CHOICE BASED CREDIT SYSTEM AND
CONTINUOUS ASSESSMENT AND GRADING PATTERN

SYLLABUS FOR

MASTER'S DEGREE PROGRAM
IN
BIOTECHNOLOGY
(2016-17 ONWARDS)

JSS COLLEGE OF ARTS COMMERCE AND SCIENCE
(An Autonomous College of University of Mysore; Re-Accredited by NAAC with 'A' Grade)

POSTGRADUATE DEPARTMENT OF STUDIES IN BIO-TECHNOLOGY
Ooty Road, Mysore – 570 025, India

Scheme of Study

Credit matrix for Masters Degree Program in Biotechnology

Credits to be earned	I Sem	II Sem	III Sem	IV Sem	Total Credits
Hard Core Course	12	16	12	16	56
Soft Core Course	04	04	04	–	12
Discipline Centric Elective Course	04	–	–	–	04
Open Elective Course*	–	–	04	–	04
Semester Total	**20**	**20**	**20**	**16**	**76**

I SEMESTER				
Course Code	**Course title**	**Hard Core(HC)/ Soft Core(SC)/ Discipline Centric Elective(DCE)**	**Credit pattern (L:T:P)**	**Credits**
BT101	Structural Biomolecules	HC	3:1:0	4
BT102	Biochemical Techniques and Biophysics	HC	3:1:0	4
BT103	Practical – I**(Includes Seminar)	HC	0:0:4	4
BT104	**Choose any ONE from the following** 1. Enzymology and Metabolism 2. Cancer Biology	SC	3:1:0	4
BT105	**Choose any ONE from the following** 1. Microbiology 2. Cell Biology	DCE	3:1:0	4
			Total credits	**20**
II SEMESTER				
Course Code	**Course title**	**Hard Core(HC)/ Soft Core(SC)**	**Credit pattern (L:T:P)**	**Credits**
BT201	Molecular Biology	HC	3:1:0	4
BT202	Molecular Genetics	HC	3:1:0	4
BT203	Practical – II** (Includes Seminar)	HC	0:0:4	4
BT204	Gene Technology	HC	3:1:0	4
BT205	**Choose any ONE from the following** 1. Metabolomics 2. Food and Environmental Biotechnology	SC	3:1:0	4
			Total credits	**20**

III SEMESTER				
Course Code	**Course title**	**Hard Core(HC)/ Soft Core(SC)/ Open Elective(E)**	**Credit pattern (L:T:P)**	**Credits**
BT301	Cell Signalling and Communication	HC	3:1:0	4
BT302	Immunotechnology	HC	3:1:0	4
BT303	Practical – III**(Includes Seminar)	HC	0:0:4	4
BT304	**Choose any ONE from the following** 1. Biostatistics, Bioinformatics and Bioprocess Technology 2. Clinical and Advanced Techniques in Biotechnology	SC	4:0:0	4
BT305	Applied Biotechnology * **(For other discipline students)**	OE	4:0:0	4
			Total credits	20
IV SEMESTER				
Paper Code	**Course title**	**Hard Core(HC)**	**Credit pattern (L:T:P)**	**Credits**
BT401	Plant Biotechnology	HC	3:1:0	4
BT402	Animal Biotechnology	HC	3:1:0	4
BT403	Dissertation*** (includes Research Paper presentation)	HC	0:4:4	8
			Total credits	**16**
			Total credits to be earned for M.Sc. Biotechnology	**76**

***Open Elective Course shall be entirely from different discipline of study**

**** Weekly Four hrs of practicals for four days and two examinations**

*****Dissertation should be in-house only and should be allotted to the students in the 3rd semester**

1. A student opting I, II and III semester has to appear for at least 12 credits. (Soft core may be studied any time).
2. Minimum number of students per Softcore/Discipline Centric Elective is 15.

L – Lecture – 1 credit = 1 hour

T – Tutorial – 1 credit = 2 hours

P – Practical – 1 credit = 4 hours

Marks distibution of Continous Assessment:

Assessment	IA (20M)	Seminar (5M)					Assignment (5M)		Total (30M)	Total reduced to 15 M
		A-1M	B-1M	C-1M	D-1M	E-1M	a-2.5M	b-2.5M		
C1										
C2										

M – Marks

A – Collection of material

B – Prepartion of slides

C – Confidence during presentation

D – Interaction during presentation

E – Reprot submission

a – Collection of material

b – Prepartion of report

First Continous Assessment – 15% – to be announced at the end of 8th week – includes assignments / tests / tutorials.

Second Continous Assessment – 15% – to be announced at the end of 16th week – includes assignments / tests / turotials.

Semester End Assessment – 70% – By written exam.

Conversion of grades in to credits should be based on relative evaluation calculations.

LIST OF SOFTCORE (DISCIPLINE CENTRIC ELECTIVES) AND OPEN ELECTIVE

1. Enzymology and Metabolism
2. Cancer Biology
3. Microbiology
4. Cell Biology
5. Metabolomics
6. Food and Environmental Bio-technology
7. Biostatistics, Bioinformatics and Bioprocess Technology
8. Clinical and Advanced Techniques in Bio-technology
9. Applied Biotechnology **(Open Elective)**

Program: M.Sc. Biotechnology

Program Outcome (PO):

After studying this programme, the students are able to:

PO1: Develop interpersonal skills, written and oral communication and also to improve their body language and eye contact during presentations.

PO2: Develop leadership qualities and to respect the others idea and take decisions for the welfare of the society.

PO3: Uphold the moral values in the society.

PO4: Design the experiments to solve the current problems in the society related to health, environment and industries.

PO5: Write the research papers, project proposals and application of mathematics in understanding biological science.

Program Specific Outcome (PSO):

After studying this programme, the students are able to:

PSO1: Understand the nature of biomolecules, their analysis and application in day to day life.

PSO2: Pursue higher education like M.Phil. and Ph.D..

PSO3: Appear for examinations such as CSIR-NET, ARS-NET GATE, ICMR, DBT, etc. for career development.

PSO4: Fetch jobs in different industrial sectors and also teaching.

PSO5: Follow standard operating procedures of the equipment, troubleshooting the problems and analyse and interpretation of data.

PSO6: Follow biosafety in handling corrosive, explosive and radioactive and biohazardous compounds.

I SEMESTER

COURSE CODE: BTA010
COURSE TITLE: STRUCTURAL BIOMOLECULES (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Study the structure and functions of different biomolecules
CO2-Understand carbohydrate types and structural elucidation
CO3-Understand protein structure and Ramachandran plot
CO4-Understand protein sequencing
CO5-Know the chemical synthesis of peptides
CO6-Classify the lipids
CO7-Learn DNA structure and purification

UNIT No.	CONTENT	Duration in Hrs
I	**Carbohydrates**- Classification of Carbohydrates- Monosaccharides, Disaccharides and Polysaccharides and outlines of their structure. Chemistry of Monosaccharides- Pentoses, Hexoses, Deoxy sugars, Amino sugars, Muramic acid, Neuraminic acid. Linkages in disaccharides- sucrose, lactose and maltose. Isolation of polysaccharides- starch, glycogen. Chemistry of Homo- and Hetero- polysaccharides- starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides and blood group polysaccharides. Structural elucidation-periodate oxidation, methylation and acid digestion. GC-MS and secondary structure	**12**
II	**Proteins**- Amino acids, Building blocks- classification and nomenclature of amino acids. Stereochemistry, D and L, R and S. Reactions of amino acids. Structure- Zwitterionic structure, pH titration, pI and its concept.	**04**
	Peptide bond- Features of peptide bond. Naturally occurring peptides- Glutathione, Enkaphalins and Endorphins; Ramachandran's plot; Synthesis of peptides- Merrifield's solid phase synthesis.	**04**
	Classification of proteins- Elucidation of protein structure- Determination of primary structure of proteins- Amino acid composition N-terminal and C-terminal residue determination. Sequencing Strategies- Reagents- Sanger's and Edman's procedures, Automated sequenators. Determination of position of S-S bonds. Secondary structure- α-helix, β-sheet, β-bend and β-turn. Prediction of secondary structure of proteins- Chou and Fasman algorithm. Helix supporting amino acids. Helix-breakers. Factors stabilizing secondary structures.	**04**

	Tertiary and Quaternary structure of proteins - Myoglobin, Hemoglobin, Immunoglobulins, Collagen and Keratin. Factors stabilizing tertiary and quarternary structures of proteins. Protein denaturation and renaturation- Anfinsen's experiments and RNAase.	**04**
III	**Lipids** – Classification and nomenclature- Fatty acids and their physical and chemical properties. Simple lipids- Compound lipids- Glycolipids- Phospholipids.	**10**
IV	**Nucleic acids**- Isolation of DNA and RNA from natural sources (Microorganisms, Plants and Animals) Purification of Nucleic acids, Physicochemical properties of nucleic acids, Hypo- and Hyper-chromicity, Melting of DNA, Tm, Factors affecting Tm, Cot-curve and its applications, Chargaff's rule Chemical reactions of nucleic acids (RNA and DNA). Secondary structure of DNA, Watson and Crick model. Comparative study of A, B and Z DNA structures and folding of DNA. Topology of DNA, Loop structure, Palindromes, Cruciform. DNA protein interaction- Zinc finger, Leucine zipper, Helix-Turn-Helix.	**10**

Reference Books

1. Proteins- Structure and Molecular properties. Thomas E. Creighton, 2nd Ed. W. H. Freeman and company.
2. Biochemistry of the Nucleic Acids. Adams et al., 10th Ed. Chapman and Hall.
3. Instant Notes in Biochemistry. Hames, B.D. Hopper, N. M and Houghton, J. D. Viva Book Pvt. Ltd. New Delhi.
4. Biochemistry. 3rd Ed. Donald Voet and Judith, G. Voet. John Wiley and Sons Inc.
5. Biochemistry. Stryer, L. 5th Ed. W. H. Freeman, New York.
6. Biochemistry. Garret, R. H. and Grisham, C. M. Saunders College Publishing.

