DEPARTMENT OF BIOTECHNOLOGY
S.V.U. COLLEGE OF SCIENCES
SRI VENKATESWARA UNIVERSITY: TIRUPATI

RESTRUCTURED CURRICULUM FOR
M.Sc. BIOTECHNOLOGY PROGRAMME
TO BE IMPLEMENTED WITH EFFECT FROM
THE ACADEMIC YEAR 2021-2022

SYLLABUS
Choice Based Credit System (CBCS)

(New Syllabus as per NEP-2020)

M.Sc. Biotechnology programme CBCS pattern (with effect from 2021-2022)

Vision:

The vision is to become a leader and centre of excellence in technology based training and innovative research in the fields of Plant, Agriculture, Animal and Medical Biotechnology.

Mission:

The Department's academic and research programmes will provide the students and research scholars value based, technology oriented education in a trusting and caring environment. The faculty strive to equip the students with technical expertise and knowledge to keep pace with the changes in technology and meet the new challenges in Life Sciences.

Programme Objectives

1. Students will gain necessary knowledge and develop specialized skills in the different areas of Biotechnology.
2. Students will think critically and creatively about the use of biotechnology to address local and global problems.
3. Students will be able to implement the scientific skills for development of industrial applications and entrepreneurship

Programme Outcomes, Programme Specific Outcomes and Course Outcomes
Programme Outcomes

Upon completion of the M.Sc. Biotechnology programme, the candidate should be able to:

No.	Programme Outcomes
PO1	Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies & Academia.
PO2	Develop an ability to solve, analyze and interpret data generated from experiments done in project work or practical courses in reaching conclusions.
PO3	Apply the knowledge based on research and other related methods to investigate the problem and provide valid conclusions
PO4	Design and develop methods to measure experimental data by following ethical principles
PO5	Demonstrate skills to use modern analytical tools/ software/ equipments to design & develop experiments and analyze and solve problems in various courses of biotechnology.
PO6	Appreciate and execute their professional roles in society as biotechnology professionals, employers and employees in various industries, regulators, researchers, educators and managers.
PO7	Augment and demonstrate the knowledge acquired to address environmental issues and evolve methods for sustainable development
PO8	Adopt code of ethics in professional and social context and demonstrate exemplary professional, ethical and legal behaviours in decision making.
PO9	Execute responsibilities efficiently in solving different issues as an individual/ member of team/ team leader
PO10	Apply written and oral communication skills to communicate effectively in healthcare, industry, academia and research
PO11	Acquire basic and advance skills in in various fields of biotechnology for self-employment and entrepreneurship
PO12	Develop skills, attitude and values required for self-directed, lifelong learning and professional development.

Programme Specific Outcomes (PSOs):

- Students will be able to demonstrate and apply their knowledge of cell biology, biochemistry,microbiology and molecular biology to solve the problems related to the field of biotechnology.

- Postgraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design, analysis, optimization and simulation of bioprocess operations.
- Students will be able to gain fundamental knowledge in animal and plant biotechnology and their applications.
- Students will be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b)how to seek; c) why to seek?
- Student will be able to (a) Describe fundamental molecular principles of genetics; (b) Understand relationship between phenotype and genotype in human genetic traits; (c) Describe the basics of genetic mapping; (d) Understand how gene expression is regulated.
- Students will be able to (a) To elaborate concepts of biochemistry with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.
- Students will be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
- Students will be able to gain hands on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research

SRI VENKATESWARA UNIVERSITY
SVU COLLEGE OF SCIENCES, TIRUPATI
M.Sc. Biotechnology programme
Amended as per NEP – 2020
(With effect from the batch admitted in the academic year 2021-22)
CHOICE BASED CREDIT SYSTEM (CBCS)

Semester –I

S. No.	Components of the Study	Title of the course	Title of the paper	Credit Hrs/ Week	No. of credit	IA Marks	Sem End Exam Marks	Total
1	Core	BTH 101	Structure and Functions of Biomolecules	6	4	20	80	100
2	Core	BTH 102	Advanced Tools and Techniques	6	4	20	80	100
3	Compulsory Foundation	BTH 103a	Microbiology and diseases	6	4	20	80	100
		BTH 103b	Microbial physiology & Genetics					
4	Elective Foundation	BTH 104a	Cell biology and genetics	6	4	20	80	100
		BTH 104b	Molecular Genetics					
5	Practical -I	BTH 105P	Bio-molecules and Advanced Tools and Techniques	6	4	--	--	100
6	Practical - II	BTH 106P	Microbiology and Cell Biology	6	4	--	--	100
	Total			36	24	120	480	600
7	Audit course	BTH 107	Human Values& Professional ethics	0	0	100	0	0

Semester - II

S. No	Components of the Study	Title of the course	Title of the paper	Credit Hrs/ Week	No. of credit	IA Marks	Sem End Exam Marks	**Total**
1	Core	BTH 201	Enzymes and Intermediary Metabolism	6	4	20	80	100

2	Core	BTH 202	Molecular Biology	6	4	20	80	100
3	Compulsory Foundation	BTH 203a	Immunology	6	4	20	80	100
		BTH 203b	Cancer Biology					
4	Elective Foundation	BTH 204a	Research Methodology, Biostatistics and Bioinformatics	6	4	20	80	100
		BTH 204b	Biostatistics					
5	Practical -I	BTH 205P	Enzymology, metabolism and Molecular Biology	6	4	--	--	100
6	Practical - II	BTH 206P	Immunology, Biostatistics and Bioinformatics	6	4	--	--	100
	Total			36	24	120	480	600
7	Audit course	BTH 207	Human Values& Professional ethics	0		0	100	0

Semester - III

S. No	Components of the Study	Title of the course	Title of thepaper	Credit Hrs/ Week	No. of credit	IA Marks	Sem End Exam Marks	Total
1	Core	BTH 301	Genetic Engineering	6	4	20	80	100
2	Core	BTH 302	Food and Industrial Biotechnology	6	4	20	80	100
3	Generic Elective	BTH 303a	Bioprocess Engineering and Technology	6	4	20	80	100
		BTH 303b	Legal, Ethical and Implications of Biotechnology					
		BTH 303c	Emerging technologies in Biotechnology					
4	Practicals	BTH 304 P	Genetic Engineering, Food and Industrial Biotechnology	6	4	--	--	100
5	Skill Oriented Course	BTH 305	Plant Tissue Culture	6	4	10	90 (40+50)	100
6	Open Elective	BTH 306a	Bioethics	6	4	20	80	100
		BTH 306b	Bioinformatics					
	Total			36	24	120	400	600

Semester – IV

S. No	Components of the Study	Title of the course	Title of the paper	Credit Hrs/ Week	No. of credits	IA Marks	Sem End ExamMarks	Total
1	Core	BTH 401	Environmental Biotechnology	6	4	20	80	100
2	Core	BTH 402	Plant Biotechnology	6	4	20	80	100
3	Generic Elective	BTH 403a	Animal Biotechnology					
		BTH 403b	Applications of Biotechnology					

		BTH 403c	Pharmaceutical Biotechnology	6	4	20	80	100
4	Practicals	BTH 404P	Environmental Biotechnology, Plant Biotechnology	6	4	--	--	100
5	Multi-Disciplinary Course/ Project Work	BTH405	MOOCS/Project	6	4	--	--	100
6	Open Elective	BTH 406a	Applications of Biotechnology	6	4	20	80	100
		BTH 406b	Tools in Biotechnology					
	Total			36	24	120	400	600

Semester – I

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 101	**Structure and functions of Biomolecules**	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To explore the knowledge and awareness of the basic principles and concepts of Biomolecules.
2. To acquaint the classification of carbohydrates, proteins, lipids and nucleic acids
3. To know the characteristic features of biomolecules
4. To understand the structure and functions of biomolecules

UNIT-I

Chemistry of carbohydrates - Definition and classification of carbohydrates. Outlines of structures and properties of important mono- (Glucose & Fructose), di- (Lactose, Sucrose, Maltose) and polysaccharides (Starch, Glycogen, Cellulose, Chitin). Physical and Chemical reactions of carbohydrates. Analysis of carbohydrates- Qualitative and Quantitative.

