M.Sc. Biotechnology

Scheme & Syllabus
For Affiliated Colleges
(Revised)

University of Kerala
Thiruvananthapuram
2018

SUMMARY OF THE SYLLABUS AND SCHEME

Semester I

Course Code	Title of the Course	Teaching Hours/week			
		L	T	P	Total
BT 101	Cell Biology and Genetics	4	1	0	5
BT 102	Biochemistry	4	1	0	5
BT 103	Biophysics and Biostatistics	4	1	0	5
BT 104	Biochemistry Lab	0	1	4	5
BT 105	Cell Biology /Genetics and Biostatistics lab	0	1	4	5
	Total Hours /week	**12**	**5**	**8**	**25**

Semester II

Course Code	Title of the Course	Teaching Hours/week			
		L	T	P	Total
BT 201	Basic Microbiology	4	1	0	5
BT 202	Molecular Biology	4	1	0	5
BT 203	Mathematics, Computer Science & Bioinformatics	4	1	0	5
BT 204	Microbiology Lab	0	1	4	5
BT 205	Molecular Biology Lab	0	1	4	5
	Total Hours /week	**12**	**5**	**8**	**25**

Semester III

Course Code	Title of the Course	Teaching Hours/week			
		L	T	P	Total
BT 301	Plant Biotechnology	4	1	0	5
BT 302	Animal Biotechnology	4	1	0	5
BT 303	Genetic engineering	4	1	0	5
BT 304	Plant BT/ Animal BT Lab	0	1	4	5
BT 305	Genetic Engineering Lab	0	1	4	5
	Total Hours /week	**12**	**5**	**8**	**25**

Semester IV

Course Code	Title of the Course	Teaching Hours/week			
		L	T	P	Total
BT 401	Immunology	4	1	0	5
BT 402	Environmental Biotechnology	4	1	0	5
BT 403	Food and dairy Biotechnology/Basics of Bioprocess Technology	4	1	0	5
BT 404	Project	0	0	10	10
BT 405	General Viva -voce				
	Total Hours /week	**12**	**3**	**10**	**25**

L –Lecture, T- Tutorial, P-Practical Total Number of Hours /week-25 hrs.

90 working days, 450 hours / semester. 5 months including exams. One seminar

II. MARK DISTRIBUTION

1. PAPER/SEMESTER

Semester	Papers	CA	ESA	Total Marks
I	BT-101-105	25 x 5	75 x 5	500
II	BT-201-205	25 x 5	75 x 5	500
III	BT-301-305	25 x 5	75 x 5	500
IV	BT-401-403 BT-404 BT-405	25 x 3 50 x 1 -	75 x 3 100 x 1 50	300 150 50
Grand Total (From S-1 to S-IV)				**2000**

CA- Continuous Assessment
ESA- End Semester Assessment

Total Marks for a semester 500

Total Maximum marks at the end of IV semester 500 x 4=2000

2. DISTRIBUTION OF MARKS FOR PROJECT EVALUATION

A. CA	
	Marks
Attendance	10
Work progress	20
Discussion	20
Total	**50**
B. ESA	
Project Content	50
Project presentation OR Viva Voce on Project	50
Total Marks for Project (CA + ESA)	**150**

III. SCHEME OF EXAMINATION PATTERN OF THE COURSE

Total Number of Hours /Week	25
One hour (period) for each subject and keep one hour for tutorial , seminar, discussions etc.	
Number of theory papers/semester and duration	3 (5 hrs each)
Number of Lab /Practicals	2 (5 hrs each)
Project	10 hours

EXAMINATION AND EVALUATION

Examination	**CA**	**ESA**	**Total**	**Components of CA**	
Theory	25	75	100	Attendance	5
				Seminar	5
				Assignments	5
				Test	10
Lab/ Practical	25	75	100	Attendance	5
				Record	5
				Test	10
				Viva	5
No. of seminars		One seminar/paper/student/semester			
No. of assignments		One assignment/paper/student/semester			
Tutorial hour		May be utilized for seminar and discussion			

PROJECT

Project work shall be assigned individually and must be carried out under the guidance of a faculty from the same college with or with out an external guide OR in an external institution under the combined guidance of internal and external guides. The student has to submit the dissertation before the examiner for evaluation and may give a presentation on the project work, if asked for.

PROJECT EVALUATION

The evaluation of the project (Both CA and ESA) (through oral presentation or Viva-voce as decided by the Chairman, Board of examinations).

	Marks
Project Content	50
Project presentation OR Viva Voce on Project	50
C A	50
Maximum marks (including CA)	**150**

4. DETAILED SYLLABUS

SEMESTER I

BT 101 Cell Biology and Genetics

Aim

- To give a detailed and comprehensive knowledge on the various aspects of cell biology and genetics including cell structure and its functions, Mendelian genetics, and population genetics in detail.

Course Objectives

- The course gives the life activities at cellular and molecular level and basic functions of the various cellular compartments and organelles.
- It also gives the structural- functional and biochemical details of all cellular activities.
- This explains the basic principles of Mendelian, population genetics and heredity and gives an overview on the classical genetics- Linkage & Crossing over.

Course Outcome

On completion of the course, students shall be able to,

- Identify and present relevant information from research publications dealing with issues of cell biology and genetics.
- They will be able to assess and relate the information to the context of cell biology.
- Plan and carry out simple experiments on the basis of cell.
- The course enables students to analyse hereditary data and apply fundamental coupling analyses and genetic calculations.

Course Content

Cell Biology

Module 1

1. An overview of Cells and Cell Research- Microscopy – Light Microscopy, Electron Microscopy, Applications of electron microscopy in Cell biology. Confocal Microscopy, Fluorescence Microscopy and FRET. Cells - structure and size and shape, Prokaryotic and eukaryotic cells.
2. Cell membrane - structure and function, transport of nutrients and ions across the membranes, Mechanism of vesicle transport and vesicle fusion. Functional diversity of cellular membranes. Plasmodesmata, Tight junctions, Gap junctions – Structure and role in movement of molecules.

Module 2

3. Tissues- major types of plant tissues- simple tissue, complex tissues and tissue systems. Animal tissues- major types of tissues. Organs and organ systems
4. Cell organelles -structure and function. Plant and animal cells - similarities and differences.

Module 3

5. Cell cycle- Mitosis and meiosis, chromosomes- structure and organization, nucleosomes organization karyotypes and ideograms. Cytological, genetical and evolutionary significance of Mitosis and Meiosis. Molecular events and regulation of cell cycle in eukaryotes. Check points, Cyclins and protein kinases, MPF (maturation promoting factor).
6. Cell -cell communication, cellular response to the environment, and mechanism of signal transduction.
7. Cancer Biology – cellular and genetic basis of cancer, apoptosis, carcinogens, environmental and diet factors in cancer.

Genetics

Module 4

8. Mendelian Genetics- Mendelian inheritance, Non-Mendelian inheritance

Module 5

9. Chromosome theory of inheritance- Linkage and crossing over. Recombination frequency. Extra-chromosomal inheritance
10. Chromosome aberrations- associated genetic diseases.

