and types of DNA, 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 and DNA repair.

Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in mechanisms oftranscription regulation, Transcriptional 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 and processing**- ribosomes, tRNAaminoacylation, aminoacyltRNAsynthetase, genetic code, wobble hypothesis, deciphering of the code, translation mechanism, translation proof reading, translation inhibitors and post translational modifications.

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

Operon concept, regulation at transcription initiation- lac and trp operon control, regulation of lytic and lysogenic cycles in lambda phage, regulation beyond transcription initiation- premature termination- trp operon, ribosomal proteins as translational repressors, ribo switches **Regulation of gene expression in eukaryotes**- regulation after transcription initiation, translational control in ferritin and tranferrin mRNA, RNA interference, role of chromatin in regulation of gene expression and gene silencing

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

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 ofDNA repair.**Molecular genetic analysis:** Molecular genetics revolution, Genetic model organisms -

Escherichia coli, *Drosophila*, *Arabidopsis*, brief account of developmental genetics, population genetics and evolutional genetics

❖ **BOOKS RECOMMENDED:**

- J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
- T.A. Brown, 2000. Essential of Molecular Biology, Vol-I & 2 Oxford University Press.
- Robert brooker, 2011. Genetics: analysis and principles, 4 edition,McGraw-Hill.
- Rastogi Smita and Neelam Pathak., 2010. Genetic engineering, Oxford University press, New Delhi.
- Molecular Biology of Genes. 4th edition by Watson, Hopkins, Roberts, Steitz, Weiner.2004
- The Cell. A molecular approach. 3rd edition by Geoffrey M. Cooper, Robert E. Hausman.2003.
- Principles of Genetics. 8th edition by Gardner, Simmons and Snustad.2002

PAPER BT 2.5 –MOLECULAR BIOLOGY

❖ **LIST OF PRACTICALS:**

1. Safety Rules in molecular biology laboratory experiments
2. Preparation of reagents for molecular biology experiments
3. Isolation of auxotrophs
4. Isolation of Genomic DNA by bacterial culture
5. Isolation of Plasmid DNA by bacterial culture
6. Isolation of Total RNA by bacterial culture
7. Purification of isolated DNA
8. Estimation of DNA by Diphenyl amine method
9. Estimation of RNA by Orcinol method
10. Denaturation and Renaturation of DNA
11. Agarose gel Electrophoresis and staining studies

Spotters/ Scientific comment

THEORY PAPER BT2.2-IMMUNOLOGY & IMMUNOTECHNIQUES

Total: 64 Hrs

Course Objective:

- To know the concepts of immune response
- To learn the immunodiagnostic techniques

Course Outcome:

Students will be able to

- Describe the immune system and Outline the mechanisms of Immune response
- Apply the major immunological laboratory techniques for clinical analysis and research

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

Types of immunity- innate immunity and acquired immunity, Cells and organs of immune system: central lymphoid organs-bone marrow and thymus; peripheral lymphoid system-spleen, lymph nodes, gut associated lymphoid tissues: immune reactive cells- development of T and B-lymphocytes, macrophages, granulocytes and naturalkillercells.

Primary antibody response and secondary antibody response and immunological memory, Immunological properties of antigens, factors influencing immunogenicity, epitope, hapten, Immunoglobulins: immunoglobulin classes, basic structure of IgG, IgM, IgA, IgE and IgD; antigenic determinants of immunoglobulins-isotypic, allotypic and idiotypic determinants; diversity and specificity of antibodies; Regulation of immunoglobulin gene expression – Clonal selection theory, genetics of antibody diversity,immunoglobulingenes

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

Antigen processing and presentation; cytokines; major histocompatibility complex; role of complements in immune response, hypersensitivity-Type I, II, III and IV; immune response againstinfectiousagents. Autoimmune disorders - General considerations, representative auto immunodisorders.

Transplantation immunology; tumor antigens, 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 B-cell and T-cell deficiency disorders, secondary immunodeficiency conditions

Unit 3: **Vaccines and antibody production** **16Hrs**

Vaccines: types of vaccines –whole organism (attenuated and inactivated) and component vaccines (synthetic peptides, DNA vaccines, recombinant vaccines, subunit vaccines).

Antibody production: Polyclonal antibodies versus monoclonal antibodies.

Production of polyclonal antisera: 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, additives, ascites tumors, storage of hybridoma cells, in vivo immunization, initial growth, screening, selection and cloning.

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

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, complement fixation - Types: Classical pathway and alternate pathway, biological functions and fixation, regulation of complement pathway, precipitation reactions – Radial and Ouchterlony immuno diffusion, immunoelectrophoresis, immunofluorescence, FACS, ELISA and Radio Immuno Assay.

❖ **BOOKS RECOMMENDED:**

- Immunology – an Introduction by Tizard, Thomson.
- Immunology by J Kuby, WH Freeman.
- Immunology & Immunotechnology by Ashim K Chakravarthy, Oxford University Press.
- Immunodiagnostics by S C Rastogi, New Age International.
- Essential Immunology by Roitt I. Blackwell Scientific Publications, Oxford.
- Practice and theory of immunoassays by P Tijssen, Elsevier

PRACTICAL BT2.6 -IMMUNOLOGY & IMMUNOTECHNIQUES

❖ List of Practicals:

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
6. Single radial immune diffusion
7. Ouchterlony double diffusion
8. Rocket immunoelectrophoresis
9. Enzyme linked immunosorbant assay

Spotters/ Scientific comments

THEORY PAPER BT-2.3 ENZYMOLOGY & METABOLISM

Total: 64Hrs

Course objective:

Describes the kinetics of enzymatic reactions and to understand enzyme substrate models and mechanism of enzyme catalysis also describes the fundamental concepts of metabolic pathways, importance and their regulatory mechanism

Course Outcome:

Studentwill be able to explain enzyme substrate models and kinetics of enzyme reaction, understand fundamental concepts of metabolic pathways, human disorders associated with metabolism

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Unit 1: Enzymes **14Hrs**

Nomenclature and classification and Enzymes, Structure and general properties of enzymes, extraction and purification of enzymes, active site and specificity of enzymes, Isoenzymes, Allosteric Enzymes, enzyme reactions- single- substrate and multiple substrate, enzyme inhibitors- types, specific nonspecific, factors affecting enzyme activity, temperature, pH, time, substrate concentration, chemical mechanisms of enzyme catalysis; experimental measurements of enzyme activity-continuous and discontinuous assays.