I SEMESTER

COURSE CODE: BTA020

COURSE TITLE: BIOCHEMICAL TECHNIQUES AND BIOPHYSICS (HARD CORE)

TOTAL DURATION: 48Hrs

Course Outcome

After studying this course, the students are able to:

CO1-Understand the separation of molecules by different chromatography, centrifugation and electrophorotic techniques

CO2-Analyse and characterize molecules by spectroscopic techniques

CO3-Understand the use of radioactive material in understanding metabolic pathways

CO4- Learn the application of thermodynamics to understand the basic concepts of life.

UNIT No.	CONTENT	Duration in Hrs
I	**Chromatographic techniques**: Chromatography; sample preparation, selection of chromatographic methods. Principles and applications of Paper, Thin layer, Ion Exchange, Gel Exclusion, Affinity, HPLC, RPHPLC and Gas liquid chromatographic techniques.	6
	Electrophoretic Techniques: General principles of electrophoresis, support media, native gels. SDS-PAGE, IEF, Capillary electrophoresis (CE), Agarose gel and Pulse field gel electrophoresis (PFGE). Blotting techniques – Southern, Northern and Western	6
II	**Centrifugation Techniques**: Introduction, basic principles of sedimentation, types of Ultra Centrifuges – Preparative and Analytical. Preparation of continuous (Linear) and discontinuous gradients and their use in centrifugation	6
	Radioisotope Techniques: Stable isotopes, nature of radioactivity, detection and measurement of radioactivity, GM-counter, Scintillation Counter, Autoradiography, safety aspects in isotopic techniques.	4
III	**Spectrophotometric Techniques**: Introduction, UV and Visible light spectroscopy, Raman spectroscopy, Electron Spin Resonance (ESR), NMR, Spectroflurometry, Luminometry and X-ray spectroscopy. Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD)	10
	Mass Spectrometric Techniques: Introduction, Mass-Spectrometer; Isomerization Techniques Ion disruption methods, Ion desorption and evaporation, analyzers, detectors, Tandem Mass Spectrometry.	6
IV	**Scope of Biophysics**: Biophysical laws, interactions of living and non-living matters, chemical foundations of biophysics, Water – a Universal solvent.	2

Chemical Bonds: Covalent (P & S) bonds, Ionic bonds, Co-ordinate bonds, Hydrogen bonds, Van der Waals forces of interaction, hydrophilic and hydrophobic interactions.	**2**
Photo-biophysics: Electromagnetic spectrum, biological importance of lasers and microwaves, vision.	**2**
Electrochemical Techniques: Introduction, principles of red-ox reaction, types of electrodes as Biosensors.	**2**
Thermodynamics: Principles and their applications in biology, concept of free energy in metabolism.	**2**

Reference Books

1. Practical Biochemistry – Principles and Techniques. Wilson and Walker. J. Cambridge Univ. Press.
2. Biophysical Chemistry. Upadhyaya, A., Upadhyaya, K. and Nath, N. Himalayan Publishing House.
3. Physical Biochemistry – David Freifelder, 2nd Edition.
4. Principles of Instrumental Analysis. 5th Ed. Douglas A Skoog, James Holler and Timothy A Nieman.
5. Analytical and Preparative Separation Methods of Biomacromolecules. Hassan Y Aboul – Enein.
6. Biophysics. Pattabhi, V and Gautham, N. Narosa Publishing House. 1999.
7. Biophysical Chemistry Part – I The conformation of Biological Macromolecules. Cantor and Schimmel.
8. Biophysical Chemistry Part – II Techniques for the study of biological structure and function. Cantor and Schimmel.
9. Biophysical Chemistry Part – III Behaviour of biological Macromolecules. Cantor and Schimmel.

I SEMESTER

COURSE CODE: BTA030

COURSE TITLE: PRACTICAL – I (HARD CORE)

Course Outcome:

After studying this course, the students are able to:

CO1-Understand the fundamental experiments in the field of Biochemistry and Microbiology.

CO2-Get the insight to operate simple equipments like colorimeter and spectrophotometer.

CO3-Identify microorganisms by their morphology and staining techniques along with growth kinetics.

CO4-Study enzyme kinetics using different parameters.

CO5-Isolate different organelles from the cells by centrifugation methods

CONTENT

1. Measurement of pH
2. Preparation buffers and solutions
3. Determination of pKa values of amino acids
4. Estimation of reducing sugar by DNS method
5. Estimation of proteins by Lowry's method
6. Ascending, descending and circular paper chromatography for separation of amino acids (1D & 2D)
7. TLC of amino acids/lipids (1D & 2D)
8. Estimation of ascorbic acid by DNPH method
9. Estimation of urea
10. Estimation of Phosphate
11. Gel electrophoresis- native and SDS-PAGE and determination of molecular weight of proteins
12. Mitosis in onion root tips
13. Meiosis in Tradescantia/Grass hopper testes
14. Cell fractionation – Isolation of chloroplast and mitochondria
15. Vital staining of mitochondria
16. Cell viability testing
17. Salivary amylase assay, time kinetics, specific activity, determination of optimum temperature and pH; Effect chloride ions on salivary amylase activity
18. Determination of Km and Vmax. and activation energy for an acid phosphatase (from potato)
19. Effect of inhibitors on enzyme activity
20. Purification of amylase from sweet potatoes: Extraction, ammonium sulphate fractionation, gel filtration. Monitoring of enzyme activity, % activity and % recovery during purification
21. Preparation of liquid and solid media for growth of microorganisms
22. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of microorganisms
23. Isolation of pure cultures from soil and water
24. Growth, growth curve; measurement of bacterial population by turbidometry and serial dilution methods. Effect of termperature, pH, carbon and nitrogen sources on growth.

25. Microscopic examination of bacteria, yeast and molds and study of organisms by gram stain, acid fast stain and staining for spores.
26. Assay of antibiotics and demonstration of antibiotic resistance.
27. Biochemical characterization of selected microbes.

I SEMESTER

COURSE CODE: BTA210
COURSE TITLE: ENZYMOLOGY AND METABOLISM (SOFT CORE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1-Study metabolism of biomolecules and their regulation

CO2- Learn the major classes of enzyme and their functions in the cell.

CO3-Study the role of co-enzyme cofactor in enzyme catalyzed reaction, properties of enzymes and regulation of biochemical pathways.

CO4- Differentiate between equilibrium and steady state kinetics and analyzed simple kinetic data and estimate important parameter (Km, Vmax, Kcat, etc).

UNIT No.	CONTENT	Duration in Hrs
I	Introduction, Classification and nomenclature, factors affecting enzyme activity **Enzyme Kinetics**: Rate of a reaction, order, Michaelis-Menten equation, initial velocity and steady state approach, V_{max} and K_M, linear transformation of MM equation- LB plot. **Enzyme inhibition**-Competitive, Uncompetitive, non-competitive, mixed, partial, substrate inhibition, suicide inhibition, determination of *Ki* **Molecular mechanism of enzyme action**: Mechanism of chymotrypsin, ribonuclease, and lysozyme.	**12**
II	**Allosterism:** Cooperativity-positive and negative cooperativity, Sigmoidal kinetics, MWC and KNF models, ATCase& Heamoglobin **Isoenzymes**: Lactate dehydrogenase. **Application of enzymes**: In medicine- as analytical agents, enzymes as markers for diagnosis; In industry - Food and beverage, detergent, textile pharmaceutical and leather;Immobilized enzymes- Methods, properties and applications of immobilized enzymes.	**12**
III	**Carbohydrates:** Glycolysis, Gluconeogenesis, TCA Cycle and its regulation, Glycogen metabolism- synthesis and breakdown. **Proteins:** Amino acid degradation- deamination, transamination and degradation of individual amino acids, urea cycle, Overview of amino acid biosynthesis.	**12**
IV	**Lipids:** Beta-oxidation of saturated and unsaturated fatty acids, alpha and omega oxidation. Biosynthesis of saturated, unsaturated fatty acids and phospholipids. Cholesterol biosynthesis and regulation. **Nucleic acids:** Pathways for degradation of purines and pyrimidines, de novo biosynthetic pathway of ribonucleotides, salvage pathway, related disorders,	**12**

biosynthesis of deoxyribonucleotides, regulation of degradation and biosynthesis.