Module 6

11. Population genetics- genetic variation, polymorphism, gene pool, gene frequency, distribution pattern. Hardy-Weinberg equilibrium. Disequilibrium, factors affecting gene equilibrium

References

1.	Genetics	AVSS Sambamoorthy	Narosa , New Delhi
2.	Principles of genetics	DP Snustad, MJ Simmons JB Jenkins	John Wiley
3.	Genetics	PK Gupta	Rastogi, Meerut
4.	Cell & Molecular Biology	PK Gupta	Rastogi, Meerut
5.	Genetics	PJ Russell	Benjamin Cummings
6.	The science of genetics	AG Atherly, JR Girton, JF Mc Donald	Harcurt Brace College Publishers New York
7.	Basic Human Genetics	EJ Mange, AP Mange	Sinauer Associates Inc, Massachusetts
8.	The cell –a molecular approach	GM cooper	Sinauer Associates Inc, Massachusetts
9.	Essential Cell Biology	Alberts, Bray, Johnson	Garland Pbl. NY

10. Concepts of genetics — Klug and Cummings — Person education N. Delhi

Online resources:
Authentic Web based resources like NCBI, PubMed, Science direct etc.

Semester I
BT 102 Biochemistry

Aim

- To give an introduction about the basic biochemistry related to the biological molecules, their diversity and biosynthesis, degradation and role in the biological systems.
- This also aims to develop a thorough knowledge among the students about the various biochemical reactions- metabolic pathways- responsible for the manifestation of life disease and metabolic errors.

Course Objectives

- The overall objective of the course is for the student to gain a basic working knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavors.
- This course gives an idea on different biological molecules, their origin, biological role and its degradation according to the needs and demand of the system under various conditions.
- The interrelation of each of these metabolic pathways and their contribution in various metabolic disorders are also explained in detail.
- The application of the knowledge generated in the practical aspects of Biotechnology.

Course Outcome

On completion of the course, the student should achieve an understanding of the following:

- The structures of amino acids, their chemical properties and their organization into polypeptides and proteins.
- Methods for isolating and characterizing proteins the basic elements of protein structure key
- Principles of protein function.
- Enzymes and how they catalyze reactions as well as enzyme kinetics
- Structure of fundamental monosaccharides and polysaccharides structure
- Basic function of nucleotides structure of different classes of lipids and their roles in biological systems

Course Content

Module 1

1. Macromolecules - structure, classification and properties of Carbohydrates, Proteins and Lipids and Nucleic acids.

Carbohydrates- Monosaccharides-classification and structure, Isomerism in monosaccharides, Disaccharides- mclassification and types of disaccharides, its biological significance and finctions, Oligosaccharides-hetero-oligosaccharides and homo-oligosaccharides, Polysaccharides- classification- hetero-polysaccharides, and homo-polysaccharides, storage polysaccharides and structural polysaccharides.

Module 2

Proteins- classification of proteins, building units of proteins- Amino acids- structure, properties and function, classification of Amino acids, peptide bonds, ramachandran plot, oligo peptides polypeptides, Structure of proteins- primary , secondary and tertiary structures, quaternary structures, supra-secondary structures- motifs and domains,

Isolation and purification of proteins- different molecular and instrumental methods involved. Characterization of protein- structural and amino acid composition, Functions of proteins.

Module 3

Lipids- structure and classification, various types of lipids – Oils and fats, Triglycerides- structure and function, Phospholipids- structure, classification and functions, Biological significance of various types of Phospholipids, Glycolipids and lipoproteins, serum lipids and its significance, Cholesterol and its derivatives,

Nucleic acids- classification of Nucleic acids, Building blocks of Nucleic acids, structure of Nucleotides, classification of nucleotides, Purines, Pyramidines, structure and function of DNA and RNA, Non-genetical function of Nucleic acids and its derivatives.

Module 4

2. Metabolism of carbohydrates - Glycolysis, TCA cycle, Gluconeogenesis, Pentose Phosphate pathway, Glycogen metabolism-Glycogenesis, glycogenolysis. Biosynthesis of starch, glycogen and glucose. Photosynthesis.
3. ETS and bioenergetics of cellular respiration. Redox reactions, standard oxidation reduction potential, mitochondrial electron transport chain, Oxidative phosphorylation, structure of ATP synthase, chemiosmotic hypothesis
4. Metabolism of Lipids- Oxidation of lipids. Beta-oxidation, Biosynthesis of lipids, Ketone bodies

Module 5

5. Metabolism of proteins and amino acids – Digestion and absorption, Biosynthesis and degradation of amino acid. Urea cycle, regulation.
6. Metabolism of Nucleotides –biosynthesis, degradation and regulation of nucleotides and related molecules. Energy compounds and its biosynthesis- ATP, NAD, NADP, FAD, Creatin phosphates
7. Secondary metabolism- classification and role of secondary metabolites of plants and microbes - Role of secondary metabolites
8. Metabolic network - Interrelationship of metabolisms Krebs cycle, amino acid synthesis,

Module 6

9. Enzymes -Enzyme classification and nomenclature. General properties of enzymes, factors affecting enzyme activity. Steady state kinetics. Michaelis – Menten equation

and constants, maximum velocity, enzyme specificity, linear plot Lineweaver-Burke plot, Eadie-hofstee plot. Enzyme activation, inhibition-competitive and non competitive. Enzyme kinetics, mechanism of enzyme action, Allosteric interactions and product inhibition; Enzyme purification. Coenzyme; Clinical and Industrial applications of enzymes. Immobilization of enzymes and their application. Ribozymes and their applications. Enzyme engineering.

References

1.	Harpers Biochemistry	RK Murray, DK Grammer, PA Mayes VW Rodwell	MC Graw Hill USA
2.	Text Book of Biochemistry	DM Vasudebvan and Sreekumari	Jaypee Brothers Medical Publishers New Delhi
3.	Biochemistry	U Satyanaryana	Becks & Allied Kolkotta
4.	A text book of plant Physiology and Biochemistry	SK Verma	S Chand New Delhi
5.	Instant notes Biochemistry	Hames, Hooper & Houghton	VIVA books Pvt ltd, N. Delhi
6.	Biochemistry	Stryer, Jermy, Berg	Freeman Newyork
7.	Biochemistry	Voet & Voet	Wiely & Sons
8.	Principles of Biochemistry	GL Zubay, WW Parson & DE Vance	Wm C Brown Publishers Australia
9.	Bioorganic chemistry	HR Hortan, LA Moran, RS Ochs	Prentice Hall USA
10.	Environmental Biochemistry	CP Jrasa	Saup & Sons N Delhi
11.	Biochemistry of Green plants	DW Krogman	Prentice Hall USA
12.	Fundamentals of Enzymology	NC Price & L Stevens	Oxford science publications NY
13.	Principles of Biochemistry	AL LEHINGER, DL NELSON & COX	Worth publishers NY

Online resources:

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER I

BT 103 BIOPHYSICS AND BIOSTATISTICS

Aim

- To equip the students with knowledge of thermodynamics of biological system and bioenergetics. Also to give an introduction to the biophysical aspects of various biological physiological activities at cellular and molecular level.
- To get introduced to the fields of various instruments used in biotechnology- including the basic principle - application and working.
- To help students to have an idea on basic mathematical problems and calculations needed in Biotechnology aspects

Course Objective

- The course is designed to train the students in biophysics and bioinstrumentation techniques essential for the understanding of life sciences and biotechnology, for which basic knowledge in physics or Biophysics at graduate level is expected and is necessary for the proper understanding of this topic at postgraduate level.
- This course consists of basics of thermodynamics as applicable in the field of Biological systems- bio energetics- energy trapping and its transactions methods- biophysics of various biological activities.
- The course helps to attain knowledge on mathematical calculations and problems helping in competitive exams.