Unit 2: Bioenergetics and Respiration: **18Hrs**

Principles of thermodynamics: free energy, enthalpy (H), entropy (S), Free energy change in biological transformations in living systems; high energy compounds ATP, NAD, FAD, FMN, quinines. oxidation – reduction reactions, 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, Microsomal electron transport – Photophosporylation and Photorespiration cyclic and non – cyclic reactions; photochemical events associated with pigment system-I and II, Fermentation reactions (alcoholic fermentation).

Unit 3: Metabolism (i); Carbohydrate metabolism: **16Hrs**

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, Breakdown of glycogen, starch and disaccharides, glycogenolysis and its regulation, Biosynthesis of glucose (gluconeogenesis), glycogen synthesis and its regulation, Disorders of carbohydrate metabolism.

Lipid metabolism: Oxidation of fatty acids, Ketone bodies, Fatty acid biosynthesis- control of fatty acid synthesis. Biosynthesis of cholesterol, triacylglycerols, phospholipids, bile acids. Formation of prostaglandins, leukotrienes, prostacyclins. Metabolism of lipoproteins. Disorders of lipid metabolism

Unit 4: Metabolism (ii); Amino acid metabolism: 16Hrs

Amino acid degradation, transamination, oxidative deamination, pathways of degradation of different amino acids, biosynthesis of essential and non-essential amino acids, Regulation of amino acid biosynthesis. Inborn errors (human genetic disorders) of amino acid metabolism. Amino acids as precursors-formation of Gamma Amino butyric acid (GABA), serotonin, Polyamines, creatine, Melatonin

Nucleic acid metabolism biosynthesis of purine and pyrimidine nucleotides, degradation of purine and pyrimidine nucleotides, Salvage pathway, deficiency disorders in human (Adenosine deaminase deficiency, gout, Lesch-Nyhan syndrome)

❖ BOOKS RECOMMENDED:

- Enzyme Biochemistry, Biotechnology and Clinical Chemistry. Palmer T., Harwood Pub., 2001
- Fundamentals of Enzymology. Price, N.C. & Stevens, L., Oxford Pub.
- Enzymes, Copeland, R.A., Wiley India,
- Enzymology and Enzyme Technology, Bhatt, S.M.
- Biochemical Engineering fundamentals, Baily & Ollis McGram-Hill Pub.
- Fundamentals of Biotechnology. P. Prave et al., WCH Weinhein Pub.
- Principles of Fermentation Technology. P.F. Stanburry & Whitaker Pergamon Press
- Biochemistry, Lehninger A.L.
- Text of Biochemistry, West and Todd.
- Metabolic Pathways – Greenberg.
- Biochemistry, 2nd Ed, G. Zubay

PRACTICAL PAPER BT 2.7- ENZYMOLOGY AND METABOLISM

❖ **List of Practicals**

1. Maltose calibration curve and Assay of amylase from Saliva.
2. Effect of temperature on enzyme activity of salivary amylase
3. Estimation of urea by DAMO method
4. Estimation of melatonin in milk/fruits/ plant material
5. Estimation of anthocyanin fruits/plant material
6. Effect of temperature on yeast metabolism
7. Assay of catalase from potato/apple
8. Effect of temperature on activity of catalase
9. Estimation of carbohydrates by phenol sulphuric acid method
10. Estimation of pyruvate by 2,4-dinitrophenyl hydrazine method
11. Estimation of tryptophan by $FeCl_3$ method

Spotters/ Scientific comments

THEORY PAPER BT 2.4-BIOSTATISTICS & BIOINFORMATICS

Total: 64Hrs

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 and provide students with basic understanding and applications of bioinformatics.
- The course will provide the basic concepts behind the sequence and structural alignment, database searching, protein structure prediction and computer-based drug designing.

Course Outcome :

- Students will be able to understand and describe and use the biological databases, perform structured query and analyze and discuss the results in biologically significant way.
- Students will become familiar with a wide variety of bioinformatics tools and softwares and apply these to conduct basic bioinformatics research and thus develop platform for molecular biology experiments.

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Biostatistics

Unit 1: Statistical concepts: **16Hrs**

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: **16Hrs**

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. Regression and correlation. Hypothesis testing: Z-test, t-test, F-test, chisquare test; ANOVA.

Bioinformatics

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

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 like TIGR, Hovergen, TAIR, Plasmo DB, ECDC etc; Searching for sequence database like BLAST and FASTA algorithm. Biological background for sequence analysis; identification of protein sequence from DNA sequence

UNIT 4: Sequence analysis **16Hrs**

The gene bank sequence database; submitting DNA sequences to the database; Sequence alignment; Pair wise alignment technique and Multiple sequence alignment; use of CLUSTAL W and CLUSTAL X for the multiple sequence alignment; SEQUIN; Phylogenetic analysis: Concept methods of tree construction and softwares; Protein secondary structure prediction**;** Computer Aided Drug Design (CADD) in Drugdiscovery; Primer designing and DNA microarray or Biochips.