Reference Books

1. Instant Notes in Biochemistry. Hames, B. D. Hopper, N. M and Houghton, J. D. Viva Book Pvt. Ltd. New Delhi.
2. Biochemistry. 3rd Edn. Donald Voet and Judith, G. Voet. JohnWiley and Sons Inc.
3. Biochemistry. Stryer, L. 5th Edn. W. H. Freeman, NewYork.
4. Biochemistry. Garret, R. H. and Grisham, C. M. Saunders College Publishing.
5. Fundamentals of Enzymology. Price NC and Stevans, L. Oxford Uni. Press.
6. Enzymes. Palmer, T. Harwood Pub.

I SEMESTER

COURSE TITLE: CANCER BIOLOGY (SOFT CORE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1-Understand the normal and cancerous cell

CO2-Understand protooncogens, tumor suppressor genes and apoptotic genes – regulation

CO3-Learn the diagnosis and treatment of cancer

UNIT No.	CONTENT	Duration in Hrs
I	**Cancer Biology: the basics** Introduction, historical perspective, classification, Carcinogenesis, cancer initiation, promotion and progression, Cancer cell cycles, Genomic instability, Apoptosis, Genes and proteins as players in apoptosis, DNA viruses/ cell immortalization.	08
II	**Cancer Genes I: Oncogenes and signal transduction** Cellular proto-oncogenes, oncogene activation, Growth factors, growth factor receptors, signal transduction , Transcription, Transcription factors and cancer, Retroviral oncogenes, Tumor suppressor, Tumor suppressor gene pathways, DNA methylation, epigenetic silencing of suppressor genes.	16
III	**Understanding Cancer as a Disease: natural history of cancer development** Free radicals, antioxidants and metabolic oxidative stress and cancer, Epidemiology of selected cancers, Gene rearrangements, detecting oncogene abnormalities in clinical specimens, Cell: cell interactions, cell adhesion, angiogenesis, invasion and metastasis, Antiangiogenic therapy of cancer.	12
IV	**Current concepts in cancer therapy** Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy/translating therapies from the laboratory to the clinic, Gene discovery in cancer research, cancer genome anatomy project , Cancer immunity and strategies of anticancer immunotherapy, stem cells and their applications in cancer therapy.	12

Reference Books

1. Molecular Biology of the Cell. Bruce Alberts

I SEMESTER

COURSE CODE: BTA220
COURSETITLE: MICROBIOLOGY (ELECTIVE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Understand the microbial taxonomy
CO2-Handle, preserve and sterilize microbes
CO3-Learn microbial interactions with different hosts
CO4-Know the application of microorganisms in the field of agriculture, environment and health sciences

UNIT No.	CONTENT	Duration in Hrs
I	The beginning of microbiology: The discovery of the microbial world – Hook, Anton van Leeuwenhoek and Cohn; Contribution of Pasteur and Koch, development of pure culture methods; the enrichment culture methods. Methods in Microbiology: Pure culture techniques; the theory and practice of sterilization.	**10**
II	Microbial diversity: Criteria of bacterial classification, molecular taxonomy, characteristics of primary domains; Bergey's Manual. Structure Prokaryotic cells, cell walls of eubacteria; flagella and motility, cell inclusions like endospores and gas vesicles. Archaea: Halophiles, methoanogens, thermophiles. Eukarya: General characteristics and outline classification of Algae, fungi, and protozoa Viruses: Bacterial, plant, animal and human viruses; classification and structure	**14**
III	Microbial growth: 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. Overview of basic metabolism and microbial nutrition: Metabolic diversity among microorganisms; chemolithotrophy; hydrogen-iron-nitrite-oxidizing bacteria; nitrate and sulfate reduction; methanogenesis and acetogenesis; fermentation, nitrogen fixation; hydrocarbon transformation. Microbes and environment: Nutrient cycles; microbial communication system; quorum sensing, microbial fuel cells; prebiotics and probiotics; vaccines.	**14**

IV	Microbial diseases: Important infectious diseases caused by bacteria and viruses; tuberculosis, AIDS, rabies, pathogenic fungi, emerging and resurgent infectious diseases. Important diseases of plants. Chemotherapy/antibiotics: Types, mode of action, resistance to antibiotics.	**10**

Reference Books

1. Microbiology. Fundamentals and Applications. Purohit. Agribios.
2. Microbiology. Prescott, L., Harley, J. P. and Klein, D. A. Brown Communication. Inc. IA.

I SEMESTER

COURSE TITLE: CELL BIOLOGY (ELECTIVE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:
CO1-Understand the structure and function of bacterial, plant and animal cell
CO2-Learn cell signalling and communication
CO3-Study the growth factors and their function
CO4-Understand cell cycle and regulation
CO5-Learn tumor biology of a cell

UNIT No.	CONTENT	Duration in Hrs
I	**Membrane and membrane phenomenon**: Membrane structure and principles of organization,	8
	Membrane proteins, glycoproteins and glycolipids, specialization of plasma membrane, transport across cell membrane – types of transport, ion channels, active transport and ion pumps, symport, antiport, plant and prokaryotic membrane transport proteins.	
	Cell organelle and membrane proteins: Mechanism and regulation of vesicular transport, Golgi and post golgi storing, receptor mediated endocytosis.	3
II	**Microfilament, cell motility and cell shape**: actin, actin architecture and assembly, myosin, muscle contraction, microtubules structure and dynamics, microtubule associated protein, cilia, flagella, intermediate filaments.	4
	Multicellularity: Extracellular matrix, hyaluronan and proteoglycan, matrix proteins and their receptors, adhesive proteins, cell junctions, structure and function of plant cell wall.	4
	Cellular signaling: Extra cellular signaling, G-protein linked receptors, role of cAMP, receptor tyrosine kinases, Ca^{2+} as a second messenger, multiplex signaling pathways, insulin receptor and regulation of blood glucose, regulation of cell surface receptors and transcription factors in signaling pathways, Chemical messenger – peptide and steroid hormones, mechanism of hormone action.	7
III	**Growth factor**: Growth factor structure (PDGF, VEGF), mechanism of action (PDGF, VEGF), receptors, signal transduction, plant growth factors and hormones – auxins, cytokinins and others.	5
	Cell Cycle: General strategy of cell cycle, discrete cell cycle events, cell cycle control, early embryonic cell cycle, yeast cell cycle, molecular genetics of cell cycle control, cyclins, cyclin dependent kinase, inhibitors, cell	6

division control in multicellular organism, apoptosis.

IV	**Tumor biology**: Retroviruses, retro viral transformation of host, development and causes of cancer, proto-oncogene, conversion from proto-oncogene to oncogene, tumor suppressor gene, role of p53 in cancer, cell culture uses in research, molecular medicine and cancer.	**6**
	Nerve cells: Action potential, voltage gated ion channels, nicotinic acetylcholine receptor, other neurotransmitters and their transporters, sensory transduction – the visual and olfactory system.	**5**

Reference Books

1. Molecular Biology of the Cell. Alberts, B., *et al.,* 4th Edition. Garland Publ. Inc.
2. Molecular Cell Biology. 5th Edn. Lodish, H., *et al.,* W H Freeman.
3. Genes VII. Lewin, B. Pearson Education International.
4. Cell and Molecular Biology. Karp, J. John Wiley and Sons Inc.

II SEMESTER

COURSE CODE: BTB020

COURSE TITLE: MOLECULAR BIOLOGY (HARD CORE)

TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1- Get an idea about the genomic organization of prokaryotes and eukaryotes.

CO2-Obtain in depth knowledge of genetic code, DNA replication and transcription in prokaryotes.

CO3-Understand the principles, concepts of translation, post translation mechanism

CO4-Learn regulation of gene expression in prokaryotes and eukaryotes

CO5-Gain the insight into molecular mechanism of antisense molecules, inhibition of splicing and application of antisense and ribozyme technologies.