UNIT-II

Chemistry of amino acids and proteins - Classification of amino acids, Structures of amino acids, Chemical reactions of amino acids. Peptide bond - Nature of peptide bond, pi/φ rotation. Ramachandran plot, Secondary structure predictions, helices and beta-sheets, Determination of primary structure. Proteins and their classification, properties of proteins, determination of amino acid sequences (N and C terminus) Tertiary/quaternary structure of proteins (myoglobin/ hemoglobin model). Structural organization of proteins - Outline structures and biological functions. Protein folding and significance.

UNIT-III

Chemistry of lipids - Classification of lipids, Properties of lipids, Outline structures of saturated and unsaturated fatty acids, fats and waxes, phospholipids, glycolipids, cholesterol, prostaglandins, leukotrienes. Lipids as signaling molecules. Structure and functions of, heterocyclic molecules, porphyrins and vitamins.

UNIT-IV

Chemistry of nucleic acids - Structure of purines and pyrimidines, modified bases nucleosides and nucleotides; Properties of nitrogen bases and nucleotides, Structure, variation and properties of DNA and RNA. DNA denaturation and renaturation kinetics, Determination of DNA complexity, Hyperchromacity, Tm, cot curves and their significance.

Reference Books

1. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
2. Rodwell, V., Bender, D., Botham, K. M., Kennelly, P. J., & Weil, P. A. (2015). Harpers illustrated Biochemistry (30th ed.). McGraw Hill Professional.
3. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
4. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

Course outcomes:

The student will be able to

1. Understand the classification of carbohydrates and their biochemical functions.
2. Correlate the reactions of amino acids that are basis for identification tests and biochemical pathways.
3. Know the structure of different classes of lipids and their roles in biological systems.
4. Comprehend the structure and functions of nucleic acids

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	-	-	1	-	1	1	1	-
CO2	3	3	2	1	2	-	1	-	1	1	1	-
CO3	2	2	2	1	-	-	1	-	1	1	1	-
CO4	3	2	3	2	-	-	1	-	1	1	1	1

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 102	Advanced Tools and Techniques	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To impart knowledge about the various analytical and biophysical techniques.
2. To make the student to be able to carry out purification and characterization of various biomolecules.
3. To educate the student to characterize the separated biomolecules by electrophoresis and spectroscopic techniques.
4. To familiarize with the concepts and the techniques of Radioactivity

UNIT-I

Isolation techniques - Cell disruption techniques - sonication, french press, enzymatic, non-enzymatic techniques. Isolation of proteins - salting in/out, ammonium sulphate fractionation. Nucleic acids - polar solvents precipitation. Lipids - extraction by differential solubility. Concentration of macromolecules flash evaporation, lyophilization, pressure dialysis, reverse dialysis, hollow fiber membrane filters and reverse osmosis. Microscopic studies (principles and applications): Light, compound, phase contrast, confocal and SEM and TEM.

UNIT-II

Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC. Basic principles of sedimentation, Types of centrifuges -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods. General principles of electrophoretic techniques. Poly Acryl amide Gel Electrophoresis. Isoelectric focusing. Isotachophoresis. 2-D Electrophoresis. Capillary electrophoresis. Agarose gel electrophoresis of DNA and RNA. Blotting techniques. DNA fingerprinting.

UNIT-III

Electromagnetic spectrum of light. Principles, instrumentation and applications of UV-Visible, infrared, Raman, fluorescence, flame photometry, atomic absorption, plasma emission, ESR, ORD, CD, NMR spectroscopy. Spectrofluorimetry and mass spectrometry, X-ray diffraction. Flow cytometry.

UNIT-IV

Radioisotope tracer techniques - Nature and types of radioactivity, Preparation of labeled biological compounds. Labeling of carbohydrates (C^{14} acetate), proteins (S^{35} methionine, I^{125} aminoacid) and nucleic acids (P^{32} dATP). Detection and measurement of radioactivity. Autoradiography, Biological uses of radioisotopes, Safety guidelines.

Reference Books

1. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
2. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
3. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
4. Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath (Himalaya publishing).

Course outcomes:

The student will be able to

1. Learn about various techniques for isolation and concentration of macromolecules. They will also understand the principles and applications of different Microscopes
2. Understand the techniques of chromatography, centrifugation and electrophoresis
3. Achieve a basic understanding of characterization of biomolecules by different Spectroscopic techniques
4. Familiarize with the various radioisotope tracer techniques and their role in biology. Eventually they learn safety measures in handling radio-isotopes.

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	1	3	1	3	3	1	2
CO_2	3	3	2	2	2	1	3	1	3	2	1	1
CO_3	3	3	2	3	2	1	2	1	3	3	1	1
CO_4	3	3	2	2	2	1	2	2	3	3	1	1

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 103a	Microbiology and diseases	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course objectives:

1. To impart the knowledge on discovery and classification of microorganisms
2. To develop understanding on microbial nutrition, cultivation and growth pattern of microorganisms
3. To understand the concept of gene and its transfer mechanism in microbes.
4. To know about viral, bacterial, fungal and protozoan diseases in plants and animals

UNIT - 1: Introduction to Microbiology

Discovering the microbial world. Classification of microorganisms up to order level - bacteria, algae, fungi, protozoa.

Structure of prokaryotic and eukaryotic microorganisms. General and distinctive characteristics of the major groups of microorganism bacteria, mycoplasma, chalmidae, rickettsias, actinomycetes, fungi, algae, protozoa Prions and viruses.

Isolation, cultivation and enumeration of microorganisms - direct and indirect methods, Maintenance of culture.

Outlines of characterization and identification of common bacteria, fungi, algae and protozoa.

UNIT - II: Microbial nutrition, growth and regulation

Nutritional requirements to microorganisms - Mode of nutrition - phototrophy, chemotrophy - methylotrophy organotrophy, mixotrophy, saprophytic, symbiotic and parasitic, Interaction of microbes. Growth of microorganism (bacteria) - normal and biphasic growth curve, batch and continuous cultures, chemostats, shift up and shift down. Growth determination, Microbial metabolism - energy yielding and energy requiring processes. Control of microorganisms - principles, physical and chemical agents, Assay of antimicrobial action. Batch and continuous sterilization .of media and air. Viruses - nature, cultivation and assay methods, structure, physico-chemical properties, classification, pathogenicity, Replication of viruses. Microbes of biotechnological importance - examples of bacteria, yeast, algae and viruses.

UNIT-III: Microbial Genetics

Chemical nature of gene, Concept of gene, operon, mosaic genes/split genes. Plasmids incompatibility. Classification: copy number, control and its significance. Structure and functions of insertion elements (IS) - transposable elements. Mechanism of transposition.

Catabolic transposons and their significance. Horizontal transfer of genome among the microbial community - transformation, conjugation transduction - generalized transduction, specialized transduction - cotransduction. Benzer's classical studies on II locus. Cistron complementation - Elucidation of co-linearity between DNA and protein sequence. Genetics of viruses – bacteriophage, lambda, SV 40, retroviral genome (HIV), replication, lytic and lysogenic cascades.