❖ **BOOKS RECOMMENDED**

- Bioinformatics – D. Mount
- Programming in C by Balaguru Swamy.
- Introduction to Bioinformatics by Arthur M. Lesk, Oxford.
- Biostatistics – Daniel. (Wiley).
- Statistics by S. C. Gupta.
- Statistical Methods by G.W. Snedecor & W. G. Cochran.
- Fundamentals of Biostatistics – Khan & Khanum.
- Let us C – Kanetkar.
- Fundamentals of Biostatistics by U. B. Rastogi (Ame Books Ltd).

PRACTICAL PAPER BT 2.8 BIOSTATISTICS & BIOINFORMATICS

❖ **List of Practicals**

1. Biological databases and organization-searching Pub Med, Introduction to NCBI, NCBI Database, EMBL, DDBJ.
2. Sequencing alignment-BLAST, FASTA, Clustal W
3. Phylogenetic analysis – PHYLIP and Tree view
4. Primer Designing – Oligo and Primer 3
5. Protein Modelling, Protein structure Analysis, Ras Mol, Jem Boss, Docking, Ligplot interactions
6. Retrieving and Submitting DNA sequence to the databases
7. Problems on central tendencies, measures of dispersion
8. Graphical representation of data

III – SEMESTER
THEORY PAPER BT 3.1- GENETIC ENGINEERING

Total: 64 Hrs

Course objectives

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

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

Genetic engineering as tool in biotechnology**.**History and development of genetic engineering.Application of genetic engineering in field of biotechnology. Extraction and purification of Genomic and plasmid DNA, isolation of RNA, Handling and quantification of Nucleic acids**Enzymes:** restriction endonuclease- Types and Nomenclature, recognition of sequences- cleavage patterns and their modifications. Application of restriction enzymes.DNA modifying enzymes- DNA ligase, DNA polymerase, Phosphatase,Polynucleotide Kinase and Nucleases.

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

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

Unit 3: Gene manipulation: 16Hrs

Restriction mapping, cloning in plasmid, insertion of foreign DNA into host cells-transformation, electroporation, transfection-transient and stable, screening methods for transformants. Construction and screening of genomic and cDNA libraries, Genomic DNA libraries application.Chromosome walking, Chromosome Jumping, BAC libraries and assembly of BACs into contigs. Expression:-Cloned gene expression in *E. coli* and purification. Principles for maximizing gene expression; expression vectors-pMal, pET-based vectors; Protein purification-His-tag, GST-tag MBP-tag etc.Mutagenesis:-Site direct mutagenesis; deletions mutagenesis.

Unit 4: Gene analysis techniques: 16Hrs

Hybridization techniques- Southern, Northern, South-western, Far-western, Colony hybridization, fluorescence in situ hybridization, molecular probes-preparation, labeling,

amplification, applications, Polymerase chain reaction-Principle, primer designing, Types-RT-PCR, real-time PCR, colony PCR, Multiplex PCR, Hot-start PCR, asymmetric PCR, Sequencing methods- chemical sequencing of DNA (Maxam and Gilberts methods and Sangers dideoxy method), automated DNA sequencing, sequencing by DE-MALDI-TOFMS, microarray.

Gene therapy, transgenics and Genome editing: *Ex vivo* and *in vivo* gene therapy, Vectors and other delivery systems for gene therapy, In-vitro gene therapy, gene therapy of genetic diseases: eg. Neurological, metabolic disorders and cystic fibrosis, viruses for gene therapy-lentivirus, adenovirus. Gene targeting, knock-out mice, genome editing by CRISPR-CAS

❖ BOOKS RECOMMENDED

- Gene cloning and DNA analysis-An Introduction. T.A. Brown. 5thedition. Blackwell Publishing.
- Molecular Cloning -A laboratory Manual Vol: 1, 2 & 3. 3rd Edition. 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

❖ **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 plasmid by agarose gel electrophoresis
7. Quantification and quality checking by UV spectrophotometry and electrophoresis
8. Preparation of competent *E.coli* cells, Construction of recombinant plasmid
9. Genetic Transformation of *E.coli* with a recombinant plasmid.
10. Screening transformed cells for the presence of recombinant plasmid and gene
11. Transformation frequency and cloning efficiency.

Spotters/Scientific comments

THEORY PAPER BT3.2- INDUSTRIAL BIOTECHNOLOGY

Total: 64 Hrs

Course Objectives:

- This course covers microbial growth and application of microbes in industrial product formation and importance will be given on techniques for screening, improvement of potential industrial microbes.
- The course discuss on significance of fermentation processes and overview of the Upstream and downstream process from raw material to product in industry.

Course Outcome:

- Explains various cell culture methods, strain improvement and to design and develop medium for inoculum development.
- Understand thetechniques of sterilization and able to explains various aspects of fermenter for an industrial fermentation process.

*****

Unit 1: Microbial Strain Improvement: 14Hrs

Isolation, selection and improvement of industrially important microorganisms; Screening of microorganisms for primary and secondary metabolites, enrichment, specific screening for the desired product. Strain improvement for the selected organism -random and strategic screening methods; Role of DNA technology; Protoplast fusion techniques; Problems associated with strain improvement programme; Preservation of improved strains.