UNIT No.	CONTENT	Duration in Hrs
I	**DNA topology**: Closed and super coiled DNA, DNA topoisomerases, DNases – exo and endonucleases, restriction endonucleases.	**4**
	DNA replication: Enzymes in DNA replication, DNA Pol I, II III, replication in single stranded DNA viruses, replication in prokaryotes, eukaryotic DNA replication, eukaryotic polymerases, role of other proteins and enzymes in replication, fidelity of replication, replication of mitochondrial DNA, inhibitors of replication.	**6**
II	**Genetic code**: Elucidation, Contributions of Khorana and others, triple binding assay, Wobble hypothesis.	**2**
	Transcription: Transcription unit, RNA polymerase in prokaryotes, mechanism of transcription-initiation, elongation and termination. Eukaryotic transcription - eukaryotic RNA polymerase, transcription factors, initiation, elongation and termination of transcription, inhibitors of transcription; post transcriptional modifications – capping, polyadenylation, splicing, introns and exons. Structural organization of mRNA, tRNA and rRNA, nuclear export of mRNA and mRNA stability	**8**
III	**Translation**: Molecular anatomy and biogenesis of ribosome, partial reconstitution experiments; Amino acid activation- amino acylation of tRNA; prokaryotic and eukaryotic translation– mechanism of initiation, elongation and termination, inhibitors of translation, post translational modifications, protein glycosylation.	**6**
	Protein localization: Synthesis of secretory proteins and membrane proteins; import into nucleus, mitochondria, chloroplast and peroxisomes.	**4**
	Regulation of gene expression in Prokaryotes: Basic control circuits, positive and negative regulation; Operon concept – *lac*, *ara* and *trp* operons-catabolite repression, regulatory elements in prokaryotes, attenuation,	**4**

antitermination, regulation of gene expression in Bacteriophage.

IV	**Regulation of gene expression in Eukaryotes**: *cis* control elements – promoters, enhancers, *trans* acting factors, DNA binding motifs of transcription factors, mechanism of regulation by transcription factors, AP1, NFkB histone acetyl transferase and deacylase, hormonal regulation of gene expression, post transcriptional control.	**8**
	Antisense RNA and ribozymes: Molecular mechanism of antisense molecules, inhibition of splicing, disruption of RNA structure, hammerhead, hairpin ribozymes, strategies for designing ribozymes; Application of antisense and ribozyme technologies. RNA interference, RNA induced gene silencing.	**6**

Reference Books

1. Molecular Biology. Freifelder, D. Narosa Pub House.
2. Advance Molecular Biology. Twyman, R. M. Viva Book Pvt. Ltd.
3. Molecular Biology. JD Watson
4. Molecular Biology of the Cell. Bruce Alberts.

II SEMESTER

COURSE CODE: BTB010
COURSE TITLE: MOLECULAR GENETICS (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Understand the molecular mechanism of inheritance
CO2-Learn mutation and DNA repair mechanism
CO3-Know gene mapping and study of chromosomal abnormalities
CO4-Understand phylogenetics and micro-evolution
CO5-Study the development of an organism

UNIT No.	CONTENT	Duration in Hrs
I	**Laws of inheritance in haploid organisms**- *Chlamydomonas* and *Neurospora*, uniparental, maternal and cytoplasmic inheritance in yeast, *Neurospora*, paramecium and plants	4
	Genomic organization: Prokaryotes, eukaryotes, viral genome, extrachromosomal genome-plasmids, mitochondria & chloroplast, repetitive elements- LINES and SINES, simple sequence repeats	4
	Mobile genetic elements: discovery, insertion sequence in prokaryotes, complex transposons (Tn10, Tn5, Tn9 and Tn3 as examples), mechanisms, control, consequences and applications of transposition by simple and complex elements.	4
II	**Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, Molecular basis of mutations, insertional mutagenesis	4
	Recombination: Homologous and non-homologous recombination, Holliday model, site-specific recombination	2
	DNA Repair: Mechanism of genetic repair- direct repair, photo reactivation, excision repair, mismatch repair, post-replicative recombination repair, SOS repair	2
III	**Gene mapping methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.	4
	Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.	4

	Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.	**2**
IV	**Genes and development**: Model systems for studying development- *Drosophila, Caenorhabditis, Arabidopsis* Genetic control of development in Drosophila: anterioposterior axis specification, role of maternal genes, segmentation of larval body, gap genes, pair rule genes, homeotic genes, complex gene interaction in development, sequential gene action. Floral meristems and floral development in *Arabidopsis*	**10**
	Human Genetics: Human chromosomes, karyotype – construction, characteristics, staining techniques and nomenclature; chromosomal abnormalities – sex chromosomal and autosomal, inherited disorders, genetic counselling, gene therapy; Human Genome Project, Human Genome Map.	**4**
	Population Genetics: Genetic variation, Hardy-Weinberg Law, random mating, genetic frequency, natural selection, genetic drift, migration, genetic equilibrium.	**2**
	Evolution:Molecular basis of evolution, Molecular clock, Molecular phylogenetics	**2**

Reference Books

1. Genetics. Strickberger, M. W., Prentice Hall of India Pvt. Ltd.
2. Genetics – A Molecular Approach. Brown, T. A. Chapman and Hall.
3. Genes VII. Lewin, B. Pearson Education International. 2003.
4. Genetics- A Conceptual Approach. Benjemin A Pierce.

II SEMESTER

COURSE CODE: BTB030
COURSE TITLE: PRACTICAL – II (HARD CORE)

Course Outcome:

After studying this course, the students are able to:

CO1-Get the skills in the field of Molecular biology and Genetic engineering viz., Isolation and purification of nucleic acids and their quantification

CO2-Learn genetic manipulation in microbes and gene cloning

CO3-Learn the preparation of wine and analysis of food samples

CONTENT

1. Transformation in bacteria
2. Conjugation in bacteria
3. Phage titration
4. Culture of Drosophila melanogaster and Observation of drosophila mutants
5. Isolation of salivary gland chromosomes
6. Identification of normal and abnormal human karyotype
7. Localization of Barr bodies
8. Estimation of free fatty acids by titrametric method
9. Saponification value for commercial oil samples
10. Determination of iodine value of an oil
11. Determination of total carbohydrates by phenol-sulphuric acid method
12. Estimation of cholesterol
13. *In vitro* transcription
14. Total RNA extraction
15. Estimation of DNA by Diphenylamine (DPA) method
16. Estimation of RNA by orcinol method
17. Isolation of DNA different samples: plant leaves, coconut endosperm, yeast, animal tissues
18. Determination of purity and concentration of isolated DNA using spectrophotometer
19. Isolation of plasmid DNA from *E.coli*
20. Agarose gel electrophoresis of DNA
21. Cloning of DNA into a vector
22. Restriction digestion of DNA
23. RAPD
24. DNA ligation
25. Analysis of microbial quality of foods – Litmus test, catalase test and dye reductase test in milk, estimation of lactic acid in milk
26. Preparation of wine
27. Estimation of percentage of alcohol in wine
28. Chemical method to differentiate between ethanol from methanol
29. Estimation of total acids in wine.

II SEMESTER

COURSE CODE: BTB040
COURSETITLE: GENE TECHNOLOGY (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1- Learn different molecular tools used in recombinant DNA technology

CO2-Understand applications like gene sequencing, variants of PCR, gene therapy, human genome project, molecular markers, microarray

CO3- Know the development of GMOs and bioethics.

UNIT No.	CONTENT	Duration in Hrs
I	**Cloning and Expression vectors**: Plasmids, lambda vectors, M13 Phage, Cosmids, Phagemids, BACs, PACs, plant and animal viruses as vectors, Transposons, YAC and MAC vectors, Expression vectors: Promoters, expression cassettes, Baculovirus, Virus expression vectors for mammalian cells, binary and shuttle vectors.	**8**
II	**Recombinant DNA and Molecular probes**: Restriction enzymes for cloning, Technique of restriction mapping, construction of chimeric DNA: cloning in plasmid, Phage and cosmid vectors, hosts for cloning vectors.	**4**
	Molecular probes: preparation, labelling, amplification, techniques of molecular probing, applications, and Molecular markers.	**2**
	Gene analysis techniques: Nucleic acid hybridization, Southern and Northern blotting, mapping genes to chromosomes, *in situ* hybridization, Polymerase chain reaction- Types, RAPD, AFLP, RT-PCR, realtime PCR, microsatellites, applications.	**4**
	Gene libraries: Construction and screening of genomic and cDNA libraries, chromosome walking, Chromosome Jumping, BAC libraries and assembly of BACs into contigs.	**2**
III	**Isolation, Sequencing and synthesis of genes**: Isolation of genes for: specific proteins, proteins having tissue specific expressions, isolation of genes using DNA or RNA probes. Sequencing by Maxam and Gilberts methods, Sangers dideoxy method, automatic DNA sequencers, by PCR, DNA sequencing through transcription, sequencing using DNA chips, sequencing by DE-MALDI-TOFMS. Gene synthesis machines, gene synthesis using PCR, mRNA.	**8**
	Gene Therapy: Human diseases targeted for gene therapy, Vectors and other delivery systems for gene therapy, *Ex vivo* and *In vivo* gene therapy, tissue of choice for gene therapy, In-vitro gene therapy, gene therapy of genetic diseases: eg. Neurological, metabolic disorders and cystic fibrosis, gene therapy for acquired diseases infections, cardiovascular, cancer. Nanotechnology for drug targeting and gene therapy, Future of gene therapy	**6**