Course outcome

On completion of the course,

- The students will develop the capability to demonstrate a multiscale nature of biophysics by exploring macroscopic and microscopic applications.
- The students will learn to approach a research problem logically and will be able to do statistical analyses in research.

Course Content

BIOPHYSICS

Module 1

1. Structure of atoms, molecule, Physico-chemical forces- ions, ionic bonds, covalent bonds, Hydrogen bonds, vander Wals forces, hydrophobic interactions, polar and non-polar molecules
2. Major Biological Macromolecules – role of various interatomic and molecular interactions in the formation and stability of macromolecules, supra-molecular assemblies and cellular components.

Module 2

3. Concept of Energy- matter and energy, thermodynamics- entropy, enthalpy Bioenergetics- life as an energy system- major energy transformations mediated by life- Photochemical reaction of photosynthesis- Oxidative photophosphorylation, ATP, GTP, Creatin phosphate, muscle contraction, generation and transmission of nerve impulse.
4. Biophysics of Muscle movement , Impulse generation and impulse transmission

Module 3

5. Electromagnetic radiation- electromagnetic spectrum, photoreceptors- types of radiations-visible spectrum, absorption spectrum. Plant pigments and hormones as receptors of radiations- light receptors of animals. Biophysics of Vision.
6. Spectroscopy- various types of spectroscopic techniques, spectrophotometer- UV-Visible spectroscopy- Beer Lambert Law, IR spectroscopy, Raman Spectroscopy, X-ray diffraction technique-principle and application, NMR spectroscopy-principle and application, Fluorescent spectroscopy-principle and application.

Module 4

7. Microscopy- Light microscopy- Phase contrast Microscopy, Fluorescent microscopy, Modern Developments in Microscopy- FRET Microscopy, Confocal Microscopy, Electron Microscopy- Transmission and Scanning Electron Microscopy- Principle and applications, Resolution of a Microscope.
8. Centrifugation - Principle and application of various types of centrifugation-sedimentation coefficient, Svedberg unit.
9. Chromatography- Principle and application, Classification of Chromatography Adsorption and Partition chromatography, Paper Chromatography, TLC, Liquid Chromatography - ion exchange chromatography, Gel permeation chromatography, affinity chromatography, HPLC and GC.

Module 5

10. Electrochemical instruments - pH meter and Mass spectrometry.
11. Electrophoresis- principle and application, PAGE- Native and SDS-PAGE, Isoelectric focusing, 2D -gel Electrophoresis, immune electrophoresis.
12. Molecular hybridization Techniques- southern blotting. Northern blotting and Western blotting, Electro blotting
13. Principle and applications of tracer technique in biology: Radioactive Isotopes and half life of isotopes; Effect of radiation on biological system; autoradiography; radiation dosimetry; scintillation counting, safety aspects

BIOSTATISTICS

Module 6

1. General principles, sampling, sampling errors
2. Mean, Median, Mode, standard deviation and standard error
3. Probability- normal and binomial distribution, Poisson distribution- Frequency distribution - representation of frequencies.
4. Testing and Significance - Paired T- test. Unpaired T-test, Chi-squire test Correlation and regression.
5. Graphs and diagrams - Bar diagrams, pie chart. Histograms and frequency curves

References

1.	Principles of Biochemistry	AL LEHINGER, DL NELSON & COX	Worh publishers NY
2.	A text book of Biophysics	RN Roy	New Central book Agency Kolkotta
3.	Biophysics	Dr. S Thiravia Raj	Saras Publications Tamil Nadu
4.	Principles of Biostatistics	M Paggana & Gaurveeau	Duxbery Australia
5.	Essentials of Biophysics	P Naryananan	New age International PVt ltdN. Delhi
6.	Biochemistry	Stryer, Jermy, Berg	Freeman Newyork
7.	Principles of Biochemistry	GL Zubay, WW Parson & DE Vance	Wm C Brown Publishers Australia
8.	Harpers Biochemistry	RK Murray, DK Grammer, PA Mayes VW Rodwell	MC Graw Hill USA
9.	Basic Evaluation methods	Breakwell and L Millwart	Uty. Press Hyderabad
10.	Biophysics An Introduction	RMJ Cotterill	John Wiely and Sons NYork
11.	Basic Biophysics for Biotechnologist	M Daniel	Agrobios Jodhpur

Online resources:

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER I

PRACTICAL

BT 104 BIOCHEMISTRY LAB

Aim

- To train students on the basic techniques of biochemistry

Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains how to prepare buffers and reagents, various methods of estimation of proteins, enzyme extraction and purification

Course Outcomes

At the end of this course,

- The students will equip themselves with the basic biochemistry techniques which can later applied for their laboratory research and also for many other industrial researches.
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Course Content

Laboratory techniques

1. Titration curve of acetic acid and Glycine
2. Titration of acetic acid to determine the pKa value.
3. Preparation of buffer of a known pH (phosphate buffer, acetate buffer)
4. Determination of isoelectric pH of a given amino acid.
5. Methods of protein estimation- spectrophotometric determination of proteins by Lowry's method and Bradford method.
6. Enzyme extraction and purification - ammonium sulphate precipitation, protein purification by Gel permeation chromatography, ion exchange chromatography
7. Electrophoretic separation of proteins- SDS-PAGE Chromatography- column chromatography and Thin Layer Chromatography (TLC).

SEMESTER I

BT 105 CELL BIOLOGY, GENETICS AND BIOSTATISTICS LAB

Aim

- To train students on the basic techniques of cell biology and Genetics
- To make aware of the students a basic knowledge on computing biological problems statistically.

Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains how to make slides for cytological examinations, other histochemical analysis, solving problems based on genetics and statistical analysis.

Course Outcomes

At the end of this course,

- The students will equip themselves with the basic cytology aspects to be performed in the laboratory.
- The students will be able to analyze genetic problems and will be able to approach a research problem statistically.