Unit 2: Bioprocessing 20Hrs

Upstream processing: Typical structure of advanced Bioreactor and their working mechanism; Design features; Heat transfer and Mass transfer; Specialized bioreactors- design and their functions; types of bioreactors: Airlift, Tubular, Membrane, Tower, Fluidized bed, Packed bed and Photo. Sterilization, Development of inocula: Yeast, bacteria, fungal and actinomycetes. Techniques of inoculation, Types of fermentation process-submerged fermentation, surface or solid state fermentation, batch fermentation, continuous fermentation.

Down Stream Processing: Cell disintegration- Physical, chemical and enzymatic methods. Biomass separation by centrifugation, filtration and flocculation. Extraction- solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction. Purification– Chromatography, concentration, ultra-filtration, reverse osmosis, drying and crystallization.

Unit 3: Enzyme Biotechnology: **16Hrs**

Sources of enzymes; Enzyme production involving isolation, purification, encapsulation and immobilization; immobilized enzymes (or whole cells) and their industrial application; representative enzymes: lipases, proteases, amylases, glucose isomerase, glucoamylase, pectinase, rennin, L-asparaginase; enzymes used in medicines and different industries like textile, food, detergent, baking and beverage.

Unit 4: Industrially important Products: 14Hrs

Microbiological fermentation Products:-Alcohol- Ethanol, Alcoholic beverage – Wine, Beer & Whisky, Organic acids – Citric acid, Amino acids–Glutamic acid and Vitamin– $B_{12.}$ Microbial Production of Therapeutic Compounds: Antibiotics: penicillin, streptomycin, Rifamycin and Quinolinones. Recombinant protein- Insulin, hepatitis-B vaccine. Fermented foods-sausages, olives, bread, idly and acidophilus milk.

❖ BOOKS RECOMMENDED

- Biotechnology – Volumes 1 to 5 by Rehem.
- Industrial Microbiology by LE Casida Jr.
- Industrial Microbiology by Presscot and Dunn.
- Immobilized enzymes byMessing.
- Biochemical engineering fundamentals by Bailey and Ollis.
- Biotechnology by B D Singh (Kalyani).
- Industrial Biotechnology. Cruger & Cruge
- Industrial Biotechnology. Arnold and Demain
- Microbial Biotechnology. Alexander, G, WH Freeman and Company
- Microbial Technology. Peppler, Volumes 1 & 2.
- Industrial Enzymes and their Applications. Uhlig H. John Wiley and sons

PRACTICAL PAPER BT 3.7- INDUSTRIAL BIOTECHNOLOGY

❖ **List of Practical**

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. Study of Downstream processing techniques
6. Study of alcohol fermentation- alcohol from different substrates
7. Production of red wine fromgrapes and estimation of percentage of alcohol by specific gravity method
8. Production of beer from sorghum/ cereals
9. Immobilization of yeast by calcium alginate gel entrapment and assay for enzymes- invertase
10. Study of fermenter
11. Visit to industry/Biotech park-report to be submitted along with the record

Spotters/ Scientific comments

THEORY PAPER BT 3.3- PLANT & AGRICULTURAL BIOTECHNOLOGY

Total: 64 Hrs

- **Course objective:**
- To understand modern plant tissue culture, genetic engineering and biofertilizers
- To understand a wide range of useful and valuable traits in agricultural biotechnology

Course outcome:

On completion of the course, students able to understand

- Mass multiplication and conservation of rarer and endangered medicinal plants.
- Enhancement of secondary metabolites from medicinal plants.
- Comparison of biofertilizers and chemical fertilizers.
- Crop improvement through hybrid varieties.

*****

Unit 1: Plant tissue culture: 17Hrs

History and scope of plant cell and tissue culture, Culture media; Media composition and types, hormones and growth regulators, cellular totipotency, explants preparation and surface sterlization for organogenesis. Micropropagation, somatic embryogenesis, Protoplast isolation and purification; Protoplast viability test; Protoplast culture and regeneration; somatic hybridization, cybrids and applications; somaclonal variations, Cryopreservation, Germplasm collection; Synthetic seed production and its applications

Unit 2: Gene transformation techniques: 16Hrs

Mechanism of DNA transfer –Direct gene transfer methods-particle bombardment, electroporation and microinjection. *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; Development of transgenics for abiotic & biotic stress tolerance Tools and techniques used in agriculture biotechnology, Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops; Transgenic Golden rice and sweet potato; Terminator gene technology.**Metabolic engineering of plants:**Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; Immoblization of cells.

Unit 3: Biofertilizers and Biopesticides: 15Hrs

Biological nitrogen fixation, importance and mechanism. Biofertilizers-types, VAM, Rhizobium, Azospirillum, Azotobacter, Cynobacteria, Azolla, Phosphate solubilization Microbes, Mycorrhiza, Producatin of rhizobium fertilizer, Estimation of nitrogen fixation by ^{15}N Based methods and Acetylene Reduction Assay, quality control in Bio-inoculant. Production of vermicomposting technology. Biopesticides. Importance of integrated pest management. Environmental impact of herbicide resistance crops and super weeds

Unit 4: Crop improvement: 16Hrs

Advantages of biotechnological methods overconventional methods of crop improvement, Homozygous plant production through anther & pollen culture, Embryo rescue & embryo culture in rearing viable hybridembryos, Endosperm culture & production of triploids, Apomixis, Induced Polyembryony, Androgenesis: Anther and pollen culture, Gynogenesis-ovule and ovary culture, dihaploids, their applications in genetics and plant breeding; Ethical issues associated with GM crops and GM food; labeling of GM plants and products and terminator gene technology