IV	**Genomics & Proteomics:** Concept of a genome – information content in genome sequences, Whole genome analysis – construction of cosmid libraries, BAC libraries, shotgun cloning and sequencing, automated sequencing, sequence assembly Understanding genome sequence – sequence annotation – searching for ORF's and expressed sequences, homology analysis, sequence similarity and structural similarity, comparative genomics	**8**
	Functional genomics – DNA microarray, microarray fabrication, gene expression using microarrays, transcriptome **Proteome analysis** – two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy; protein microarrays Human genome project	**6**

Reference Books

1. A Text Book of Bio-technology. H. D. Kumar.
2. Genetic Engineering: Primose, S. B.
3. Principles of gene manipulation and genomics. Primose, S. B. and Twyman, R. M.
4. Gene cloning and DNA analysis an Introduction. Brown, T. A. Blackwell Science Company.
5. Molecular Biology and Biotechnology. Walker, J. M. and Rapley, R. Panima Publishing Corporation.
6. Molecular Biotechnology – Principles and application of Recombinant DNA. GLicks, R. Bernard and Pasternak, J. Jack. Panima Publishing Corporation.
7. Genes (VIII edition). Benjamin Lewin. Pearson Education International.
8. Molecular Biology of the gene (V edition). Watson, J. D. *et al*., Pearson Education Publication.
9. Enzymology Primer for Recombinant DNA technology. Hyone-Myong Eun. Academic Press.
10. From Genes to clones. Winnacker. Panima Publishing Corporation.
11. Genomes. Brown, T. A. Jhon Wiley and sons Publication. 1999.
12. Bacterial Plasmids. Breda, P.
13. Genetic Engineering - Principles and Practice. Sandhya Mitra. MacMillan India Ltd.

II SEMESTER

COURSETITLE: METABOLOMICS (SOFT CORE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:
CO1-Understand the basic metabolism of plants
CO2-Understand different pathways involved in secondary metabolite production
CO3-Learn altering the metabolic pathways by changing the precursors
CO4-Know the purification of useful secondary metabolites and their kinetics and dynamics
CO5-Learn the applications of biotechnology tools in food and pharmaceutical industries

UNIT No.	CONTENT	Duration in Hrs
I	**Plant Metabolomics**: Developments and history of plant metabolomics, Nature and prospecting of metabolism-related secondary plant products, tools and techniques, production in culture: optimization; selection, hormonal kinetics for secondary metabolites, production, mechanism and control.	**10**
II	**Production of secondary metabolites:** Induction, Alkaloids, antitumor compounds, food additives, steroids and saponins, detoxification of secondary metabolites, production of secondary metabolites by bioconversion, genetic transformation for production of secondary metabolites, large-scale production in bioreactors, Metabolomics-assisted breeding.	**14**
III	**Microbial metabolomics**: Systems biology of microbial metabolism; microbe sensors, *In silico* metabolomes, Food and Applied metabolomics, Biomarker discovery. Experimental Approaches- Genome sequencing, Gene expression arrays, Nuclear Magnetic Resonance, Mass spectroscopy, Capillary electrophoresis, Two dimensional gel electrophoresis, Gene expression arrays, Pathway analysis, HPLC, Protein sequencing, Bench-scale fermentation, AFLP/RLFP analysis.	**12**
IV	**Pharmacometabolomics**: personalized medicine and future of health system, Pathways discovery and disease pathophysiology, Bioinformatics analysis of targeted metabolomics; Environmental metabolomics, Bioactive compounds and Pharmacognosy, Clinical Applications of Metabolomics, Nutrigenomics and Metabolomics, Novel Technologies for Metabolomics, Data Handling for Metabolomics.	**12**

II SEMESTER

COURSE CODE: BTB210
COURSE TITLE: FOOD AND ENVIRONMENTAL BIOTECHNOLOGY (SOFT CORE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Get a **c**omprehensive insight into the fermented foods and enzymes in food industry
CO2- Obtain knowledge of functional foods, genetically modified foods and nutraceuticals.
CO3-Understand current status of biotechnology in environment protection.
CO4-Understand the principles of bioremediation
CO5-Know the significance of GMO to the environment.

UNIT No.	CONTENT	Duration in Hrs
I	Fermented foods, milk-based products, fermented vegetables, fermented meats, fish, beverages, vinegar, mould fermentation - tempeh, soysauce, rice wine. Enzymes in dairy industry, cheese making and whey processing, impact of enzyme technology (bioethanol, protein hydrolysates, bioactive peptides), Enzymatic processing of fruit juices; role of enzymes in baking, meat and meat processing, phytase in animal feeds, DNA-based methods for food authentication, comparative methods of toxicity testing in (novel) foods, biological approach to tailor-made foods, catabolic processes and oxygen-dependence reactions in food, application of generic technologies in food and nutritional sciences; anti-cancer components in foods.	**14**
II	Functional foods and Biotechnology: Biochemical processing in the improvement of functional foods with targeted health benefits and increased nutrient value; applying molecular, biochemical, cellular and bioprocessing concepts, bio-mobilization of major nutrients such sterols, lipids, vitamins and minerals, use of specific phenolic metabolites from botanical species. Pre- and Pro-biotics, single cell protein, single cell lipids. Manipulation of fruit ripening process. Food processing, principles and practices, food ingredients and processing aids from biotechnological processes, corn sweeteners, bacterial starter cultures, cold-adapted enzymes. Food spoilage, preservation, mycotoxins in food commodities. Genetically modified foods, designer foods, Nutraceuticals, detection of GM foods.	**12**

III	Renewable and non-renewable resources, current status of biotechnology in environment protection. Characterization of waste. Waste water management: Bioreactors for waste-water treatment, Aerobic biological treatments, anaerobic biological treatments, treatment of industrial effluents-dairy, distillery, paper and sugar industries. Membrane-based waste water treatment. Oil pollution – treatment with microorganisms.	**10**
IV	Bioremediation: Concepts and principles, bioremediation using microbes, in situ and ex situ bioremediation, biosorption and bioaccumulation of heavy metals. Xenobiotics: Degradation capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons. Renewable energy: Relevance of GMO to the environment. Solid waste management: Waste as a source of energy, biotechnology in paper and pulp industry, production of oil and fuels from wood waste, anaerobic and aerobic composting, vermiculture, biofuels.	**12**

Reference Books

1. Food Microbiology. Frazier, W. C. and Westhoff, D. C. Tata McGraw Hill.
2. Agriculture Bio-technology. Purohit. Agrobios India.
3. Food Bio-technology. Knorr, D. Marcel Dekker Inc.
4. Environmental Bio-technology. Jogand, S. N. Himalaya Publishing House, New Delhi.

III SEMESTER

COURSE CODE: BTC010
COURSETITLE: CELL SIGNALING AND COMMUNICATION (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Understand the multi-cellularity of organisms
CO2-Learn the role of extracellular matrix in signalling
CO3-Learn about various signalling pathways from the cell surface to the nucleus
CO4-Understand cell signalling in plants and microbe-plant
CO5-Study the insect-plant interaction.

UNIT No.	CONTENT	Duration in Hrs
I	**Multicellularity:**Role of Extracellular matrix - hyaluronan and proteoglycan. Matrix proteins and their receptors, adhesive proteins and cell junctions in multicellularity. Structure and function of plant cell wall	4
	The importance of the matrix in signal transduction: Cell surface receptors as reception of extra-cellular signals, Amplification of signal during transmission - a quantitative study, Tyrosine kinase and tyrosine phosphatase, Cell membrane components and adapter proteins required for signal transmission, Upstream and downstream signal transduction without cell surface receptor activation, G-protein coupled signaling; the secondary messengers in signal transduction pathways cAMP, Ca^{2+}, Reactive Oxygen Species and Hypoxia Signalling, Apoptosis Signaling Transduction Pathway, PI3K/AKT Cell Survival Pathway.	8
II	**Various signal transduction pathways from cell surface to nucleus**: MAP kinase pathway, SAP/JNK pathway, p38 pathway, ERK pathway, NFkB pathway, Cell survival pathway, Wnt signaling pathway, Jak/Stat pathway, Smad pathway,TGF β Signaling, EGFR, VEGF And their Signalling, Cytoskeleton And Cell Signalling, Carbohydrate Recognition Signaling, MMPs And Cell Signalling, Cross talk among cell surface receptors, Cross talks among cytoplasmic components, Translocation of signal components during signal transmission, From cytoplasm to cell membrane, NF-κB Signaling from cytoplasm to nucleus, Cell cycle and its Signalling.	8
	The end point of signal transduction--- gene transcription: Nuclear receptors and ranscription factors in signalling, Signalling from single gene expression to multiple gene expression: Super array as a tool for the study of multiple gene transcription, Practical application of the signal transduction research, RNA Interference And Cell Signalling, Senescence and Its	6

Signaling Pathways.