Unit IV: Diseases caused by microorganisms

Viral diseases: Flu, Dengue fever, Hepatitis, Bacterial diseases: Cholera, tuberculosis, anthrox, Fungal diseases: Athlets foot, Dutch Elm disease, ergotism, Protozoa diseases (Protoctista): Malaria, Sleeping sickness, dysentery and Plant Pathogens: TMV, Rust

REFERENCES:

1. Microbiology: concepts and Applications. Michael J. Pelczar, Jr., E.C.S., Chan, Noel R. Krieg, 1993. Me. Graw Hill, Inc.
2. Introductory Microbiology. 1995, by Trevor Gross.
3. Fundamentals of Microbiology. 4ltled. 1994. I.E.AIcamo. Scientific Publication,
4. Microbiology, 1990. 4th Ed.B.D. Davis, R. Dulbeco, H.N. Eisen and H.S. Ginsberg and J.B. Lippincott Company.
5. Fundamental Principles of Bacteriology. 1994. A.J. Sake. Tata McGraw Hill.
6. Laboratory Experiments in Microbiology. 3rd ed. Brief Version. 1992. T.R. Johnson and C.L. Case. Addision Wesley International Publications. PP 350.
7. Microbiological Applications: A Laboratory Manual in General Microbiology. 5lh ed. 1990. H.J. Benson. Panima Publications. PP 459.
8. Microbes in Action: A Laboratory manual of Microbiology. 4'hed. 1991. H.W. Seeley, Jr. P.I. Van Denmark and J.J. Lee., W.H. Freeman and Co. New York, PP 450.
9. Microbiology: Concepts and Applications. 1988, P.A. Ketchum. Wiley Publication, New York.
10. Manual of Clinical Microbiology. 5lfl ed. 1991. A. Balows. Ed. American Society of Microbiology, PP 1, 364. Practical Course
11. Sherman, N.B.D. A guide to the identification of the Genera of Bacteria.
12. Bergey's Manual of Determinative Bacteriology.
13. Industrial Microbiology by Cassida

Course outcomes:

The student will be able to

1. Acquire the knowledge on classification and structure of different microorganisms
2. Understand the microbial techniques for isolation, cultivation and maintenance of pure cultures
3. Learn structure, function of gene and its transfer methods
4. Develop understanding on cause, spread and control of diseases caused by different microorganisms

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}

CO_1	3	3	3	3	2	1	3	2	1	1	2	1
CO_2	3	2	3	3	3	2	3	1	2	3	3	3
CO_3	3	2	3	1	3	2	3	2	2	2	2	2
CO_4	3	3	3	2	2	3	3	3	3	3	3	2

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 103b	Molecular Plant physiology	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

This course enables the students to:

1. To understand about photosynthesis and detailed mechanism involved in the CO2 fixation by plants
2. To learn about Respiration and photorespiration
3. To impart knowledge about the structure and functionality of chloroplast protein and their encoding genes.
4. To know molecular mechanism of plant hormones action and molecular aspect of growth and development processes

Unit 1: Photosynthesis**:** Anatomy of chloroplasts, photosynthetic pigments, Structure of photosystems I and II and their coding genes, Molecular oxygen evolving complex, Photolysis of water; mechanisms of electron transport; Calvin cycle and its light/dark regulation. RuBisCO activities, C3, C4 and CAM pathways.

Unit 2: Photorespiration and Respiration: Photorespiration, Gross and net photosynthesis, Glycolysis, Citric acid cycle; Electron transport and ATP synthesis; Pentose phosphate pathway, Mitochondrial ATP synthase, Engineering or genetic modification of photorespiration

Unit 3: Photo morphogenesis: Molecular structure of phyto chrome, Photo conversion, Nuclear translocation of Pfr and modification of gene expression, Family of PHY genes and multiplicity of responses. Structure and function of Cryptochromes. Photoperiodism and biological clocks.

Unit 4: Plant Hormones: Overview about various plant hormones, Molecular mechanism of plant hormones action, Hormone receptors and signal transduction, Gene expressions at developmental stages and stresses, Phytohormone signalling in plant defense mechanism, Cross-talk and molecular aspect of growth and development processes.

Book Recommended:

TEXT BOOK:

1. Plant Physiology, 5th Edition by Lincoln Taiz and Eduardo Zeiger, Sinauer Associate (2010). ISBN: 978-0878938667

2. Plant Physiology, 4th Edition, by Salisbury F. B. and Ross C. W. (2004), Wadsworth Publisher, ISBN: 9788131501658, 8131501655

REFERENCE BOOK:

1. The Molecular Life of Plants by Russell L. Jones, Helen Ougham, Howard Thomas, Susan Waaland (2012) Wiley-Blackwell. ISBN: 978-0-470-87011-2

2. Plant Hormones under Challenging Environmental Factors by Ahammed, Golam Jalal, Yu, Jing-Quan (2016) ISBN 978-94-017-7758-2

Course Outcomes:

The student will be able to

1. Explain the detailed characteristics of chloroplast and mechanism of photosynthesis
2. Engineer photorespiration as well as apply other approaches to increase plant biomass
3. Gain the proficient knowledge about structure and functionality chloroplast protein and encoding genes as well as hormonal response on plants
4. Correlate phytohormone signalling in plant defense mechanism

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	2	-	3	-	1	-	1	-
CO_2	2	2	3	1	2	-	3	-	1	-	1	-
CO_3	2	2	1	1	2	-	3	-	1	-	1	-
CO_4	3	3	3	3	2	2	1	-	1	1	-	-

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 104a	Cell Biology and Genetics	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course objectives:

1. To know the structure and functions of prokaryotic and eukaryotic cells and understand cell membrane composition and its functions
2. To impart knowledge on organization of genetic material
3. To develop understanding on mechanism of cell division and chromosomal abnormalities
4. To gain awareness on Mendelian genetics and role of mutations in evolution

UNIT -1: Cell and Cell membrane composition

Organization of prokaryotic and eukaryotic cell. Plasma membrance - Molecular organization, current model and function, Cytoskeleton - microtubules, cilia and flagella, Structure and function of cytoskeleton. Structure and function of endoplasmic reticulum, Golgi apparatus, Structure and function of lysosomes, peroxisomes. Structure and function of mitochondria and chloroplast.

UNIT - II: Nucleus and Chromosome organization

Nucleus - structure and function of nuclear membrane, nucleolus. Eukaryotic chromosome and its high resolution organization, DNA-histone interactions - formation of chromatin fibers - Hetero/Eu chromatin - structural transition - Histone-H1-significance in regulation of expression. Polytene and lamp brush chromosomes.

UNIT - III: Cell division and chromosomal variations

Mechanism of cell division - mitiotic apparatus, cytokinesis, chromosome movement - present concept – Regulation of eukaryotic cell cycle - Over view of cell cycle. Mutation causing cell cycle control. Meiotic process - stages, chromosome pairing, chiasma formation molecular mechanisms of recombination, synaptonemal complex. Nondysjunction, Chromosomal abnormalities - euploidy, haploidy - their fundamental and practical significance. Polypliody - induction - Aneuploidy - type and genetic significance. Tumor biology - cell to cell interaction, cell adhesion, cell transformation mechanism and oncogenesis.

UNIT IV: Principles of genetics

Mendelian genetics, Linkage and gene mapping, Quantitative genetics and problems, Hardy Weinberg Law, Sex chromosomes and sex determination. Inbreeding, Mutagenesis - Types of mutations, mutagens, Molecular mechanisms of mutations, Spontaneous, induced mutations, reversion, suppression, and analysis of mutants. Role of mutagenesis in evolution, chromosomal deletions, duplications, inversions.