❖ **BOOKS RECOMMENDED**

- R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
- Razdan, M.K 1993. An Introduction to plant Tissue culture.Oxford and IBHPublishing Co.Pvt.Ltd. New Delhi.
- S S Bhojwani and M K Razdan, Plant Tissue Culture, Elsevier Publ.1996
- Agricultural biotechnology, 1st edition, (2008) Rawat H, Oxford Book Co, India.
- Agrobiotechnology and plant tissue culture, Bhojwani SS, Soh WY, Oxford & IBH Publ, India Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India
- Agricultural biotechnology, (2005), Kumar HD, Daya Publ House, India
- Biofertilizer Tecchnology, Singh & Purohit (2008) AGROBIOS (India)
- Jodhpur,India.
- Introducation to Plant Biotechnology (2003) H.S. Chawla, Oxford &IBH Publishing Co.Pvt.Ltd.
- Plant tissue culture by K. K.Day

PRACTICAL PAPER BT 3.8- PLANT & AGRICULTURAL BIOTECHNOLOGY

❖ **List of Practical**

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. Isolation and staining of rhizobium from root nodules of leguminous plants
12. Seed inoculation with rhizobium culture and observation for root nodulation
13. Preparation of biocontrol formulation
14. Preparation of biofertilizer formulation

Spotters/ Scientific comments

THEORY PAPER BT 3.4(A)-MEDICAL BIOTECHNOLOGY

Total: 64 Hrs

- **Course Objective:**
- To understand the human disease diagnostics and organ function tests
- To know the applications of DNA vaccines, Monoclonal antibodies, Antisense technology and Gene therapy. To describe the tumour biology and therapies

Course outcome:

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 Gene therapy
- Understand the tumor biology with hormonal and enzymatic therapies

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Unit 1: Diagnosis of Microbial diseases and Organ function 16Hrs

*Diagnosis of Microbial Diseases of Humans***:** Mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Bacteria (Typhoid, TB), Viruses (AIDS, Hepatitis- B, Rabies), Fungi (Aspergillosis, Histoplasmosis,) Protozoa (Malaraia).

Evaluation of organ functions: Organ function tests - liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase.

Unit 2: DNA-based Vaccines, Monoclonal Antibodies and Gene Therapy 16Hrs

*DNA-based Vaccines***:** Introduction. Subunit vaccines, Newer vaccines- Peptide vaccines, Minicells as Vaccines, Recombinant DNA (rDNA) vaccines, Attenuated vaccines. Vector vaccines, Edible vaccines.

*Monoclonal Antibodies and Regenerative Medicine***:**Production of monoclonal antibodies,Monoclonal Antibody in Therapy, Targets in Therapy, Generation of MAbs, Antibody Engineering/Recombinant MAbs, Humanized MAbs, Immunotherapy using MAbs, Immunomodulation.

Gene therapy: Definition and salient features. Approaches for gene delivery; SMART, Antisense, Triple-helix-forming Oligonucleotides. Gene therapy strategies - developmental stage approach, DNA Recombination, *Ex vivo* in Humans. Gene therapeutic strategies against diseases - HIV; Mechanism of HIV-1 Entry into cells, therapeutic strategies against HIV in cell culture, HIV with ribozymes.Clinical Trials.Cystic Fibrosis (CF); Molecular mechanism of CF pathogenesis, CFTR Gene Transfer in animal Models, clinical trials.

Unit 3: Antisense Therapeutics and RNAi 16Hrs

Introduction. Ribozymes- Delivery, Stability, Bioavailability, and target specificity. Recommendations of Phosphorothioate oligonucleotides; Characteristics, pharmacological and toxicological properties, Applications of RNAi, advantages of antisense drugs.

RNAi- Mechanism of RNAi, siRNA synthesis and delivery strategies. Micro RNA. Applications of RNAi: RNAi studies in embryonic stem cells, Hematopoietic stem cells (HSCs).

Unit 4:Tumor biology, Enzyme and Hormone therapies 16Hrs

Introduction, properties of tumor cell, causes of tumors, tumor antigens, immune response and diagnosis. Proto-oncogenes, oncogenes (RAS, WNT, MYC, ERK and TRK), tumour suppressor genes (pRb, p53).Culturing of tumor cells, tumor cell lines and their applications

Enzyme therapy: Introduction, Therapeutics Enzymes; DNase I, Alginate Lyase, Adenosine Deaminase, Dihydro folate Reductase, Lipase (Glucocerebrosidase) and Streptokinase.

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

❖ **BOOKS RECOMMENDED**

- Text Book of Microbiology by Anantahnarayan and Jayaram Panicker, Universities Press.
- Medical Biotechnology by Pratibha Nallari and V Venugopal Rao, Oxford University Press
- Essentials of Medical Biochemistry by R C Gupta, CBS Publication
- Medical Biotechnology By Jogdand, Himalaya Publishing
- Clinical Biochemistry Eds Jaroslav Racek, Daniel Rajdl, Charles University Publication

PRACTICAL PAPER BT 3.9(A)- MEDICAL BIOTECHNOLOGY

❖ **LIST OF PRACTICAL**

1. Determination of total cholesterol in serum by Zak's method
2. Determination of calcium in serum
3. Estimation of Blood sugar
4. Preparation of Selective and Differential media used in Diagnostic Microbiology
5. Study of normal micro flora of skin on blood agar/nutrient agar
6. Study of Blood smear
7. Enumeration of erythrocytes in human blood
8. Enumeration of WBC in human blood
9. Erythrocytes sedimentation rate
10. Laboratory Diagnosis of Diseases; WIDAL & VDRL

Spotters/Scientific Comments

THEORY PAPER BT 3.4(B)- GENOMICS & PROTEOMICS

Total: 64 Hrs

Course Objectives:

The course aims to evaluate the students to the important concepts of technologies relevant to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course Outcome:

On the completion of the course

- The student will be able discern the crucial concepts and techniques applied in genomics, transcriptomics and proteomics.
- Be able to 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, RNAmics 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

- Peter M Gresshoff. Plant Genome Analysis (1st Ed.), CRC Press.UK.1994
- John R S Finchman. Genetic Analysis – Principles, Scope and Objectives (1st Ed.).
- Blackwell Science. Singapore.1994.
- Smith D.W. Biocomputing Informatics and the Genome Projects (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 publishres.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 Practicals:**

1. Isolation of Chloroplast DNA
2. Isolation of Mitochondrial DNA
3. Southern Blotting
4. Development of RAPD Maps
5. Retrieving Genomic database - case study
6. Molecular weight determination of protein by SDS-PAGE
7. Study/retrieving of 3-Dimensional protein structure

Spotters/Scientific comment

THEORY PAPER BT-3.5 BIOENTREPRENEURSHIP

Total: 32 Hrs

Course Objective:

This course enables the students to:

- Develop awareness about the biotechnology enterprise.
- Exposure of management principles and the global scenario of biotechnology industries.
- Develop skills to work in interdisciplinary team

Course Outcome:

At the end of the course, a student should 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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Unit1 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, genetic modifications and food consumption, release of genetically engineered organisms, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization, marketing consultancy, bio-learning module

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, biotech company roadmap, legal, regulatory and other business factors.

Unit 4: Funding support: 10 Hrs

Support mechanism for Biotechnology entrepreneurship in India, Preparation of proposal for funding from various funding agencies (UGC, DBT, DST, BIRAC, ICMR etc, Exit and licensing strategies, valuation), Role of knowledge centres and R&D (knowledge centres like universities and research institutions, role of technology and up gradation).

Problem and Solution of Entrepreneurship: Risk and benefit, Steps involved in commercialization of a biotechnological product, Case studies.

IV-SEMESTER

THEORY PAPER BT 4.1-ENVIRONMENTAL BIOTECHNOLOGY

Total: 64 Hrs

Course Objectives

- The course explains the application of biotechnology in environment.
- The students will 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, obtain knowledge on basic principles and technologies of decontamination of persistent organic pollutants (dangerous contaminants of the environment) mainly by means of biotechnological approaches.

Unit 1: Basic concepts and issues: 16Hrs

Environmental pollution, major types of wastes and pollutants. Global environmental problems: Ozone depletion, greenhouse effect, and acid rain, their impact and management.Current status of biotechnology in environment protection.

Biotechnological methods of pollution detection: General bioassay, cell biological methods, immunoassays, DNA-based methods. Biosensors: Components of Biosensors, advantages and limitations, biocatalyst based, ion-affinity based and microorganism based biosensors.

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

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-types, use of microorganisms in mining of gold, uranium and copper, biosorption.

Biodegradation of Xenobiotic Compounds: Biodegradation- Factors affecting process of biodegradation, Methods in determining biodegradability.Degradation of simple, aromatic, chlorinated, compounds.Degradation of toxic chemicals pesticides, herbicides, surfactants, and Polyaromatic hydrocarbons Oil degradation, creation of superbug. Biodegradation of lignocelluloses, PAH

Unit 3: Heavy metal pollution and Treatment of wastes: 16Hrs

Sources of heavy metal pollution; Microbial interactions with inorganic pollutants - Microbial metal resistance; Microbial transformation; Accumulation and concentration of metals; Biosorption - Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation

Treatment of wastes: Solid wastes; sources and management. Biomedical wastes, Types of biomedicalwastes; Hazards caused by biomedical wastes; Treatment strategies for biomedical

wastes.Effluent treatment systems Sewage water treatments systems; Primary, secondary and tertiary treatments.Treatment schemes for waste waters of, Dairy, pulp and paper, dye, leather and sugar.

Unit 4: Need for management of resources: 16Hrs

Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production; Biogas and biofuel production; Bioelectricity, biocementation and biocement, Bioplastics- PHB, PLA, cellulose and protein based plastics. biocomposting; vermiculture; organic farming; biomineralization, Green composite – starch based. Concept of green patent, Biological indicators, DNA barcoding

Environmental Genomics: Metagenomics and metaproteomics, ecogenomics or communitygenomics, the study of genetic material recovered directly from environmental sampleand future applications in bioremediation.

❖ **BOOKS RECOMMENDED**

- G M Evans, J C Furlong, Environmental Biotechnology-Theory and Applications, John Wiley & Sons,e-book, 2003.
- Hans-Joachim Jordening, Josef Winter, Environmental Biotechnology: Concepts and Applications, John –Wileyand Sons, 2006.
- InduShekhar Thakur, Environmental Biotechnology: Basic concepts and Applications, I K Internationals Pvt Ltd., 2006
- A H Scragg, Environmental Biotechnology, Longman, 1999,
- Recent reviews from scientific journals.
- Environmental Biotechnology, Christopher. F Forster, D. A. John Wase, 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.

PRACTICAL PAPER BT 4.5 ENVIRONMENTAL BIOTECHNOLOGY

❖ LIST OF PRACTICAL

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

Spotters/Scientific Comment

THEORY PAPER BT 4.2- ANIMAL BIOTECHNOLOGY, BIOSAFETY & BIOETHICS

Total: 64 Hrs

Course Objective

- Understanding the principles of animal cell culture and its application.
- Understanding the latest developments in cell culture techniques and the techniques of animal cell culture and its industrial and medical applications are, described.
- 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

- 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.