Course Content

Laboratory techniques

1. Cytological and Histological techniques- determination of number of viable cells in a cell population
2. Mitosis - Onion root tip squash preparation- Preparation of Karyotypes, Determination of Mitotic index.
3. Meiosis - squash preparation of immature anther- identification of different stages.
4. Microtomy and histochemical techniques - Preparation of thin sections of tissues and developing embryos and staining with tissue specific stains
5. Isolation and estimation of chloroplasts
6. Solving the problems of genetics
7. Calculation of mean, standard deviation, standard error and student's t-test Preparation of

histograms, frequency polygon and pie diagram.

SEMESTER II

BT 201 BASIC MICROBIOLOGY

Aim

- To give an introduction about the microbial world- their distribution- morphology and reproduction and about the role of microorganism in various fields of human life and Industry.

Course Objectives

- Imparts advanced training in Microbiology for the students
- Makes the student aware the role of microbes in the daily life as well as in the various fields of science. How it can be controlled is also dealt with.

Course outcome

At the end of this course,

- The students get trained in all aspects of microbiology as it is required for Biotechnology.

Course Content

Module 1

1. Ultra structure of bacteria, fungi, algae, protozoa and viruses.
2. Classification of microbes, molecular taxonomy, Artificial and Natural systems of classification, Traditional characters used for the classification of Microorganisms.

Module 2

3. Current methods of identification, characterization, classification of Microorganisms. Microscopic examination of Microorganisms, Microscopes and Microscopy – Principle and applications for the study of Microorganisms.
4. Morphology and Fine structure of bacteria, cultivation of Bacteria, growth of bacteria – growth curve, Reproduction and growth, Pure culture and cultural characteristics. Microbial techniques, Staining techniques

Module 3

5. Characteristic features of eubacteria, archae, fungi- Molds and Yeasts, algae, protozoa and viruses- Viruses of bacteria, Viruses of plants and animals.
6. Biology of *Escherichia coli*, *Bacillus subtilis*, *Rhizobium sp.*, *Agrobacterium tumefaciens*, *Saccharomyces cerevisiae*, and phage lambda.

Module 4

7. Microbial nutrition. Growth, Microbial metabolism and energy production, mr
8. Microbial interaction (human microbe interaction, normal biota of the human body, plant microbe interaction).

Module 5

9. Control of Microorganisms- Physical chemical methods, Disinfectants, Antibiotics and mechanisms of antibiosis.
10. Microbial physiology and microbial genetics.

Module 6

11. Microbial ecology and Biogeochemical cycles
12. Environmental microbiology

References

1.	A text book of Microbiology	P Chakraborthy	New central Book agency culcutta
2.	Modern Concepts of Microbiology	H.D. Kumar, S. Kumar	Vikas Publishing House, Pvt. Ltd. New Delhi
3.	Advances in Microbial Biotechnology	J.P. Tewari, T.N. Lakhanpal, J. Singh, R. Gupta, B.P. chamola	A.P.H. Publishing Corporation, New Delhi
4.	Instant notes in Microbiology	J. Nicklin, K. Graeme- cook, T. Paget & R. Killington	Viva books Pvt. Ltd., New Delhi
5.	Principles of Microbiology	R.M. Atlas	Mc Giraw Hill, NY
6.	Introductory Microbiology	J. Heritage, E.G.V. Evans, R.A. Killington	Cambridge University Press
7.	Human Parasitology	B.J. Bogitsh , T.C. Cheng	Academic Press, NY
8.	Microbiology	Pelczar, Chan, Krieg, Tala Mc. GrawHill	Publishing Company, New Delhi
9.	Microbiology- An Introduction	G.J. Tortora, B.R. Funke, C.L. Case	Wesley Longman, NY
10.	Microbiology	L.M. Prescott, J.P. Harley, D.A. Klein.	Wm. C. Brown Publishers, Australia

Online resources:

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER II

BT 202 MOLECULAR BIOLOGY

Aim

- To understand biological activities and metabolism at DNA and protein level

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 research and applied research in various fields of life sciences.

Course Content

Module 1

1. **Nucleic acids** - DNA and RNA structure and functions, DNA as genetic material. Griffth, Avery- McCarty-MCLeod, Hershy- Chase, Franklin Conrat Experiments

2. **DNA Structure**: Chemistry of DNA, Forces stabilizing DNA structure, Helix parameters, Forms of DNA (A,B,C,D,T and Z), Watson – Crick and Hoogsteen base pairing , Physical Properties of ds DNA (UV absorption spectra Denaturation and renaturation), Chemical that react with DNA.

Module 2

3. **DNA topology**: DNA supercoiling, Supercoiled form of DNA, Superhelical density, Energetic of supercoiled DNA, Biology of supercoiled DNA (Topological domain of DNA,DNA topoisomerases, Mechanisms of supercoiling in cells, mechanisms of action of topoisomerase I and II, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication).

4. **Organization of DNA into chromosome**s: Packaging of DNA and organization of chromosome in bacteria and eukaryotic cells; packaging of DNA in eukaryotic nucleosome and chromatin condensation assembly of nucleosomes upon replication. Chromatin modification and genome expression.

Module 3

5. **Mutations**- molecular mechanism - types of DNA mutations and its significance. DNA repair - repair mechanisms - need of DNA repairs, DNA recombination - molecular mechanism of recombination- relationship between repair and recombination, SOS mechanism. Proteins and enzymes involved DNA repair and recombination.

6. **DNA – Protein Interactions**: General features interaction of Helix- turn Helix motif, B sheet, Zn- DNA binding domain etc with DNA.

Module 4

7. **DNA Replication**: Mechanism of DNA polymerase catalyzed synthesis of DNA, types of DNA polymerases in bacteria and their role. Initiation of chromosomal DNA replication and its regulation in prokaryotes assembly of replisome and progress of replication fork, termination of replication. Types and function of eukaryotic DNA polymerases initiation of replication in eukaryotes, role of telomerases in replication of eukaryotic chromosomes. Inhibitor of DNA replication (Blocking precursor synthesis nucleotide polymerization, altering DNA structure).

Module 5

8. **Transcription**: RNA polymerases, features of prokaryotic and eukaryotic promoters. Strong and weak promoters. Assembly of transcription initiation complex in prokaryotes and eukaryotes and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts. Transport of RNA within eukaryotic cell. Regulatory elements of genes-promoters. Fate of mRNA.

9. **Translation- Synthesis and Processing of Proteome**: Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Post translational processing of protein (protein folding, processing by proteolytic cleavage, processing by chemical modification, inteins). Protein degradation.

Module 6

10. **Regulation of Gene expression in prokaryotes and eukaryotes**: Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination, global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

11. **DNA- transposable elements**- types of transposable elements, its importance in variation and evolution. Possible origin of virus, Oncogenes.