REFERENCES:

1. Cell Biology - De Robertes & De Robertes
2. Cell and Molecular Biology -Baltimore.L
3. The cell - Hooper
4. Cell and Molecular Biology - P.K.Gupta
5. Cell Biology- Verma and Agarwal
6. Cell Biology- Rastogi
7. Cell Biology-twyn

Course outcomes:

The student will be able to

1. Differentiate prokaryotic and eukaryotic cell
2. Understand the organization of genetic material in lower and higher organisms
3. Appreciate the mechanism of mitotic and meiotic process and identify the abnormalities
4. Understand the molecular mechanisms of mutations and its importance in in evolution

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	3	-	2	1	2	1	1
CO_2	3	3	3	3	3	3	-	2	1	2	1	-
CO_3	3	3	3	3	3	3	3	2	3	2	3	3
CO_4	3	3	3	3	3	3	2	2	3	2	-	3

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 104b	Molecular Genetics	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course objectives:

1. To know the Principles of Segregation
2. To impart knowledge on sex determination in drosophila, birds, man
3. To develop understanding on modern concept of gene and transposons
4. To gain awareness on mechanism of genetic transfer in bacteria

UNIT – I: Recapitulation of Mendelian Principles

Principles of Segregation; Laws of inheritance dominance, recessiveness, laws of segregation, Dihybrid and trihybrid ratios- laws of independent assortment-test cross and back cross. Incomplete dominance- eg: flower colour, chromosomal theory of inheritance.

Extension to Mendel's laws- Multiple allelism eg. Coat colour in rabbits, eye colour in drosophila, ABO blood groups, incompatibility and pseudoallelism

UNIT-II: XY-chromosomes

Sex determination in drosophila, birds, man. X-linked inheritance, haemophilia, colour blindness, Y-linked inheritance- holandric genes. Mechanisms of sex determination – Simple Mechanisms, The balance concept of Sex determination. Mosaics and Gynandromorphs. Sex differentiation. Sex-influenced dominance; Sex-linked inheritance- Morgan's discovery of sex linkage in drosophila. Patterns of inheritance of Sex-linked genes.

Unit- III: Gene as a unit of expression

Modern concept of gene, co-linearity of gene and polypeptide, types of genes (constitutive, structural, regulatory, luxury, overlapping, split genes etc.,)

Biology of plasmids: Types of plasmids, incompatibility grouping, control of copy number replication of Col E1 and F plasmid.

Transposons: Transposable elements in prokaryotes and eukaryotes, types of bacterial transposons - insertional sequences, complex transposons, Mechanisms of transposition (Replicative and Non replicative), Transposable viruses and retroposons. Complex

transposons-Tn10, Tn5, Tn9 and Tn3 as examples. Mechanisms, control consequences and applications of transposition by simple and complex elements.

UNIT-IV: Mechanism of genetic transfer in bacteria

Transformation, Transduction, Conjugation. Mapping of bacterial chromosome. Genetic recombination in bacteria, models and mechanism, role of rec A proteins.

Homologous Recombination, Holiday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination, Rec A and other recombinases.

Viral genetics: Organisation of genome in Lambda, T4 phage, φx174 and M13.

References

1. Benjamin Lewin. Gene VII. Oxford University Press, U.K., 2000
2. William H Elliott and D C.Elliolt., Biochemistry & Molecular biology, Oxford
3. S.R. Maloy, J.E. Cronon, and D. Freifelder., Microbial Genetics Jones & Bartlet 1996.
4. Streips U.N. and Yasbin R.E , Modern Microbial Genetics. Wiley-liss, 1991.
5. Stent G.S.Calender R., Molecular Genetics. CBS publishers, 1986.
6. E.J.Gardner,D.P.Simmons,M.J.Snustad, Principles of Genetics , 8th ed. John wiley private Ltd., Singapore.2003.
7. David Freifelder, Microbial Genetics. Narosa Publishing House,New Delhi 2000.
8. David freifelder and G.M.Malacinik, Essentials of molecular biology 1996,
9. David J Sheratt, Mobile Genetic Elements, Oxford University Press. 1995
10. J.W. Dale, "Molecular Genetics of Bacteria" Wiley & Sons 1994.
11. D.L.G. Hartl , "Basic Genetics" Jones Publ., 1991.
12. M. P. Arora, "Fundamental of Genetics", Himalaya Publishing House, Mumbai, 2004.
13. C.B. Powar, "Genetics", Volume 1, Himalaya Publishing House, Mumbai, 2003.

Course outcomes:

The student will be able to

1. recapitulation of Mendelian Principles
2. Understand the mechanisms of sex determination
3. Gain knowledge about types of genes
4. Understand the viral genetics

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	3	2	1	1	-	-	-	1	1	-	-
CO_2	2	3	2	1	1	-	-	-	1	1	-	2
CO_3	3	3	2	3	1	-	-	-	1	1	-	-
CO_4	3	2	2	1	1	-	-	-	1	1	-	-

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 105 P	Bio-molecules and Advanced Tools and Techniques	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Practical –I: BIO-MOLECULES AND ADVANCED TOOLS AND TECHNIQUES

1. Estimation of reducing sugars by benedict's titrimetric method
2. Estimation of total carbohydrates by anthrone method
3. Estimation of proteins by Lowry and biuret methods
4. Estimation of cholesterol
5. Separation of chlorophyll pigments by paper chromatography
6. Separation of amino acids/ sugars/ lipids by thin layer chromatography
7. Ultra violet absorption spectra of nucleic acids and proteins
8. Polyacrylamide gel electrophoresis of proteins
9. Agarose gel electrophoresis of nucleic acids
10. Determination of isoelectric point of glycine

Reference Books

1. An introduction to practical biochemistry by D.T. Plummer (Mc Graw Hill).
2. Biochemical methods by Sadasivam and Manikam (Wiley Eastern limited).
3. Biochemistry-- a laboratory courses by J.M. Beckar (Academic Press).
4. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
5. Laboratory manual in Biochemistry by J. Jayaraman (Wiley Eastern limited).

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 106 P	Microbiology and Cell Biology	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Practical – II: Microbiology and Cell Biology

1. General laboratory rules and regulations.
2. Preparation of culture media.
3. Isolation and enumeration of microorganisms from soil by the serial dilution-agar plating method.
4. Methodology for obtaining pure culture of microorganisms.
   a) Streak plate method.
   b) Spread plate method.
   c) Pour plate method.
5. Simple staining.
6. Grams staining.
7. Determination of bacterial growth turbidity measurements (Spectrophotometric method).
8. Antibiotic sensitivity testing by disc diffusion method
9. Mitosis in onion root tip cells: All phases (Squash method).
10. Meiosis in onion flower buds: All phases including zygotene, diplotene and diakinesis of Prophase I (Smear method).

Reference Books

1. Laboratory Manual in Microbiology by P. Gunasekaran (1996), New Age Publ.
2. Manual of clinical laboratory immunology by Rose NR.
3. Microbiology laboratory Manual (2001) by Aneja, K.M
4. Microbiology laboratory Manual 4th Edit. By Cappuccino
5. The experimental foundations of modern immunology by Clark W.R.
6. Cell Biology - De Robertes & De Robertes

Semester - II

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 201	Enzymes and Intermediary Metabolism	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To provide knowledge on classification, nomenclature, isolation, and purification of enzymes
2. To educate them to understand the importance of energy relationships and its transformation in living organisms
3. To explain the metabolic pathways involved in biosynthesis of macromolecules
4. To impart awareness on the types and symptoms of metabolic diseases and their inheritance

UNIT-I

Classification of enzymes and their significance - Isolation and purification of enzymes - assay of enzyme activity. Determination of KM, Vmax and K cat. Enzyme inhibition - competitive, non-competitive, uncompetitive allosteric regulation and irreversible enzyme inhibition. Enzyme action, Active site determination. Isoenzymes - detection, characterization and significance. Ribozymes, Abzymes, multicomplex and multifunctional enzymes.