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Unit 1:Introduction: **16Hrs**

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: Natural-serum, plasma and tissue extract, advantages and disadvantages of natural media. Artificial media, chemically defined media, balanced salt solution and their importance in animal cell culture. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium.Role of carbon dioxide.Role of serum and supplements. Enriched media, Serum free media and their applications.

Culture of animal cells: Preparation of animal materials, Tissue disaggregation methods-Mechanical and enzymatic (Trypsinization and Collagenase), Primary explantation techniques (single coverslip cultures, double coverslip cultures, flask method).

Unit 2: Primary culture: **16Hrs**

Primary culture and its types; Characteristics of cells in culture: contact inhibition; anchorage dependence; cell-cell communication etc; Isolation of mouse and chick embryos, human biopsies, 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, neuro ectodermal, hematopoietic gonad and tumor cells, Lympocyte preparation, culture of amniocytes, fish cells

Cloning of Animals: Methods and uses.Introduction, nuclear transfer for cloning, cloning from- embryonic cells, adult and fetal cells. Cloning from short-term cultured cells: cloning of

sheep, and mice.Cloning from long-term cultured cells: Cloning of cows from aged animals. Cloning efficiency, cloning for production of transgenic animals, gene targeting for cloned transgenic animals, cloning for conservation, human cloning: ethical issues and risks.

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

Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies; Tissue culture as a screening system; cytotoxicity and diagnostic tests; Mass production of biologically important compounds (e.g. Vaccines); Harvesting of products; purification and assays;

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. *In vitro* fertilization and Embryo transfer: *In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animal e.g: Cow.

Unit 4: Bioethics: **16Hrs**

Introduction to bioethics, genetic manipulations and their ethical issues, ethical issues in GMOs, GM foods and crops in developed and developing countries, environmental release of GMOs, ethical issues involved in stem cell research and use, use of animals in research experiments, animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers, human genome project and its ethical issues.

Biosafety: Historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; recommended biosafety levels for infectious agents and infected animals; biosafety guidelines - government of India, roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs; risk assessment; risk management and communication; national regulations and international agreements.

❖ **BOOKS RECOMMENDED**

- Gene Cloning and DNA Analysis (6th Edition) by T.A. Brown. John Willey & Sons Inc, USA, 2010.
- Lewin's Gene XI (11th Edition) by Krebs JE, Kilpatrick ST and Goldstein ES. Jones and Bartlett Publishers, Inc, 2013.
- Animal Cell and Tissue Culture (1st Edition) by ShivangiMathur. Publisher: Agrobios (India), 2009.
- Animal Biotechnology by 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) by Michael R. Green and Joseph Sambrook. Cold Spring Harbor Laboratory
- Animal Cell Culture-A Practical Approach (3rd Edition) by 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.
- Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)
- Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).
- Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)Narayan, P., Patent Law, Eastern Law House (1975).
- Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
- Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

PRACTICAL PAPER BT 4.6- ANIMAL BIOTECHNOLOGY, BIOSAFETY & BIOETHICS

❖ List of practical

1. Preparation of Balanced Salt Solutions
2. Culture and maintenance of cell lines, trypsinization
3. Quantification of cells by trypan blue exclusion dye
4. Preparation of serum from Blood
5. Preparation of plasma from Blood
6. Preparation of primary culture from Mechanical and enzymatic methods
7. Study of Growth kinetics of cells in culture

Spotters/Scientific comment

THEORY PAPER BT -4.3(A) FOOD BIOTECHNOLOGY

Total: 64 Hrs

Course Objective

The objective of this course is to provide knowledge on various processing technologies of food and food products, preservation, long term storage and food safety aspects.

Course Outcome

Students will be able to:

- Acquire an understanding of relevance of food components,
- Acquire an understanding application and detection techniques in food.
- acquire an understanding in industrial operations in food, role of microbes

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Unit 1 Food chemistry **16 Hrs**

Carbohydrates, amino acids, proteins, lipids, vitamins – water soluble and fat soluble, macro and micro nutrients. Digestion, absorption & metabolism. Nutraceuticals, anti oxidents, organic acids

Enzymes used in food industry- proteases, amylases, invertases, pectinase, xylanase,

Lipase, papain, chymosin, lactase, cellulose, production of novel sweeteners, corn sweeteners, artificial sweeteners- saccharin, aspartame, sucralose.

Unit 2: Food spoilage and Preservation **16 Hrs**

Foods spoilage - Sources of contamination, microorganism- bacteria, yeast, mould affecting various food items (milk**,** bread, canned food, vegetables and fruits, meat, egg, fish, poultry)

Food preservation: Functional and fermented foods; bakery and cereal products, preservation of fruits and vegetables – dehydration, pickling. Low temperature processing and storage- chilling, cold storage. High temperature processing- Drying, heat sterilization. Irradiation- types and source of irradiation, impact of radiation on foods, irradiation of packing material, health consequences of irradiated food

Chemical preservation – organic, inorganic preservatives, Sulphur dioxide, benzoic acid, sorbic acids, antioxidants, cleaning, sanitizing, fungicidal agents. High concentration- sugar and salt concentrates. Biopreservatives, ohmic heating, micro wave, hurdle technology

Unit 3: Food born infections and intoxication **16 Hrs**

Bacterial – Brucella, bacillus, clostridium, Escherichia; food intoxication – botulism, staphylococcal toxin, mycotoxin (aflatoxin, patulins, ATA, ochratoxins, fuminosins, ergot alkaloids); food born out breaks (laboratory testing procedures and preventive measures); moulds, algae, protozoa, viruses. Biosensors in food industry

Food borne diseases: gastroenteritis; Bacillus cereus, campylobacter, Yersenia, Salmonella, Shigella

Unit 4: Food Processing and quality assurance **16 Hrs**

physical, chemical and biological types of Food processing, definition of shelf life, perishable food, semi perishable food, shelf stable food. Fermentation of beer and wine. Cheese production. Milk- pasteurization, fermented and non-fermented milk products. Canning and bottling of fruits and vegetables- process, containers, lacquering, spoilage. Layout of food processing unit and components- grinders, mixers, sterilizers, driers, cold storages; Packaging materials – origin, types, characteristics and packaging techniques

Food quality assurance : Quality standards- food safety act, FSSAI, ISO series, HACCPL, national laws and regulations; PFA,FPO,BIS and agmark and international laws and regulations. FAO and CODEX alimentarius.