III	**Signal transduction in plants:** Cross-talk with the environment- wound and mechanical signalling - fatty acid signalling, peptide signalling, oligosaccharide signalling; protein kinases and signal transduction. Abiotic stresses - Dehydration-stress, salt-stress, cold acclimation, heat-stress	**6**
	Role of active oxygen species (AOS) in plant signal transduction: AOS in plants, AOS as signal molecules, AOS-part of a signalling network.	**4**
	Action of phytohormones: Multiple signals regulating growth and development of plant organs and their adaption to environmental stresses.	**2**
IV	**Symbiotic plant-microbe interaction:** Rhizospheric signals (PGPR) and early molecular events in the ectomycorrhizal symbiosis; Lipo-chito-oligosaccharides (LCO) signalling in the interaction between rhizobia and legumes; endophytes.	**4**
	Recognition and defence signalling in plant-microbe interaction: Resistance genes - gene-for-gene resistance; co-evolution and specificity of R genes; the TIR domain, the NBS domain; genetic organization of resistance genes; quorum sensing.	**4**
	Plant-insect interaction: Induction of direct and indirect defence	**2**

Reference Books

1. Animal Cell Biotechnology – Methods and Protocols. Nigel Tenkins.
2. Molecular biology of the Cell –Alberts et al.
3. Molecular Cell Biology. 5th Edn. Lodish, H, et al., W H Freeman
4. Cell and Molecular Biology. Karp, J.John Wiey and Sons In.
5. The Cell-Molecular approach. 4th Ed. Geoffrey M Cooper and Robert E Hausman.
6. Cell Biology- A Laboratory Handbook. 3rd Ed, 4th Vol, Julio E Celis

III SEMESTER

COURSE CODE: BTC020
COURSE TITLE: IMMUNOTECHNOLOGY (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Study the basic concepts of immunology
CO2-Learn MHC and their role in transplantion
CO3-Understand cytokines and their role in immune system
CO4- Understand tumor immunology, autoimmune diseases, Hypersensitivity, Vaccine production

UNIT No.	CONTENT	Duration in Hrs
I	**Immune system:** Structure, functions and organization of cells and organs involved in immune systems – T cells, B-cells, macrophages, Eosinophils, Neutrophils, Mast cells; bone marrow, spleen, thymus, lymph node, peyer's patch; Infections and immune responses – Innate immunity, acquired immunity; clonal nature of immune response; Immunohaematology – blood groups antigens, blood transfusion and Rh incompatibilities.**Antigens:** Types, haptens, adjuvants, antigenic specificity.	**10**
	Antibodies: Structure of immunoglobulins, heterogeneity, sub-types – iso-, allo- and idio- types and their properties	**4**
II	**Complements:** Structure, components, properties and functions of complement pathways, biological consequences of complement activation; Immunological diversity; Effector mechanism: T-cell cloning, mechanism of antigen recognition by T-cells and B-lymphocytes and their properties, receptors and related diseases. Role of class II MHC molecules in T-cell cloning, antigen specific and alloreactive T-cell cloning, applications of T-cell cloning in understanding relevant antigens and T-cell subtypes; T-cell cloning in vaccine development.	**8**
	MHC and Tumor immunology: Structure and function of MHC and the HLA system; regulation of Ir-genes; Tumor immunology– Tumor specific antigens, Immune response to tumors, theory of surveillance, immune diagnosis of tumor; Tumor markers – Alpha fetofoetal proteins, carcinoembryonic antigen	**6**
III	**Immune responses and Transplantation:** HLA and tissue transplantation; Tissue typing methods for organ and tissue transplantation in humans; Graft versus host rejection, Host versus graft rejection; Xenotransplantation; Immunosuppression theory; Autoimmune diseases – Hashimoto's disease, Systemic lupus erythematosis, Multiple sclerosis, Myasthenia gravis,	**8**

	Rheumatoid arthritis and the remedies.	
	Allergy: Type I – Antibody mediated – Anaphylaxis, Type II – antibody dependent – Cytolytic and Cytotoxic, Type III – Immune complex mediated reactions– Arthus reaction, serum sickness, Type IV– Cell mediated hypersensitivity reaction– Tuberculin type.	**4**
IV	Lymphokines and Cytokines– assay methods, related diseases; Immunological tolerance; production of interleukins and interferons– applications. Antigen-Antibody interaction, Production of monoclonal and polyclonal antibodies.	**4**
	Immunizations: Conventional vaccines, sub-unit vaccines, DNA vaccines, toxoids, antisera; common immunization – small pox, DPT, hepatitis, polio, measles	**4**

Reference Books

1. Immunology. Roitt, Gower Medical Publisher.
2. Fundamental Immunology. Paul W E Raven Press.
3. Immunology. Kuby
4. Immunology, Janewas Traves, Walpart, SHlomehik. Churchill Livingstone.
5. An introduction to Immunology. Rao, C. V. Nasora pub house.
6. Immunology – A short course. Coico, R., Sunshine, G. and Benjamini, E. John Wiley and sons.
7. Cellular Interactions and Immunobiology. BIOTOL series. Butterworth-Heinemann.

III SEMESTER

COURSE CODE: BTC030

COURSETITLE: PRACTICAL – III (HARD CORE)

Course Outcome:

After studying this course, the students are able to:

CO1-Get an idea on the study of antigen antibody interaction

CO2-Learn production of alcohol by submerged fermentation and production of enzymes by koji fermentation.

CO3-Study plant enzymes

CO4-Get an insight into *invitro* culturing of plant cells and organs followed by production plant associated metabolites.

CO5-Know the preparation of animal cell culture media, Preparation of lymphocytes

CO6-Study the preparation of antibodies and Purification of antibodies

CONTENT

1. Animal cell culture: preparation of media, culture and maintenance of cell lines, trypsinization
2. Culture of transformed cells
3. MTT assay for cytotoxicity
4. Lymphocyte preparation
5. Preparation of antigen and antibody production
6. Purification of IgG/IgY
7. Routes of injection
8. Slide agglutination test/Blood grouping
9. Antibody labelling
10. Immunoprecipitation test- Ouchterlony double diffusion
11. ELISA for quantification of an antigen
12. Rossette assay
13. Western blotting and detection
14. Study of fermenter (demo)
15. Immobilization of yeast by calcium alginate, gel entrapment and assay for enzyme *invertase* and *catalase*.
16. Study of alcohol fermentation – alcohol from different substrates – estimation of alcohol content
17. Solid state fermentation
18. Assay methods – vitamins and amino acids
19. Preparation of MS media
20. Induction of callus
21. Micropropagation
22. Suspension culture
23. Preparation of synthetic seeds
24. Database search for nucleotide and aminoacid sequences using BLAST
25. Study of sequence alignment
26. Construction of trees/dendrogram using sequence analysis
27. Structure prediction using homology searches

III SEMESTER

COURSE CODE: BTC210
COURSETITLE: BIOSTATISTICS, BIOINFORMATICS AND BIOPROCESS TECHNOLOGY (SOFT CORE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Study the application of statistics to understand and analyse the experimental results of biological sciences
CO2-Know the retrieval of biological data
CO3-Understand the phylogenetic analysis and primer designing
CO4-Study drug discovery and molecular docking
CO5-Learn the designing of fermenter, different types of fermenter, optimization of media, strain improvement, downstream processing

UNIT No.	CONTENT	Duration in Hrs
I	**Statistical concept**: Data structure, sampling methods, collection, classification and tabulation of data, graphical and diagrammatic representation, histogram, frequency polygon, frequency curve, bar graph, pie chart.	2
	Measure of central frequency: Mean, median, mode, mean deviation, standard deviation, standard error	3
	Types of distribution of data: Normal, binomial, Poisson, Z-test, t-test and ANOVA. Correlation and regression.	3
II	Introduction, history, internet and bioinformatics, knowledge, discovery and data mining, problems faced in bioinformatics area, opportunities in bioinformatics, human genome project.	2
	Biological databases and their management: database concept, introduction, history of databases, databases management systems, types of database, Codd rules, data normalization biological databases – introduction, application and its importance, biological database and their functioning, types of biological database, microbiological database, primary sequence database, carbohydrate database, RNA database, genome database, organism database, biodiversity.	5
	Sequence database: Introduction, nucleotide sequence database, protein sequence database, the EMBL nucleotide sequence database, structure databases.	4
	Bioinformatics software: Clustal V Multiple sequence alignment, Clustal W Version 1.7, Ras Mol, Oligo, Mol script, TREEVIEW, ALSCRIPT, genetic analysis software, Phylip.	4