References

1. Advanced Molecular H.S. Bhamrah Viva Books, Pvt. Ltd., New

	Biology		Delhi
2.	Plant Biochemistry and Molecular Biology	Hans, Walter Held	Oxford, NY
3.	Molecular Cell Biology	H.S. Bramrah	Anmol Publications Pvt. Ltd., New Delhi
4.	Molecular Biology of the Gene	Watson, Baker, Bell, Gann, Levine, Losick	Pearson Education Pvt. Ltd., New Delhi
5.	Apoptosis and Cancer chemotherapy	John A. Hickman & Caroline Dive	Humana Press, NJ
6.	Molecular Modelling	Principles and Application, Andrew R. Leach	Longmann, England
7.	PCR 3	Practical Approach, C. Simon Herrington & John O'Leary	Oxford, NY
8.	Essential Molecular Biology	A Practical Approach, T.A. Brown	Oxford, NY
9.	Cell & Molecular Biology	Concepts & Experiments Gerald Karp, John Wiley & Sons	NY
10.	Gene Vlll	Benjamin Lemin	Oxford University Press

Online resources:

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER II

BT 203 MATHEMATICS, COMPUTER SCIENCE AND BIOINFORMATICS

Aim

- To understand the essential mathematics needed in Biology learning.
- To basic computational analysis and its applications
- To make the students understand what is Bioinformatics and Computational Biology- To make them aware the application of various computational tools in Bioinformatics and related subjects.
- To introduce to the world of various databases and its importance in biological research.

Course Objectives

- The introductory mathematics is aimed to understand elementary mathematics needed for study of Biochemistry, biophysics, statistics and genetics.
- The course explains the applications of computer in biotechnology and statistical analysis of experimental data.
- The course gives an introduction on the origin and evolution of Bioinformatics and its importance in Biotechnology, Genomics and Proteomics.
- Various methods of genome analysis and proteome analysis is also described.
- It gives an outline on the various bioinformatics and computational tools used in analyzing protein, gene and genome data bases.

Course outcome

At the end of the course,

- The student will be aware with a basic knowledge of modern molecular biology and genomics.
- The student will understand how theoretical approaches can be used to model and analyze complex biological systems.

Course Content

MATHEMATICS

Module 1

1. **Algebra, ,**

   Complex numbers; algebra of complex numbers; geometrical representation; real and imaginary parts; modulus and arguments of a complex number; conjugate of a complex number- triangle inequality; club roots of unity

2. **Logarithms**

   Properties of logarithms- Common and Natural logarithms- Characteristics and Mantissa

3. **Progression** - Arithmetic progression- Geometrical progression- harmonic progression-

4. **Quadratic equations and Expressions**

   Theory of quadratic equations- relationship between their roots and coefficients; quadratic expressions; linear and quadratic inequations in one variable;

5. **Binomial Theorem**

   Binomial expressions- Permutations and Combinations

6. **Coordinate Geometry**

   Basic concepts- straight lines- rectangular Cartesian coordinates- distance between two points- and area of a triangle- Locus– equation of straight lines in various forms- angle between two given lines- conditions for two lines to be parallel or perpendicular- distance of a point from a line- bisectors of angles- lines through the point of intersection of two given lines- concurrency of lines; Circles- equation of circle in various forms- Circles through the points of intersection of two circles- or a circle and straight lines- parametric representation of a circle.

   Set - Theory and problems

   Trigonometry- Trigonometric ratios and Identities- Trigonometrical equations and their solutions- Inverse circular functions

7. ***Calculus***

   Functions- into- onto and one-to-one functions; sum- difference- product and quotient of two functions; composit functions- inverse of a function- constant absolute value- greatest integer- polynomial - rational- trigonometric- exponential and logarithmic functions.

COMPUTER SCIENCE

Module 2

1. Computers- its application in biology- Basics
2. Basics of computer- Parts of a computer- hardware and software, operating systems- standard operating systems- MS DOS, Windows- Linux, Unix

Module 3

3. Programming - algorithms, binary language. Elements of programming languages- Python and Perl
4. Standard software packages- Sigmaplot etc
5. Databases, Internet, Searching databases. Portals

BIOINFORMATICS

Module 4

1. **History and development of Bioinformatics, Database:** Various types of databases and its importance Use of databases in biology, - sequence databases, structural databases. sequence Analysis- proteins and nucleic acids, structural comparisons, genome projects

2. Sequence alignment-various methods, DNA sequence annotation and various programmes for sequence comparison and analysis.

Module 5

3. **Proteomics:** Sequence analysis of proteins, and nucleic acids, tools and techniques in proteomics, protein-protein interactions; post translational modification, methods of 2D structure predictions.
4. **Genomics:** Structural genomics- sequence analysis software like GCG etc, Functional genomics- Gene finder, genetic mapping, and linkage analysis, application of genetic maps, human genome project.

Module 6

5. **Information theory and biology:** Entropy, Shannon's formula, Divergence from equiprobability and independence, mark of chains, ergodic processes, redundancy.

References

1.	Bioinformatics- Concepts, skills and Application	S.C. Rastogi, N. Mendiratta, P. Rastogi ,	CBS Publishers and Distributors, New Delhi
2.	Bioinformatics	M.M. Ranga,	Agrobios, Jodhpur
3.	A Handbook of Bioinformatics	N. Yadav	Anmol Publication Pvt. Ltd, New Delhi
4.	Fundamentals of Bioinformatics	I.A. Khan and A. Khanum	Ukaaz Publications, Andra Pradesh
5.	Bioinformatics	The Machine Learning Approach	The MIT Press, USA
6.	Proteomics	S.R. Pennington, M.J. Dunn	Viva Books Pvt. Ltd., New Delhi
7.	Microarray Bioinformatics	Dov Stekel	Cambridge University Press
8.	Aloagarithms on strings, trees, and sequences- Computer Science and Computational Biology	Dan Gusfield	Cambridge University Press
9.	Analysis of DNA Microarray data	Steen Knudsen,	Wiley Liss NY
10.	Mathematical models in Biology- An Introduction	E.S. Allman, J.A. Rhodes	Cambridge University Press
11.	Bioinformatics- Sequence, structure and databanks	D. Higgins, W. Taylor	Oxford University Press
12.	Bioinformatics for Geneticists	M.R. Barnes, I.C. Gray,	Wiley USA
13.	Experimental Design and Data Analysis for Biologist	G.P. Quinn, M.J. Keough	Cambridge University Press

Online resources:

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER II

BT 204 MICROBIOLOGY LAB

Aim

- To train students on the basic techniques of microbiology

Course Objectives

- The course gives an idea for the maintenance of laboratory and the practices that should be accomplished in a laboratory.
- The course explains the isolation and screening techniques of microbes and quality analysis of water.

Course outcome

On completion of the course candidates will achieve the following objectives,

- A detailed knowledge of structure, function and application of microorganisms.
- Skills in handling microorganisms in the laboratory.
- An understanding of applications of microorganisms in the industry, health-care, environmental protection, food agriculture and research.