UNIT-II

Bioenergetics - Free energy change in biological transformations, thermodynamic principles in biology, Redox potential, high energy compounds. Glycolysis - Biochemical steps involved in glycolytic pathway, TCA cycle and their Regulatory mechanisms. Glyoxalatye cycle, gluconeogenesis, HMP shunt, interconversion of hexoses and pentoses, amylogenesis, glycogen metabolism. Brief account of enzymes and co-enzymes

involved in biological oxidations, Organization of respiratory electron transport system. Mechanism of oxidative phosphorylation. Biological energy transducers, Chemiosmotic regeneration of ATP.

UNIT-III

Biosynthesis, degradation and regulation of saturated fatty acids. Degradation of lipids from membranes, Oxidation of unsaturated fatty acids and synthesis of UFA by enzymatic (synthesis of prostaglandin and leukotrines) and non-enzymatic (free radicals and lipid peroxidations) mechanisms. Cholesterol and ketone bodies. Metabolism and regulation. Metabolism of triglycerides, phospholipids, glycolipids.

UNIT-IV

Metabolism of amino acids and proteins - Hydrolysis of proteins, proteases, Biosynthesis of essential amino acids and their catabolism (deamination, decarboxylation, and transamination), Coordinated control of metabolism, Formation of ammonia and urea. Nitrogen fixation by bacteria. Metabolism of purines and pyrimidines, Biosynthesis and catabolism of Nucleosides and nucleotides, role of DNases and RNases on nucleic acids. Outlines of biosynthesis of porphyrins (Chlorophyll and Haeme). Inborn errors in metabolism - Phenylketonuria, Alkaptonuria, Sickle cell anaemia, Fructosaemia, galactosuria, Gaucher's and Krabbe's disease.

Reference Books

1. Principles of Biochemistry: White. A, Handler, P., and Smith.
2. Biochemistry, Lehninger A.L.
3. Biochemistry, David E. Metzler.
4. Biochemistry, Lubert Stryer.
5. Review of Physiological Chemistry: Harold A. Harper.
6. Outlines of Biochemistry, Conn and Stummf.
7. Text of Biochemistry, West and Todd.
8. Metabolic Pathways - Greenberg,
9. Biochemistry, 2na Edition, G. Zubay (1988). Practical Course
10. Practical Biochemistry - H. Varley.
11. Methods in Enzymology S.P. Colowick & N.O. Kapalan, Academic Press.
12. Methods in Biochemical analysis.

Course outcomes:

Students will be able to

1. Gain knowledge on different enzymes and their significance

2. Correlate how the living organisms exchange energy and matter with the surroundings for their survival, and store free energy in the form of energy-rich compounds

3. Recognize how the catabolic breakdown of the substances is associated with release of free energy; whereas, free energy is utilized during synthesis of biomolecules i.e., anabolic pathways

4. Apply the knowledge of metabolic pathways to biotechnological and biochemical research.

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	2	3	-	1	3	-	-

CO_2	3	3	3	2	2	2	2	-	1	2	-	-
CO_3	3	3	3	2	2	2	2	-	1	2	-	2
CO_4	3	3	3	3	3	2	3	-	1	3	3	3

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 202	Molecular Biology	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To provide comprehensive background of Salient features of Nucleic acids, DNA models and its replication to the course learners.
2. To impart detailed understanding of key events of transcription and post transcriptional modifications
3. To develop understanding of translational process in protein biosynthesis in prokaryotic and eukaryotic organisms
4. To make them understand the regulation of catabolic and anabolic gene expression

UNIT-I

DNA replication - Enzymes involved in DNA replication. Accessory proteins. Structures of oriC. Replisome – oriC - accessory protein interactions - Mechanism of formation of oriC open complex. Replication initiation – elongation - Okazaki fragments synthesis and processing - Direction of replication fork movement. Termination - Nature of termination sequences - Interactions between polymerase III and ter sequences. Mode of DNA replication Messelson and Stahl experiments. Replication of single stranded DNA - ØX174. Replication of bacteriophage lambda DNA (rolling circle). Replication of closed covalent circular DNA (θ model of DNA replication). Problems associated with replication of linear DNA molecules - Structure and synthesis of telomere sequences. Cell cycle and its regulation - Interplaying of cell cycle and DNA replication.

UNIT-II

Prokaryotic RNA polymerase - σ factors: -σ 70, σ32, σ54 , σ28 promoter elements- Structural differences between E σ 70, σ54 dependent promoters - Promotor polymerase interaction - Foot printing assays - Mapping of transcription start point (TSP). Gene structure, Upstream activating sequences and their role in regulation of transcription.

Transcription elongation and termination. Eukaryotic RNA polymerases - Transcription factors – transcription. Structure and functions of RNA pol I, II and III dependent promoters. Enhancer sequences. Post transcriptional modification of RNA and its regulation, Mechanism of tissue specific transcription.

UNIT-III

Translation - Central dogma theory and flow of genetic information, Genetic code and its elucidation, Wobble hypothesis, Structure and composition of prokaryotic and eukaryotic ribosomes, Structures of mRNA and tRNA. Events of protein synthesis (amino acid activation, initiation, elongation and termination) in prokaryotes and eukaryotes. Post-translational modification of proteins, Inhibitors of translation. Protein trafficking - Concept of signal peptide - transport and membrane targeting of proteins - Sec pathway - Alternative protein transport mechanisms.

UNIT-IV

Regulation of gene expression. Constitutive and inducible gene expression, Use of mutants in gene expression. P and O site determination. Regulation of catabolic gene expression Eg: lac operon, ara operon and gal operon. Regulation of anabolic gene expression Eg: Trp and His operons. Hormonal regulation of genes.

Reference Books

1. Molecular Biology. 2"13 ed. 1994. D. Freifelder. Springer.
2. Molecular Biology by G. Padmanabhan, K. Sivaram Sastry, C. Subramanyam, 1995, Mac Millan.
3. Molecular Biology and Biotechnology 2na ed. J.M. Walker and E.B. Gingold. Panima Publications. PP 434.
4. Dictionary of microbiology and molecular biology. 2nd ed. 1994. Sigleton. P. and Sainsbury, D. Sciential Publication.
5. Molecular Biology of the Gene, 1S87. 4th Ed. J.D. Watson, N.H.Hopkins, J.W. Roberts, J.A. SteitzandA.M. Weiner, 2 Vol. Benjmin/Cummings.

Course outcomes:

1. Understand the biochemical composition and genome organization in living cells
2. Learn about the mechanism of tissue specific transcription and role of RNA polymerases
3. Appreciate the correlation of genetic code with protein synthesis in prokaryotic and eukaryotic cells.
4. Gain insights of mechanism of gene expression and regulations

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	2	2	2	-	-	-	1	1	-	1

CO_2	3	2	2	2	2	-	-	-	1	1	-	1
CO_3	3	2	2	2	2	-	-	-	1	1	-	1
CO_4	3	2	2	2	2	-	-	-	1	1	-	1

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 203 a	Immunology	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To provide knowledge on the types of immunity and the immune organs
2. To demonstrate the structure of antibody types and their interaction with antigen
3. To acquaint them with the hybridoma technique and its clinical applications
4. Explain the concept of hypersensitivity, auto immunity and tumer immunology

UNIT-I

Types of immunity – innate, acquired, passive and active. Organization and structure of Lymphoid organs – bone marrow, thymus, spleen and lymph nodes. Cells of the immune System – B-Lymphocytes, T-Lymphocytes. T-cell receptor – structure and function. Macrophages. Types of cell mediated immunity and lymphocyte activated killer cells. Clonal nature of immune response, Immunological memory. Immuno regulation. Adjuvants and immunological tolerance.