	Computational biology: Introduction, data mining and sequence analysis, database similarities searches, practical aspects of multiple sequence alignment, phylogentic analysis, predictive methods using nucleic acid and protein sequences, submitting DNA sequences to the databases.	**3**
III	General Introduction to metabolic pathways involved in microbial products, concepts of over production, primary and secondary metabolites, estimation of biomass.	**4**
	Media design and industrial cultures: Introduction, typical media, media formulation, energy sources, carbon and nitrogen source, other components, media optimization, sterilization. Rheological properties of medium.Screening for industrial useful metabolites, maintenance of stock cultures	**5**
	Types of fermenters and bioreactors: design, control system, operation, optimization, control and monitoring of variables such as temperature, agitation, pressure, pH, online measurements and control, Scale up of bioreactors. Biosensor	**3**
IV	**Microbial Growth Kinetics:** Batch culture, continuous culture, fed batch culture, the growth cycle, effect of nutrients, growth rate and cell cycle.	**3**
	Downstream processing (Recovery and purification of products) of biologicals: Separation of cells, foam separation, disintegration of micro organism, mechanical and non mechanical methods,flocculation, filtration, plate filters, rotary vacuum filters, centrifugation, Stoke's law, continuous centrifugation, basket centrifuge, bowl centrifuge, , membrane filtration, ultra filtration and reverse osmosis, chromatographic techniques, absorption, spray drying, drum drying, freeze drying.	**7**

III SEMESTER

COURSE TITLE: CLINCAL AND ADVANCED TECHNIQUE IN BIOTECHNOLOGY (SOFT CORE)

TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1-Underastand diagnosis of diseases using enzymes as markers

CO2-Learn the analysis of blood and urine sample to interpret the diseases

CO3-Study metabolic disorders and their diagnosis

CO4-Study clinical trials of designed drugs/biomolecules

CO5-Know tools of Histopathalogy, Immunotechnology, microarray and DNA chips in understanding the diseases

UNIT No.	CONTENT	Duration in Hrs
I	**Diagnostic Enzymology:** Mechanisms of elevated enzyme activities. Some important enzymes – alkaline phosphates, creatine kinase, LDH, AST, ALT – isozyme changes	4
	Blood: Composition, cells, functions of plasma proteins and lipo proteins in diseases. Disorders of hemoglobin – Thalassemia, sickle cell anemia. Anemias – Microcytic, normocytic and macrocytic.	4
	Advanced methods in clinical analysis: Blood, urine and quantitative determination of metal ions in body fluids	2
	Liver: Biochemical indices of hepatobiliary diseases. Bile pigments – formation of bilirubin, urobilinogen bile acids, jaundice – pre-hepatic, hepatic and post-hepatic; liver function tests, diseases of the liver – hepatitis, cholestasis, cirrhosis, Gallstones.	6
II	Kidney**: Assessment of renal function – creatine clearance, renal calculi, uremia, laboratory investigation of kidney disorders.**	2
	Cardiovascular Disorders: major cardio vascular system – Atherosclerosis – risk factors, pathogenesis. Diagnosis and prognosis	2
	Disorders of Amino Acid and nucleotide metabolism: Gout Lesch – Nyhan syndrome, orotic acid urea phenyl ketonuria, alkaptonuria, maple-syrup urine.	4
	Clinical trials of designed drugs/bio molecules. Molecular detection of diseases, Amniocentesis	

III	**Microscopy**: Phase Contrast Microscopy, Fluorescence Microscopy, Confocal and Inverted Microscopy), Electron Microscopy (Transmission Electron Microscopy, Scanning Electron Microscopy)	**4**
	Diagnostics and immunological techniques: applications of immunological and molecular diagnostic methods (RIA, ELISA, PCR, DNA finger printing) in forensic science and disease diagnosis. *In vitro* antigen-antibody reactions, Coombs' test, complement titration test (Direct and indirect), Immunoflourescence, Immuno-enzymatic and ferritin technique, Immuno-electromicroscopy. Immuno-electrophoresis, Western blot analysis. Hybridoma technology – Monoclonal and polyclonal antibodies and their application	**8**
IV	**Nanobio-technology:** Introduction, types and synthesis of nanomaterial, protein – based nano structures, DNA-based nano structures. Applications of nanomaterials, nano biosensors, drug and gene diversity, disease diagnostics, cancer therapy, risk potential of nanomaterials.	**6**
	DNA chip technology and micro arrays: Types of DNA chips and their production, hybridization, application of micro arrays on DNA chips.	**2**
	Genomic research: Methods for whole genome sequencing, genome sequence data, e-PCR, genome sequence to annotation- methods for annotation of genome sequence.	**4**

Reference Books

1. Biochemistry – With Clinical Correlations. Devlin.
2. Clinical Biochemistry. Latner.
3. Principles of Instrumental Analysis. 5th Ed. Douglas A Skoog, James Holler and Timothy A Nieman.
4. Analytical and Preparative Separation Methods of Biomacromolecules. Hassan Y Aboul – Enein.
5. Microbiology – Principles and Explorations. 5th Ed. Jacquelyn G Black.
6. Genetic Engineering: Primose, S. B.
7. An introduction to molecular Bio-technology (Ed.) Wink.
8. Principles of gene manipulation and genomics. Primose, S. B. and Twyman, R. M.
9. Gene cloning and DNA analysis an Introduction. Brown, T. A. Blackwell Science Company.
10. Molecular Biology and Biotechnology. Walker, J. M. and Rapley, R. Panima Publishing Corporation.
11. Molecular Biotechnology – Principles and application of Recombinant DNA. Glicks, R. Bernard and Pasternak, J. Jack. Panima Publishing Corporation.
12. Molecular Biomethods Hand Book. Rapley, R and Walker, M. Jhon. Humana Press.
13. Genes (VIII edition) Benjamin Lewin, Pearson Education International

III SEMESTER

COURSE CODE: BTC560
COURSETITLE: APPLIED BIOTECHNOLOGY (OPEN ELECTIVE)
TOTAL DURATION: 48Hrs

Course Outcome:
After studying this course, the students are able to:
CO1-Give an overview on basic concepts and applications of Biotechnology
CO2-Study the applications of enzymes, bio-fertilizers and biosensors.
CO3- Study the Application of genetic engineering in animal and plant cell culture.
CO4–Learn the uses of fermentation processes to produce secondary metabolites
CO5-Give an insight to the field of biotechnology to the students who have studied non-cognate subjects in their undergraduates.

UNIT No.	CONTENT	Duration in Hrs
I	**Scope of Biotechnology in India and Karnataka.**	8
	Enzyme Biotechnology Introduction to application of enzymes in industry: Food & beverage, detergent, textile pharmaceutical and leather. **Commercial production of enzymes:** General considerations, regulation of enzyme production by microbes, genetic engineering for microbial enzyme production, enzyme engineering, large-scale purification. **Immobilized enzymes and cells:** Methods, properties and stabilization of immobilized enzymes and cells, enzyme reactors, application – manufacture of commercial products, and analytical applications. **Biosensors:** Types- Electrochemical, Thermometric, Optical, Piezoelectric, Whole cell, immunobiosensors, applications	4
	Seed Health Technology Introduction: Importance of Seed health, important seed-borne diseases; Seed Health diagnostics; Management of seed-borne diseases.	
II	**Plant Cell Culture Technology** Landmarks in Plant Cell culture and different areas of Applications in Plant tissue culture. Micropropagation: Methods and stages, applications **Somatic embryogenesis:** Induction and development, synthetic seeds. Application of somatic embryogenesis Haploid Production: Techniques, factors, androgenesis, applications and limitations	8

Protoplast culture and somatic hybridization: Isolation and culture of protoplasts, protoplast fusion and somatic hybridization. **6**

Production of secondary metabolites: Induction, Processes, Biotransformation, Bioreactor system and model for mass cultivation of plant cells.

Germplasm storage: Long term storage and short term storage.

III **Animal Cell Culture Techniques** **10**

Tissue culture laboratory: Advantages and limitations of tissue culture, types of tissue culture, equipment, aseptic and sterile handling, general safety, choice of culture vessel, media, preparation and sterilization of media, serum free media.

Animal Cell Culture: Primary culture, cell lines, cloning and selection, contamination management, cryopreservation, quantitation of cells, cytotoxicity assays.

Specialized Cells: different cell types used, development of cell lines,selective culture, specific tumor types.

IV **Microbial Pesticides and Biofertilizers** **12**

Biopesticides: Introduction, Isolation, Identification, Mode of action, Characterization, Strain variability, Mass production Technology, formulations, and Methods of applications.

Biofertilizers: Importance of biofertilizers, Microorganisms used as biofertilizers, Methods of Application, Mass production, and Commercial importance.

Food Biotechnology – Genetically modified foods, Nutraceuticals, detection of genetically modified foods. Wine preparation.

Reference Books

1. Biotechnology. B. D. Singh
2. Biotechnology. R. C. Dubey

IV SEMESTER

COURSECODE: BTD010
COURSE TITLE: PLANT BIOTECHNOLOGY (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1-Learn designing of plant tissue culture laboratory and media preparation

CO2-Undestand micropropogation of economically important and endangered species, and production of secondary metabolites

CO3-Study different methods of plant breeding techniques

CO4-Understand development of transgenic plants as bioreactors

CO5-Understand GM plants for sustainable agriculture and IPR.