Course Content

1. Isolation of bacteria from soil, water and air
2. Gram staining of bacteria
3. Microbial analysis of drinking water by MPN
4. Determination of dissolved oxygen of water
5. Estimation of Biological Oxygen demand (BOD) of wastewater or factory effluents, Determination of chemical oxygen demand (COD) of waste water
6. Estimation of nitrates in drinking water.
7. Study of bacterial flora of environment – Laboratories, soil, water, fermented foods and spoiled foods, commercial samples of water and drinks etc,
8. Bacterial growth - growth curve

SEMESTER II

BT 205 MOLECULAR BIOLOGY LAB

Aim

- To train students on the basic techniques of Molecular biology
-

Course Objectives

- The course gives hands on training on the practical experiments and techniques in molecular biology

Course outcome

At the end of the course,

- The students will be made proficient in basic molecular biology skills and molecular biology laboratory techniques

Course Content

Laboratory techniques

1. Preparation of Buffers arid solution for Molecular biology- TE buffer
2. Isolation of genomic DNA Preparation of Plasmid from known bacteria by alkaline lysis method- Preparation of solutions needed for the experiment
3. Estimation of DNA and purity checking by UV spectrophotometer
4. Agarose gel electrophoresis of plasmid and genomic DNA
5. Restriction analysis of plasmid DNA and evaluation of restriction sites
6. Construction of a recombinant plasmid Preparation of competent cells for transformation.

SEMESTER III

BT 301 PLANT BIOTECHNOLOGY

Aim

- To give an idea of plant tissue culture
- To introduce the various plant genetic engineering and transformations and its applications in various fields.

Course Objectives

- It gives introduction to the various transformation techniques employed in plant systems.
- It also describes the application of genetically modified plants in the various fields of science.

Course Outcome

At the end of the course,

- The students will gain an insight into the concepts and techniques of plant biotechnology and its application to crop plants
- They can also go for further research works during M.Phil and PhD courses

Course Content

Module 1

1. Plant cell -Plant cell and tissue and organ culture, principle - historical background
2. Plant tissue culture practical application and conventional plant breeding
3. Tissue culture media - composition and preparation- solid media and liquid media
4. Micro propagation of plants- initiation and maintenance of callus and suspension cultures- single cell clones.

Module 2

5. Organogenesis and somatic embryogenesis in plant tissue culture- development of whole -plants - Root formation, transfer of plant lets to the soil, hardening
6. Advantages of micropropagation in agriculture and horticulture
7. Shoot-tip meristem culture - raising virus free plants for rapid clonal multiplication of agricultural and horticultural plants

Module 3

8. Cell suspension cultures and its application in the production of secondary metabolites and single cell clones
9. Embryo culture and embryo rescue
10. Protoplast technology -protoplast isolation, fusion, protoplast culture, somatic hybridization, selection of somatic hybrid cells, culturing and development of somatic hybrid plants, symmetric and asymmetric hybrids, cybrids - Application of somatic hybridization plant improvement and breeding

Module 4

11. Somaclonal variation- significance in plant breeding
12. Production of haploid plants - anther and pollen culture, homozygous plants and its importance in genetics and plant breeding
13. Cryopreservation of plant cells, tissues and organs for germplasm conservation

Module 5

14. Plant genetic engineering - transgenic plants and its application in agriculture, different methods of plant genetic transformation
15. *Agrobacterium* mediated genetic engineering of plants, *Agrobacterium tumifaciens*, infection and molecular mechanism of tumor formation , Ti plasmids and RI plasmids, binary vectors, genetic markers, reporter genes and its application in genetic engineering,
16. Other methods of plant genetic transformation

Module 6

17. Metabolic engineering, Molecular plant breeding
18. Application of plant genetic engineering in agriculture, forestry and horticulture and industry, industrial application of transgenic plants, transgenic plants as bioreactors Chloroplast transformation.

References

1.	Modern Concepts of Biotechnology	H.D. Kumar	Vikas Publishing House Pvt. Ltd., New Delhi
2.	Role of Biotechnology in Medicinal and Aromatic Plants	Irfan A. Khan and Atiya Khanum	Ukaaz Publications, Hydreabad
3.	Plant Tissue Culture	Kalyan Kumar D.	New Central Book Agency (P) Ltd, Calcutta
4.	An introduction to Plant tissue Culture	M.K. Razdan	Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
5.	Biotechnology	B.D. Sigh	Kalyan Publishers New Delhi
6.	Introduction to Plant Biotechnology	H.S. Chawla	Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
7.	Plant Biotechnology Recent Advances	P.C. Trivedi	Panima Publishing Corporation, New Delhi
8.	Biotechnology	J.E. Smith	Cambridge University Press
9.	Plant Biochemistry and Molecular Biology	Hans, Walter Held	Oxford, NY
10.	Plant Cell, Tissue, and Organ Culture- Fundamental Methods	O.L. Gamborg, G.C. Philips	Narasa Publishing House, New Delhi

Online resources

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER III

BT 302 ANIMAL BIOTECHNOLOGY

Aim

- To give an idea of animal tissue culture
- To introduce the various genetic and transformation techniques in animals and and its applications in various fields.
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Course Objectives

- It gives introduction to the various transformation techniques employed in animal systems.
- It also describes the application of genetically modified animals in the various fields of science.
- The techniques of animal cell culture and its industrial and medical applications are described.

Course Outcome

At the end of the course,

- The students will gain an insight into the concepts and techniques of animal biotechnology and its wide industrial and medicinal applications.
- They can also go for further research works during M.Phil and PhD courses

Course Content

Module 1

1. Animal cell - structure and organization, animal physiology.
2. Animal cell culture- Equipments and facilities for animal cell culture. Media and its preparation, pH and pH maintenance in culture media, role of carbon dioxide, serum and- serum free media, artificial media.

Module 2

3. Types of animal cell culture- primary and secondary cell culture, development cell lines or established cultures.
4. Biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines.
5. Measurement of cell viability, cytotoxicity.
6. Screening of cytotoxic compounds and its importance.

Module 3

7. Basic techniques of mammalian cell culture, methods of sub culturing.
8. Scaling up of cell cultures, bioreactors for animal cell cultures.

Module 4

9. Application of animal cell culture- industrial application, and clinical application-

production. Stem cell research- types of stem cells, application of stem cells.

10. Somatic cell genetics, animal cloning and micromanipulation, apoptosis.

Module 5

11. Genetic engineering of farm animals - cloning vectors, viral vectors.
12. Methods of genetic transformations.
13. Transgenic animals and its uses.

Module 6

14. Gene therapy- methods of gene therapy
15. Ethical issues in animal biotechnology.

References

1.	Modern Concepts of Biotechnology	H.D. Kumar	Vikas Publishing House Pvt. Ltd., New Delhi
2.	Biotechnology- Fundamentals and Applications	S.S. Purohit & S.KMathur	Agrobotanica , India
3.	Agricultural Biotechnology	S.S Puroht	Agrobotanica , India
4.	Fungi in Biotechnology	Anil Prakash	CBS Publishers, New Delhi
5.	Biotechnology	B.D Singh	Kalyan Publishers, New Delhi
6.	Biotechnology	J.E Smith	Cambridge University Press
7.	Biotechnology	D. Balasubramanium, etal K.Dharnmalingam, K.Jayaraman.	University Hydrabad
8.	Animal Cell Culture	John R.W. Masters	Oxford University Press
9.	Culture of Animal Cells	R.Ian Fresheny,	Wiley Liss Publication, New York

Online resources

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER III

BT 303 GENETIC ENGINEERING

Aim

- To acquaint the students to the versatile tools and techniques employed in genetic engineering and recombinant DNA technology.