UNIT-II

Nature of antigens and antibodies. Structure and function of antibodies. Isotypes, Allotypes and Idiotypes. Antigen – antibody interactions. The generation of antibody diversity, antigen receptors on B & T lymphocytes. Major Histocompatibility Complex (MHC). Human leukocyte antigens (HLA), MHC restriction and typing. Lymphokines, effector cell mechanisms, genetic control of immune response. Complement system.

UNIT-III

Immunological techniques - ELISA, RIA, Western Blot, Immunoblot and Immuno fluorescent techniques. FACS. Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

UNIT-IV

Hypersensitivity - types of hypersensitivity - immediate and delayed hypersensitivity,

autoimmune diseases, transplantation and immunity, immunity to infectious agents. Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology.

Reference Books

1. Essentials of Immunology by Roit (ELBS).
2. Immunology by Roit et.al (Harper Row).
3. Text book of Immunology by S.T,Barrot (Mosby).
4. Immunology by Kubay.
5. Principles of Microbiology and Immunology by Davis et.al., (Harper).

Course outcomes:

The student will be able to

1. Out line, compare and contrast the key mechanism of innate and adaptive immunity
2. Apply knowledge in disease diagnosis through serological tests
3. Develop skill in production of monoclonal antibodies
4. Gain knowledge on undesirable immunological reactions and their complications in health management

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	2	-	-	-	2	1	2	2
CO_2	3	3	3	3	2	-	-	-	2	1	2	2
CO_3	3	3	3	3	2	-	-	-	2	1	2	2
CO_4	3	3	3	3	2	-	-	-	2	1	2	2

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 203b	Cancer Biology	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To understand the fundamentals of cancer biology
2. to understand the Principles of carcinogenesis
3. To gain knowledge about Principles of molecular cell biology of cancer
4. Understand the c Principles of cancer metastasis and ddifferent forms of therapy

Unit I

Fundamentals of cancer biology: Introduction to Cancer Biology, Tumor suppressor genes, modulation of cell cycle in cancer, Different forms of cancers, Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer

Unit II

Principles of carcinogenesis: Theory of Carcinogenesis, Chemical carcinogenesis, principles of physical carcinogenesis, X-ray radiation-mechanisms of radiation carcinogenesis, Diet and cancer.

Unit III

Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes, Oncogenes/proto oncogene activity, Growth factors related to transformation, Telomerases.

Unit IV

Principles of cancer metastasis: Clinical significances of invasion, Metastatic cascade, Basement membrane disruption, proteinase and tumor cell invasion. New molecules for cancer therapy: Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy

REFERENCES:

1. Daniel, Waynew, Biostatistics a foundation for analysis in the health sciences, John

Wiley and Sons, New Delhi, 1983.
2. Visweswara Rao K, Biostatistics: A manual of statistical methods for use in Health, Nutrition and Anthropology, Jaypee brothers medical publishers (p) ltd., 1996
3. Sundar Rao.P.S.S, and Richard.J, Introduction to biostatistics and research methods, Prentice –Hall of India, 2006
4. K.V.S.Sarma, Statistics Made Simple Do it yourself on PC, Second Edition, Prentice Hall, 2010.
5. Indrayan.A and Satyanarayana. L, Biostatistics for medical, nursing and pharmacy students, Prentice-Hall of India, 2006.
6. Armitage.P, Statistical methods in Medical Research, London: Blackwell Scientific Publications, 1989
7. Statistical concepts and applications in Medicine Monographs on statistics and Applied Probability series. 1994. J.Aitchison.
8. Introduction to Biostatistics. 1995. R.N.Forthafter and E.S.Lee. Academic Press**.** PP 656
9. Statistics with application to the biological and health sciences. 1985. R.D.Remington and M.A. Schork, Prentice –Hall.
10. Zar, Jerrold, H., Biostatical Analysis, Engel Wood Cliffs Prentice Hall, 1974.
11. Lewis, Alvin, E, Biostatistics, Affiliated East West Press (P) Ltd., New Delhi, 1971.
12. Goldstein, Avrom, Biostatistics an introductory text, New York, The Mac Millian Company, 1971.
13. Ingelfinger, Joseph A and Others : Biostatistics in Clinical Medicine, 1983.
14. Bemstein, L and Weatherall, M. Statistics for Medical and other Biological; students, edenberg, E & S Livingstone, 1952
15. Schelfer, William C, Statistics for the Biological sciences, Reading Addition Wesley, 1969.

Course outcomes:

The student will be able to

1. To understand cancers, the mechanisms involved from theory concept, experimental, research and human health-care perspectives
2. To acquire the required experimental skills in cancer biology from research and human healthcare perspectives
3. To develop understanding about principles of carcinogenesis
4. Acquire knowledge on signal targets towards therapy of cancer and Gene therapy

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	1	-	1	3	3	3	3
CO_2	3	3	3	3	3	1	-	1	3	3	3	3
CO_3	3	3	3	3	3	1	-	1	3	3	3	3
CO_4	3	3	3	3	3	1	-	1	3	3	3	3

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 204a	Research methodology, Biostatistics and Bioinformatics	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

1. To choose the appropriate research design and develop appropriate research hypothesis for a research project
2. To describe the appropriate statistical methods required for a particular research design
3. To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis
4. To provide knowledge about the basics of sequence alignment and analysis.

UNIT-I

Preparation of informal proposal, modified proposal and formal proposal. Experimental design
and Collection of results, submission of progress report (year wise) and submission of technical
report (Format: Title page, Introduction, Aims of the proposal/research, methodology,
results, references, acknowledgments, budgetary preparation). Submission of final technical report. Patenting and intellectual property rights.

UNIT-II

Brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance
– F & t tests, chi-square tests, ANOVA.

UNIT-III

Introduction to Bioinformatics – Genomics and Proteomics. Bioinformatics – Online tools

and
offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL,
and PDB. Database searching using BLAST and FASTA.

UNIT-IV
Multiple sequence alignment and Dynamic programming. Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

Reference Books:

1. Bioinformatics – D.Mount
2. Programming in C by Balaguru Swamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Biostatistics – Daniel. (Wiley).
5. Statistics by S.C.Gupta.
6. Statistical Methods by G.W.Snedecor & W.G.Cochran.
7. Fundamentals of Biostatistics – Khan & Khanum.
8. Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).

Course outcomes:

The student will be able to

1. Discuss the various steps involved in conducting research
2. Learn to apply hypothesis testing via some of the statistical distributions
3. Develop understanding about Biological data and database search tools
4. Acquire hands on training on various computational tools and techniques employed in Biological sequence analysis

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	2	2	1	-	2	1	1	1	1
CO_2	3	2	3	2	3	1	-	-	1	1	1	-
CO_3	3	2	3	2	3	1	-	-	1	1	1	1
CO_4	3	2	3	2	3	1	-	-	1	1	1	1

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 204b	Proteomics	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Course Objectives:

This course enables the students to:

1. To organize protein in four structural levels: Primary, Secondary, Tertiary and Quaternary, study on post translational modifications, structural determination and folding
2. Extend comprehensive knowledge about characterization, tools and techniques in determination of abundance of protein in particular tissue and its quantification.
3. Obtain information about atomic mass, amino acid sequence and basic physical and chemical properties of protein, the technology used in determining these informations.
4. Gain knowledge about the production of industrial important proteins and enzymes, designing new proteins with special functions and storage and use of proteomics database.

UNIT-I:

Protein Basics: Proteomics basics, Forces that determine protein structure and physicochemical properties, Mechanisms of protein folding, Molten globule structure, Characterization of folding pathways.