❖ **BOOKS RECOMMENDED**

- Food Microbial fundamentals and frontiers by Doyle, Beuhat and Montville
- Biotech food fermentation-Vol I & II by V.K. Joshi & Ashok Pandey
- Fermentation Biotechnology by B.C.Saha
- Microbiology by M.J. Pelzar, E.C.S. Chan and N.R. Krieg-Mc Graw Hill.
- Modern Concepts in Biotechnology by HD Kumar Vikas N. Delhi
- Food Science Potterr & Hotchkins by CBS N. Delhi
- Food Microbiology by MR Adams and Moss Panima N. Delhi
- Food ProcessingBiotechnological applications by Marwah &Arora Asiatic Publ. N. Delhi

PRACTICAL PAPER BT 4.7(A)- FOOD BIOTECHNOLOGY

List of practicals

1. Production of yoghurt and acidophilus milk.
2. Direct Microscopic count and Rapid platform rests of Milk
3. Estimation of Fat in Milk by Bulyrometer.
4. Isolation of microbes from spoiled vegetables and fruits
5. Production of Mushrooms
6. Detection of pamolein oil and groundnut oil
7. Bacteriological examinations of Utensils
8. Bacteriological examinations of sugars

Spotters/Scientific comments

THEORY PAPER BT4.3(B)- PHARMACEUTICAL & NANOBIOTECHNOLOGY

Total: 64 Hrs

Course Objective:

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

Course Outcome:

- Students will be able to
- Comprehend natural drug extraction and drug design
- Describe applications of nanotechnology

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Unit 1:Drug discovery and drug design 18 Hrs

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, rational drug design, Concept of lead drug, pro drug and its application, structure based and combinational approach, peptidomimetic strategies for drug discovery; Drug delivery System, Biopolymers for drug delivery.Animal models and their purpose - Mice, Rats, Rabbit and Primates

Use of natural products in traditional medicines, Marine natural products, Use of herbal remedies and the potential of drug development from natural products.

Extraction and Isolation techniques: Introduction, Principle and Applications of different extraction & isolation methods viz Soxhlet extraction, microwave extraction, supercritical fluid extraction, solid phase extraction,Column chromatography, Flash chromatography.

Unit 2: Quality assurance and validation 16 Hrs

Analytical methods and tests for various drugs-Physicochemical and bioanalytical considerations. 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:Fundamentals of Nanobiotechnology 12 Hrs

Concepts, historical perspective; Nanoscale materials: Definition and properties; Different formats of nanomaterial and applications; Cellular nanostructure; nanopores; Bimolecular motors; Bio-inspired Nanostructures, Quantum dots.

Unit 4: Applications of Nanobiotechnology 18 Hrs

Nanomaterials for catalysis, development and characterization of nanobiocatalysts, applications of nanobiocatalysis in the production of drugs and drug intermediates

Nanoparticles for drug delivery: Strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Nanoparticles for diagnostic applications, materials used in diagnostics.

Nanoparticles for diagnostic imaging: Concepts of smart stimuli responsive nanoparticles, nanodevices for biosensor development.
Nanotechnology for therapeutics: implications in cancer therapy, neurodegenerative diseases nanotechnology for tissue engineering.

❖ BOOKS RECOMMENDED

- Biopharmaceuticals, Biochemistry and Biotechnology by Gary Walsh, Wiley Pub.
- Synthesis of Medicinal Agents from Plants by AshishTewari, Elsevier
- The Theory & Practice of Industrial Pharmacy by Leon Lachman, Herbert A. Lieberman & Joseph & Kanig, Vergese Publishing House Bombay
- Nanotechnology in Biology & Medicine by Tuan Vo-Dinh, Taylor Francis.
- Nanotechnology by M. Karkare, IK Intl. Publishers.
- Unbounding the future by K Eric Drexler
- Nanotechnology – A gentle Introduction to the Next Big Idea, Mark Ratner and Daniel Ratner, Pearson Education.

PRACTICAL PAPER BT 4.7 (B)-PHARMACEUTICAL & NANOBIOTECHNOLOGY

❖ **List of practical**

1. Extraction of phytochemicals – Soxhlet extraction
2. Determination of Antioxidant activity of the Plant metabolites
3. Antibiotic sensitivity test using disc diffusion method
4. Study of sterilization indicators
5. Chemical synthesis of nanoparticles
6. Green synthesis of nanoparticles
7. Characterization of nanoparticles - UV vis spectroscopy
8. Study of Antimicrobial activity of nanoparticles by agar diffusion method

Spotters/Scientific Comment

BT4.4 -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

BT-4.8 STUDY TOUR/FIELD VISIT

As a part of the curriculum of M.Sc. Biotechnology, Study Tour/Field Visit will be organized to an industry/ Institute /University/ production field. The major objective of the trip is to familiarize the students with the instrumentation, processes, production and applications. This study tour/ field visit will be benefit for the students to get the career opportunities in academics, research and industrial sector.