Course objectives

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- 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 a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in in basic and applied fields of life science researches.

Course content

Module 1

1. Genetic engineering as tool in biotechnology.
2. Milestones in the development of genetic engineering. Application of genetic engineering in biotechnology.
3. Molecular tools in genetic engineering - vectors, enzymes - restriction endonuclease.
4. DNA ligase, acid phosphatase and other DNA modifying enzymes.
5. Restriction enzymes - restriction analysis of genomes- restriction sites- cloning of blunt end DNA, adapters.

Module 2

6. DNA libraries- cDNA library. Genomic Library- Preparation of cDNA libraries and Genomic DNA libraries application of DNA libraries.
7. Gene cloning, gene expression.
8. DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence *in situ* hybridization, DNA fingerprinting, chromosome walking.

Module 3

9. Techniques for gene expression: Northern and Western blotting, Gel retardation technique, DNA foot printing, Primer extension, S1 mapping, Reporter assays.

10. DNA sequencing and sequence assembly. Maxam-Gilbert's and Sanger's methods, techniques of in vitro mutagenesis, Site-directed mutagenesis, gene replacement and gene targeting, Shot gun sequencing, chemical synthesis of oligonucleotides; sequencing strategies for large genomes.
11. PCR- Principle and applications , Various types PCR.

Module 4

12. DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting.
13. Vectors- and its uses in Genome sequencing.
14. Cloning for gene expression- industrial production of animal and plant proteins in microbes - industrial application of genetic engineering- industrial production of recombinant proteins.

Module 5

15. Genetic engineering of eukaryotes- genetic engineering of plants and animals- vectors used for transformations - shuttle vectors.
16. Protein engineering Metabolic Engineering, site directed mutagenesis.
17. Application of genetic engineering in gene expression studies.
18. Transgenic and gene knockout technologies to study molecular biology, chromosome engineering.

Module 6

19. Molecular markers. DNA based and **PCR - based markers** , RFLP, RAPD,RLGS, AFLP STS, EST, SSCP, VNTR, Multi locus probes, Microsatellites and minisatellites, STMS, DAF, AP-PCR .
20. Gene therapy.

References

1.	Biotechnology -Fundamentals and Applications	S.S. Purohit & S.K Mathur	Agrobotanica , India
2.	Agricultural Biotechnology	S.S. Purohit	Agrobotanica , India
3.	Biotechnology -Fundamentals and Applications	S.S. Purohit & S.K Mathur	S.S. Purohit & S.K Mathur
4.	Molecular Biotechnology	S.B. Primrose	Panima Publishing Corporation, New Delhi
5.	Text Book of Biotechnology	C.R. Chhatwal	Anmol Publications pvt Ltd, New Delhi
6.	Applied Molecular Genetics	R .L. Miesfeld ,	Wiley Liss ,New York

Online resources

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER III

Practicals

BT 304 PLANT BIOTECHNOLOGY/ ANIMAL BIOTECHNOLOGY LAB

Aim

- To train students on basic and plant and animal cell and tissue culture techniques.

Course Objectives

- The course gives hands own experience in the tissue culture of plant and animal cells.

Course outcome

At the end of the course,

- The student will be well versed with the theoretical as well as practical background knowledge in plant and animal sciences need for understanding plant and animal biotechnology.
- The will gain working knowledge of laboratory techniques used in plant biotechnology.

Course Content

Laboratory techniques

1. Preparation tissue culture Media, methods surface sterilization of explants
2. Stock preparation and calculations
3. Organ culture. Induction of callus, callus propagation, Organogenesis and transfer of plantlets to soil
4. Protoplast isolation, cell counting viability studies
5. Culturing of protoplast and regeneration of plants/ tissues from protoplasts
6. Production of haploids by anther culture, cytological examination of chromosomes in regenerated plants
7. Estimation of phenols from callus cultures
8. Preparation media for animal cell culture, sterilization by membrane filtration
9. Cell counting and viability checking by vital staining Sub culturing
10. Cytological examination of cultured cells

SEMESTER III

Practicals

BT 305 GENETIC ENGINEERING LAB

Aim

To introduce the students to the concepts and practice of genetic engineering.

Course Objectives

- To understand the basics of genetic engineering.
- To learn different methodologies in genetic engineering.
- To enable students to design a cloning experiment.

Course Outcome

At the end of the course,

- Students obtain a thorough knowledge in basic Molecular biology and genetic engineering methods practiced in research.

Course content

Laboratory techniques

1. Isolation of plasmids and purification
2. Electrophoretic separation of plasmid by agarose gel electrophoresis
3. Quantification and quality checking by UV spectrophometry and electrophoresis
4. Restriction analysis and construction of restriction map of plasmid
5. Preparation of competent *E.coli* cells, Construction of recombinant plasmid
6. Genetic Transformation of *E.coli* with a recombinant plasmid
7. Screening transformed cells for the presence of recombinant plasmid and gene
8. Transformation frequency and cloning efficiency

SEMESTER IV

BT 401 IMMUNOLOGY

Aim

- To get introduced to the principles of immune systems of animals.
- To introduce to the world of molecular and diagnostic techniques of immunology, immunotechniques and its application.

Course Objectives

- This course is designed to impart the students the importance of immunology and its theoretical aspects and on the principles of immunology and immunotechnology
- The application of immunology in medicines is also dealt with.
- It also explains the various antigen-antibody reactions involved in diseases, stem cell technology and vaccine development.

Course Outcome

At the end of the course the students will,

- Get a deep foundation in the immunological processes.
- Students will gain knowledge on how the immune system works and also on the immune system network and interactions during a disease or pathogen invasion.

Course Content

Module 1

1. History and scope of immunology. Types of immunity- innate, acquired, passive and active. Brief account on Immune system, Physiology of immune response- HI and CMI specificity and memory. Antigen-antibody reactions. Antigens- types- hapten.
2. Immunoglobulins- structure, distribution and function.

Module 2

3. Lymphoid tissues- ontogeny and physiology of immune system- origin and development, differentiation of lymphocytes.
4. Antigen distribution in population- HLA in human health and disease. Transplantation immunity- organ transplantation and HLA tissue typing.

Module 3

5. Effector mechanisms in immunity- macrophage activation. Cell mediated cytotoxicity.
6. Humoral and cell mediated immunity, Hypersensitivity reactions. Cellular interactions in human response.

Module 4

7. Antigen recognition. Lymphocyte activation, colonal proliferation, differentiation.

8. Cytokines in immunity, Interleukines and their role.

Module 5

9. Genetic Immuno regulations. Introduction to tumour immunology, autoimmune disorders.
10. Use of transgenic animals in immunology, experimental immunology, vaccine, development, stem cell technology. Immunodiagnostics.