UNIT-II:

Protein isolation and profiling: Method for protein isolation and purification, Profiling by Native-PAGE, SDS-PAGE, 2-D/IEF SDS-PAGE, staining and de-staining, imaging and analysis of 1-D and 2-D gels.

UNIT III: Protein characterization: Protein sequencing using various methods, Protein identification by mass spectrometry, Determination of post translation modification, Proteomics

tools and databases, Thermal, enzymatic, physical, pressure, solvents, interactions effect on protein, Application of DSC, Protein denaturation, aggregation and gelation.

UNIT IV: Protein structure: Background and basic principles of various spectroscopic techniques used for protein structure determination, Absorption and fluorescence, Circular dichroism, FT-Raman, FT-IR, NMR, Protein crystallization and X-ray crystallography, MALLS. Development of novel proteins**:** Basic concepts for design of a new protein, Site directed mutagenesis for specific protein function, Specific examples of novel engineered proteins. 8L

Reference Books:

1. Carl, Branden and Tooze, John. Introduction to Protein Structure, Garland Publishing
2. (Taylor and Francis Group). New York.
3. Yada, R. Y.; Jackman, R. L.; Smith, J. L. Protein Structure-Function Relationships Blakie Academic and Professional: London
4. Clark, R. J. H and Hester, R. E. Spectroscopy of Biological Systems, John Wiley and Sons, New York
5. Nakai, S. and Modler, H. W. Food Proteins: Properties and Characterization, VCH Publishers, New York.

Course outcomes:

At the end of the course, a student should be able to:

1. Handle a proteins and its characterization.
2. Know the principles of proteome quantification.
3. Demonstrate how various types of mass spectrometers (e.g. Orbitrap, triple-quad, Q-TOF) can be used for proteome quantification, structure determination of proteins by various methods.
4. Use software tools to analyse various quantitative proteomic data types, Principles of statistical analysis of proteomic data, how quantitative proteomics can be applied in biology, clinical research and drug discovery and designing novel proteins.

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	2	-	-	-	1	1	-	-
CO_2	2	2	2	1	2	-	-	-	1	1	-	-
CO_3	2	2	3	1	3	-	-	-	1	1	-	1
CO_4	2	2	3	2	3	-	-	-	1	1	-	1

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 205 P	Enzymology, metabolism and Molecular Biology	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Practical –I: Enzymology, metabolism and Molecular Biology

1. Assay of amylase from Saliva.
2. Assay of urease from Horse-gram.
3. Assay of acid phosphatase from Potato.
4. Determination of optimal conditions for SDH activity.
5. Determination of effect of substrate concentration on SDH activity.
6. Determination of effect of enzyme concentration on SDH activity.
7. Determination of effect of temperature on SDH activity.
8. Determination of effect of P^H on SDH activity.
9. Estimation of activity of SGOT.
10. Estimation of activity of SGPT.
11. Isolation of DNA from bacterial, plant and animal cells.
12. Estimation of DNA by Diphenylamine method.
13. Isolation RNA from yeast cells.
14. Estimation of RNA by Orcinol method.
15. Estimation of DNA and purity determination by UV absorption method.
16. Determination of melting temperature (Tm).
17. Isolation of plasmid DNA from E. coli.
18. Transformation of E. coli with ampicillin resistant plasmid.

Reference Books

1. Hawk's Physiological chemistry.
2. Practical Biochemistry by T Plummer.
3. Practical Biochemistry by J Jayaraman.
4. Klemir and others: practical Biological chemistry.
5. Practical Biochemistry – Koch and Hank Dunn and Drell.
6. Practical Biochemistry-Sawhney (2000).
7. Varley's Practical clinical Biochemistry – Ed. Alan W. Gowenlock (Heinemann Medical Books, London).
8. Techniques in molecular biology. Vol.2. 1987. ed. J.M. Walker and Wim Gaestra. Panima Publications. PP 332.
9. Methods in Plant Molecular Biology. 1989. M.A. Schuler and R.E. Zielinski. Academic Press.
10. Methods for cloning and Analysis of eukaryotic genes. 1990. ABothwell, G.D. yancoponlos and F.W.Alt: Jones and Bartlett Publishers. PP 1990.
11. PCR; A Practical approach. 1991. M.J. McPherson. P. Quirke and GR. Taylor. Eds. IRL Press, PP 253.
12. Short Protocols in Molecular Biology. 1992. P.M. Ansubel et al., Academic Press, PP 800.

13. Essential molecular biology: A Practical approach, Vol. I, II. 1991. T.A. Brown. Ed. IRL Press, PP 318-. PP 320.

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 206 P	Immunology, Biostatistics and Bioinformatics	04	4
Sessional Marks: 20		End Semester Examination Marks: 80	

Practical –II: Immunology, Biostatistics and Bioinformatics

1. Determination of A, B, O and Rh blood groups in human beings.
2. Ouchterloney double diffusion.
3. Radial immunodiffusion.
4. Immunoelectrophoresis.
5. Enzyme Linked Immunosorbent Assay (ELISA).
6. Diagnostic test for typhoid fever by Widal test.
7. Measures of Location.
8. Measures of Dispersion.
9. Correlation Analysis.
10. Regression Analysis.
11. Student Paired t-Test.
12. X^2- Test of Independence of Attributes.
13. Introduction and use of various genome databases.
14. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/
15. TrEMBL, UniProt.
16. Similarity searches using tools like BLAST and interpretation of results.
17. Multiple sequence alignment using ClustalW.
18. Use of various primer designing and restriction site prediction tools.
19. Phylogenetic analysis of protein and nucleotide sequences.
20. Sequence alignments.
21. Sequence and structure visualization

Reference Books

1. Laboratory Immunology by Bradshaw LJ.
2. Laboratory manual in Biochemistry by J. Jayaraman (Wilety Eastern limited).
3. Laboratory Manual in Microbiology by P. Gunasekaran (1996), New Age Publ.
4. Manual of clinical laboratory immunology by Rose NR.
5. Microbiology laboratory Manual (2001) by Aneja, K.M
6. Microbiology laboratory Manual 4th Edit. By Cappuccino
7. The experimental foundations of modern immunology by Clark W.R.
8. Bioinformatics – D.Mount
9. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
10. Biostatistics – Daniel. (Wiley).
11. Statistics by S.C.Gupta.

12. Statistical Methods by G.W.Snedecor & W.G.Cochran.
13. Fundamentals of Biostatistics – Khan & Khanum.
14. Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).

SEMESTER –III

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 301	Genetic Engineering	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To impart knowledge about major events in the development of rDNA technology
2. To acquire skills on techniques of construction of recombinant DNA - Cloning vectors and isolation of gene of interest.
3. To familiarize with the concepts of constructing genomic DNA library and cDNA library
4. To understand the principles and applications of Polymerase Chain Reaction (PCR).

UNIT-I

Requirements and steps involved in gene cloning, Isolation of gene/DNA fragments. Purification of genes. Enzymes used in gene cloning: Restriction endonucleases – types, nomenclature and properties. DNA polymerases-I, polynucleotide kinase, DNA ligases, terminal nucleotide transferases, Reverse transcriptase, alkaline phosphatases, S_1 nucleases. Production of DNA fragments with cohesive ends and blunt ends and their significance, vectors and hosts.

UNIT-II

Vectors for construction of genomic libraries - cosmids, bacterial artificial chromosomes (BACs), yeast artificial chromosomes (YACs) - vectors for construction of cDNA libraries - lamda ZAP. Multipurpose vectors - pUC 18/19, Blue script vectors - multiple cloning site - Strategies for unidirectional deletion of cloned DNA fragments - Generation of sequence of cloned DNA fragments. Site directed mutagenesis.