UNIT No.	CONTENT	Duration in Hrs
I	**Cell and Tissue Culture Technology:** Role of hormones in growth and development of plants, tissue-specific hormones. Callus Induction, Organogenesis, Somatic embryogenesis, cell suspension culture and synthetic seeds	4
	Micropropagation: Propagation from pre-existing meristem, shoot apical meristem, shoot and node culture, micropropagation stages and applications.	4
	Commercial laboratory production: The facility, process- stock plant preparation, production scheduling.	6
	Germplasm preservation: Preservation of seed-propagated species, preservation of pollen, preservation of vegetatively propagated species, pre-treatment of plant and propagule, cryopreservation, cryoprotectant, warming rate and recovery, gene banks, applications.	
II	**Haploid Technology**: Methods of haploid culture, Factors affecting anther and microspore cultures, applications.	2
	Protoplast Technology: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, applications of somatic hybrids/ cybrids.	6
	Secondary metabolite production: Induction of secondary metabolites by plant cell culture, technology of plant cell culture for production of chemicals, biotransformation using plant cell culture. Bioreactor systems and models for mass cultivation of plant cells.	
III	**Seed Biotechnology**	6
	Seed development and structure: Flower formation, production and development of the male and female gametophytes, pollination, fertilization, and formation of the zygote; Molecular basis of embryogenesis, post-embryonic vegetative development, seed structure and composition, genetic	

determinants of seed structure.

Hybrid seed production technology: Variability and its conservation in crop plants, Mode of reproduction in relation to plant breeding, breeding systems, controlling pollination, genetic principles, qualitative and quantitative traits, gene action, genotype environment interaction, different methods of breeding for self and cross pollinated crops, plant introduction and acclimatization, wide crosses, male sterility, apomixes, polyploidy. **4**

IV Transgenics **6**

Plant transformation techniques: Methods of gene transfer in plants, *Agrobacterium* mediated transfer- mechanism of DNA transfer, general features of Ti and Ri plasmids, role of *vir* genes, design of expression vectors, use of promoters and reporter genes; viral vectors, direct gene transfer methods- electroporation, microinjection, particle bombardment, selection of transformants, screening and field trials.

Transgenic plants: Herbicide resistance, resistance against biotic stress-bacterial, viral, fungal and insect resistance, abiotic stress, improved crop productivity, improved nutritional quality, transgenic plants for floriculture, Qualitative trait loci and marker studies. **4**

Molecular farming: Transgenic plants as production systems-production of alkaloids, steroids, colouring agents, flavoring agents, biodegradable plastics, industrial enzymes, therapeutic proteins, biopharmaceuticals, edible vaccines, plantibodies. **4**

Intellectual Property Rights (IPR): IPRs and agricultural technology-implications for India, WTO, WIPO, GATT, TRIPS. Plant Breeder's Rights, legal implications, commercial exploitation of traditional knowledge, protection. Ethical issues associated with consumption of GM food, labelling of GM crops and foods. **2**

Reference Books

1. Plant Signal Transduction. Scheel D and Wasterpack C. Oxford University Press.
2. Introduction to Plant Pathology. Strange R N. John Wiley and Sons Ltd.
3. Applied plant virology. Walkey. Chapman and Hall London.
4. Molecular Plant Pathology by Agrios.
5. Plant Tissue Culture Concepts and Laboratory Exercise. Trigiano R. N. and Gray, D. L. CRC Press.
6. Plant Tissue culture – Supplement-7. Lindsey, K. Springer International Edition.
7. Introduction to Plant Tissue Culture. Razdon, M. K. Oxford and IBH Publishing Co. Pvt Ltd.
8. Introductory to plant physiology. Noggle, R., Fritz, J. G. Prentice Hall of India Pvt. Ltd.
9. Plant Molecular Biology – A Practical Approach. Shaw, C. H. Panima Publishing Corporation.
10. A Laboratory Manual of Plant Biotechnology. Purohit. Publisher Agrobios.
11. Introduction to Plant Biotechnology. Chawla, H. S.
12. Practical Application of Plant Molecular Biology. Henry, R. J. Chapman and Hall.
13. Plant Biotechnology – Laboratory manual. Chawla, H. S. Oxford and IBH publishing Co. Pvt. Ltd.
14. Biotechnology. Gupta, P. K. Rastogi Publications.

15. Biochemistry and Molecular Biology of Plants. Buchanan, Gmissem and Jones.
16. Genetic Engineering of Crop Plants. Lyrett, G. W., Grierson, D.
17. Plant Molecular Biology. Grierson and S. N. Covey.
18. Bajaj Series Books. Vol 1 – 14.

IV SEMESTER

COURSE CODE: BTD020
COURSE TITLE: ANIMAL BIOTECHNOLOGY (HARD CORE)
TOTAL DURATION: 48Hrs

Course Outcome:

After studying this course, the students are able to:

CO1-Learn designing of animal cell culture laboratory, principles of different equipments used in the lab

CO2-Understand Biosaftey

CO3-Learn preparation of media, culturing of cell lines

CO4-Understand different types of bioreactors

CO5-Study tissue engineering

CO6-Learn methods of production of transgenic animals – methods of gene transfer, IVF and bioethics.

UNIT No.	CONTENT	Duration in Hrs
I	**Culture of animal cells:** Advantages and limitations of tissue culture, aseptic handling, facilities required, media and cell lines.Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation, immoretalization of cell lines, cell line designation, selection of cell line and routine maintenance.	**6**
	Cloning and Selection: Cloning protocol, stimulation of plating efficiency, suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate, selective inhibitors.	**4**
II	**Cell separation and characterization**: Density based, antibody based, magnetic and fluorescence based cell sorting. Characterization of cells based in morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation.	**6**
	Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad and tumor cells, Lymphocyte preparation, culture of amniocytes, fish cells, confocal microscopy. Stem cell culture and its applications	**6**
	Organic and embryo culture: Choice of models, organ culture, histotypic culture, filter-well inserts, neuronal aggregates whole embryo culture eggs, chick and mammalian embryos.	**4**

III	**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. Hemoglobin based blood substitutes, bio antificial or biohybrid organs. Limitations and possibilities of tissue engineering.	**6**
	In vitro* fertilization and Embryo transfer:In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animals e.g: Cow.	**4**
	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, monkeys, mice, pets, goats and pigs. 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.	**6**
IV	**Transfection methods and transgenic animals**: Gene transfer or transfection, transfection of fertilized eggs or embryos, unfertilized eggs, cultured mammalian cells, targeted gene transfer. Transgenic animals and applications: mice and other animals, sheep, pigs, goats, cows and fish. The legal and socio-economic impact of biotechnology at national and international levels, public awareness. Biosafety regulations- guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms	**6**

Reference Books

1. Anthony Atala, Robert P Lanza. 2002, Methods of tissue engineering, Academic press
2. Ian Freshney R. 2005, Culture of animal cells–A manual of basic techniques, John Wiley and Sons Inc. Hoboken, New Jersey
3. Animal Cell Culture – A Laboratory Manual. Frushney.
4. Animal Biotechnology. Ballinic, C. A., Philip, J. P and Moo Young, M. Pergamon Press.
5. Genetic Engineering of Animals. Puhler, A. VCH Publisher.
6. Methods of Tissue Engineering. Anthony Atala, Robert P. Lanza.
7. Animal Cell Biotechnology – Methods and Protocols. Nigel Tenkins.

Dissertation (includes Research Paper Presentation)
Course code: BTD030

Course Outcome:
After studying this course, the students are able to:
CO1-Know review of recent research articles published in high impact journals and presentation by students.
CO2-Conduct review of literature followed by hands on training to do piece of research work.
CO3-Understand the experiment and interpret the result.
CO4-Get an idea to compile the data and present in the form of dissertation.

BTA000

JSS COLLEGE OF ARTS, COMMERCE & SCIENCE
(Autonomous) Ooty Road, Mysore- 25
M. Sc. Bio-technology
I/II/III/IV Semester Examination-
Title of the Paper -

Time : 3 Hours **Max.Marks: 70**

Instructions to candidates:1) Answer questions from all Sections
2) Illustrate the answer wherever necessary

Part-A

I. Define/ Write briefly on any Five of the following. 5X2=10

1.
2.
3.
4.
5.
6.
7.

Part – B

II Answer any four of the following. 4X6= 24

8.

9.

10.

11.

12.

13.

Part-C

III Answer any Three of the following. 3X12=36

14.

15.

16.

17.

18.

JSS College of Arts, Commerce and Science (Autonomous)
Ooty Road, Mysore-570025
Postgraduate Department of Bio-technology
M.Sc., Biotechnology – I/II/III Semester
Practical Examination
Paper code-BTB------- (A/B)
Batch-I/II/III

Time: 4 Hours **Max. Marks: 35**

I		**3**
II	a. **(For odd numbers)**	**16**
	b. **(For even numbers)**	
III		**8**
IV		**8**