Module 6

11. Hybridoma technology and monoclonal antibody production, application and their uses. Cloning for vaccine development
12. Immunotechniques – ELISA, RIA, Immuno-electrophoresis, Immuno Diffusion, Western Blotting.

References

1.	Immunology	Joshi. Osma	Agro Botanica N.Delhi
2.	Instant notes in Immunology	Lydyard, helean, Fanger	Viva Books N.Delhi
3.	An introduction to Immunology	CV Rao	Narosa N.Delhi
4.	Immunology	Janus Kuby	Freeman NY
5.	Principles of cellular and molecular Immunology	Jonathan Austin, Kathyryn Wood	Oxford NY
6.	Immunology	Goldsby, Kindt, Osborne, Janus Kuby	Freeman NY
7.	Medical Immunology	Parslow, Stites, Tera, Imboden	Mc Graw Hill NY
8.	Cellular and molecular Immunology	Abbas, Lichman, Pobea,	Harcourt & Brace Co.

Online resources

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER IV

BT 402 ENVIRONMENTAL BIOTECHNOLOGY

Aim

- To give an introduction to the various aspects of environmental biotechnology to students.

Course Objectives

- The course explains the application of biotechnology in 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 the biological approaches i.e. using bioremediation etc.

- The students will know about the principles and techniques underpinning the application of biosciences to the environment

Course Content

Module 1

1. Issues and scopes of environmental biotechnology.
2. Pollution- types of pollution, methods for measurement of pollution, Environmental management-problem solving approaches- its limitations.

Module 2

3. Biological wastewater treatment- Waste water characterization: COD, BOD,
4. Inorganic constituents, solids, biological components.
5. Principles and aims of biological wastewater treatment processes,
6. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal.

Module 3

7. Suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds etc. Fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed etc.
8. Anaerobic waste water treatment systems: RBC, UASB, Anaerobic filters.

Module 4

9. Environmental problems and treatment of industrial waste waters: Distillery, tannery, paper pulp etc.
10. Toxicity testing in waste water treatment plants.
11. Solid waste management: Anaerobic digestion, Composting.

Module 5

12. Biodegradation of organic pollutants:

Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides.

13. Bioremediation: Biostimulation and bioaugmentation , *In situ* and *ex situ* bioremediation technologies for various pollutants and sites. Bioremediation of oil spills and heavy metal pollution. Use of GMO in bioremediation. Biofilteration of polluted air.

Module 6

14. Biogeotechnology: Bioleaching of metals, biobeneficiation, microbially enhanced oil recovery, biodesulfurization of coal.
15. Microbes in the environment- Biofilms and its relevance in microbial survival, its effect in the environment.
16. Microbial Insecticides: Biopesticides. Bacterial, fungal and viral insecticides

References

1.	Biotechnology – Fundamentals and application	SS Purohit SK Mathur	Agrobotanica, India
2.	Agricultural Biotechnology	SS Purohit	Agrobotanica, India
3.	Concepts in Biotechnology	Balasubraminan, Bryce, Dhramalingam, Jayraman	UTY Press. Hydrabad
4.	Fungi In Biotechnology	Anil Praksah	CBS N. Delhi
5.	Biotechnology	BD Singh	Kalyani Publishers
6.	Environmental Biotechnology	Alan Scragg	Longman England
7.	Biotechnology Unzipped	EricS grace	UTY Press. Hydrabad
8.	Biotechnology	JE Smith	Cambridge UTY Press

Online resources

Authentic Web based resources like NCBI, PubMed, Science direct etc.

SEMESTER IV

BT 403 FOOD AND DAIRY BIOTECHNOLOGY/ BASICS OF BIOPROCESS TECHNOLOGY

Aim

- To introduce Food and Dairy biotechnology to non-biotechnology students
- To introduce the subject of bioprocess technology in details
- To explain the industrial aspects of Biotechnology for the production of various of industrial products of biological origin.

Course Objectives

- The course explains the role of biotechnology in food and dairy technology.
- It gives details about the conversion of a small scale laboratory process in to a large scale industrial process.
- It also deals with the various important products produced by the bioprocess techniques.

Course Outcome

At the end of the course the students will,

- Get a detailed insight into the industrial processes carrying out in the food and dairy sector as well as how to transfer a small scale laboratory process to a large scale industrial process.

Basics of Bioprocess Technology

Module 1

1. Introduction to Bioprocess Technology – Scaling up of a Bioprocess , Upstream Processing , Downstream Processing,
2. Fermentation- Types of Fermentation, Its significance in Industry, Submerged Fermentation and Solid state fermentation, batch fermentation and continuous fermentation, Chemo stat Fermentation.

Module 2

3. Upstream Processing – Sterilization, Media Components, Cell cultures, its iisolation and maintenance, strain improvements –methods of strain improvements, inoculation of microorganisms
4. Upstream Processing – Importance of downstream processing and methods of downstream processing , centrifugation, filtration, precipitation, dialysis,, Chromatographic techniques- gel filtration, ion exchange chromatography and affinity chromatography, electrophoresis, capillary electrophoresis, Quality assurance techniques and its importance in marketing.

Module 3

5. Bioreactors - types of bioreactors , factors affecting the design of bioreactors
6. Industrial microorganisms and cultivation of microorganisms in bioreactors, Kinetics

of microbial growth.

7. Culture media sterilization for industrial application. Air in Bioreactors, pH maintenance in bioreactors

Module 4

8. Down stream processing and purification of products
9. Industrial bio-production of chemicals - and antibiotics

Module 5
Food and Dairy Biotechnology

10. Introduction to Food Technology - application of biotechnology in food processing use of food modifying enzymes - amylase, proteases, lipases etc.
11. Elementary idea of canning and packing - sterilization and pasteurization of food products

Module 6

12. Introduction to Food microbiology, Dairy microbiology, Microbial processing of milk and milk products. Sterilization and Pasteurization of milk and dairy products, Fermentation of milk, biochemical and physical changes associated with the process- Industrial processing of milk and production of food products - bread, cheese, butter, ghee and other value added products.

References

1.	Modern Concepts in Biotechnology	HD Kumar	Vikas N. Delhi
2.	Food Science	Potterr & Hotchkins	CBS N. Delhi
3.	Food Microbiology	MR Adams and Moss	Panima N. Delhi
4.	Food Processing-Biotechnological applications	Marwah &Arora	Asiatic Publ. N. Delhi
5.	Biotechnology	JE Smith	Cambridge UTY Press
6.	Perspectives in Nutrition	Gordon M Warlow	Mc Graw Hill NY

Online resources
Authentic Web based resources like NCBI, PubMed, Science direct etc.

BT 404 PROJECT

- Project work shall be assigned individually.
- It must be carried out under the guidance of a faculty from the same college with or without an external guide OR in an external institution under the combined guidance of internal and external guides.
- The student has to submit the dissertation before the external examiner appointed by the University for Evaluation.
- The work should be presented before the external examiners at the time of general Viva voce examination.

BT 405 GENERAL VIVA VICE EXAMINATION

General viva voce on theoretical and practical aspects based on the courses covered from semester I to IV.