Expression vectors – structure - promoters used in expression vectors - *lac, tac, λpL*, T7 promoters and their significance in constructing expression vectors. Promoter-probe vectors – Structure promoter probe vector - Reporter genes (*lacZ*, *gf*p, gus, luciferase) and strategies used to assay promoter activity. Vectors used for cloning in to mammalian cells - SV40. Vectors - Cloning in plants by Ti and Ri vectors.

UNIT-III

cDNA synthesis - Mechanism of cDNA synthesis, Strategies used to obtain full length cDNA. 5' and 3' RACE. Chemical synthesis - solid phase synthesis of oligonulceotides - Designing of gene from amino acid sequences, *In vitro* synthesis of gene. Ligation of foreign DNA to vectors – cohesive and blunt ends methods –linkers, homopolymer tailing and adaptors.

UNIT-IV

Cloning stratergies – cloned gene transfer techniques – transformation, transfection, electroporation, lipofection, microinjection and biolistics. Screening of cloned genes and their

expression – nucleic acid probes, colony and fluorescent in-situ hybridization, DNA micro array technology. PCR – concept and technology – types (real time, inverse and multiplex) and its significance. Analysis of DNA polymorphism: RFLP, RAPD, AFLP techniques. Applications of genetic engineering.

Reference Books

1. DNA replication, 2nd ed. 1991. A. Kornberg and T.A. baker. W.H. Freeman and Company, New York. Ny. PP931.
2. Gene transfer and expression protocols: Methods in Molecular Biology, Vol.7,1991. E.J. Murray Ed. Human Press, Clifton, NJ. PP 439.
3. Genes IV, 1990. B. Lewin. Oxford University Press. PP 857.
4. Microbial genetics. 1994. Freifelder, D. Springer.
5. Gene regulation, 2nd ed. 1994. D, latchman. Sciential Publication.
6. Bacterial and Bacteriophage genetics. 1994. E.A. Birge. Springerscan Publication.
7. Genetics: A molecular approach. 2nd ed. 1992. T.B. Brown. Panima Publications. PP 496.
8. Principles of Gene Manipulation. 1991. R.W. Old and S.B. Prim-Rose. 2nd ed. Blackwell Scientific.

Course outcomes:

The student will be able to

1. Familiar with the tools and techniques for isolation and purification of genes
2. Acquire knowledge on vectors for construction of genomic libraries and cDNA libraries
3. Understand the mechanism of cDNA synthesis
4. Know the techniques for transfer and expression of cloned gene and applications of genetic engineering in biological research.

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	2	-	1	2	1	1	2	2
CO_2	3	3	3	3	2	-	1	2	1	1	2	2
CO_3	3	3	3	3	2	-	1	2	1	1	2	2
CO_4	3	3	3	3	2	-	1	2	1	1	2	2

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 302	Food and Industrial Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To impart knowledge about the principles of food preservation and processing
2. To make the student to be learn about various aspects of the Nitrogen fixation and mass production of bio fertilizers
3. To educate the student about bioenergy and its production.
4. To give insight on role of microorganisms in environment and their applications in food and dairy Industry

UNIT-I

Scope of biotechnology in the food and drink industry: Contamination of foods by pesticides, fertilizers, industrial waste and chemical contaminants. Principles under lying food spoilage - chemical, physical and physiological changes caused by microorganisms. Control measures for food poisoning. Principles of food preservation, foods produced by microorganisms. Milk and Dairy products, Cereal products, Brewing, Protein products, Food additives and ingredients, Fruits and vegetables, large scale cultivation of edible mushrooms, meat and sausage products.

UNIT-II

Nitrogen fixation and mass production of biofertilizers - diazotrophic microorganisms, Biochemical aspects of diazotrophy. Genetics of free living and symbiotic diazotrophs. Blue Green Algae and Azolla, Micorrhizae, Vermiculture, Mass cultivation of commercially valuable macro and micro algae for agar agar, alginates, single cell protein and other products.

UNIT-III

Energy and Biotechnology: Biomass, solar energy technology, Agriculture and forestry, conversion to fuel, bio fuel cells and other devices. Biogas production – design and types of biogas digesters. Production of biohydrogen. Microbial leaching, Metal transformation, accumulation and immobilization by microbes. Application of microbes in mining and petroleum industry. Microbial enhanced oil recovery. Biodegradation of xenobiotic compounds, Hazards from xenobiotics.

UNIT-IV

Materials and Biotechnology: Biomolecules production - microbial polysaccharides, organic acids, amino acids, vitamins, antibiotics, enzymes, alcohols, food flavors, significance of Agrobacterium in enhancing food quality and yield Microbial toxins. Pharmaceuticals - vaccines, hormones, diagnostics. Applications of enzymes in industry and medicine; immobilized enzymes - their preparation and applications. Use of microbes in biodegradation of organic wastes. Industrial production of fungal, bacterial and viral biopesticides.

Reference Books

1. Fermentation: A Practical approach. 1990. B. Me Neil and L.M. Harvey. IRL Press. PP 226.
2. Biofertilizers in Agriculture and Agroforestry. 3ed. 1994. Subbarao. Oxford & IBH Publications.
3. Manual of Industrial Microbiology and Biotechnology. 1986. Edited by Arnold L. Demain and Nadine. A. Solomon. PP 466.
4. Bioreactors in Biotechnology-A Practical Approach. AR. Seregg.
5. Downstream Process: Equipment and Techniques. Advances in Biotechnological Process. Vol. 8, 1988. Ed. A. Mizrahi, Alan R. Liss. Ince.
6. Biotechnology and the Food Industry. 1989. Ed.P.L.Rogers and G.H. Plat, Gordon & Breach. Sci. Publication.
7. Principles of fermentation technology. 1984. P.F. Stanbury and A. Witaker. Perman Press.
8. Biochemsitry and genetic regulation of commercially important antibiotics. 1983. L.C. Ving,
9. Enzymes in industry and Medicine. 1987. G.F. Bickerstaff. Edward Arnold Publishers.
10. Biotechnology: Principles and Applications, 1994, by J. Hrggins, D.J. Best and J. Jones.
11. Fundamentals of Biotechnology, 1987. P. Prave, V. Paust, W. Sitting and D.A. Sukatsch (eds). VCH.
12. Crueger, W., and Crueger: Biotechnology; A Textbook of Industrial Microbiology, 2nd ed. Sinauer Associates. Inc. Sunderiand Mass/1990.
13. Demain, A.L., and N.A. Solomon, eds., Manual of Industrial Microbiology and Biotechnology, American Society for Microbiology. Washington. D.C.1986.
14. Frazier, W.C.,.and D.C. Esthoff: Food Microbiology, 4th ed., Me Graw-Hill, New York, 1988.
15. U.S. Congress, Office of Technology Assessment: "Biotechnology in a Global Economy" OTA-BA-494, Government Printing Office, Washington, D.C., 1991.
16. Industrial microbiology, Prescott and Dunn. 1997. Ed. Gerald Reed.

Course outcomes:

The student will be able to

1. Acquire knowledge on food preservation, processing and control measures for food poisoning
2. Establish indoor and outdoor cultivation units for algal cultivation
3. Learn effective management of solid waste for energy production.
4. Appreciate the industrial role of microorganisms in production of biomolecules

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-

CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 303 a	Bioprocess Engineering and Technology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To impart knowledge about Isolation, screening and maintenance of industrially important microbes
2. To make the student to learn about fermentation technology
3. To educate the student to gain knowledge in reaction kinetics, kinetics of enzyme catalyzed reactions
4. To familiarize with the concepts and the techniques of bio separation

UNIT-I

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

UNIT-II

Bioreactor designs; types of fermentation and fermenters; Concepts of basic modes of fermentation – batch, fed batch and continuous; conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design - mechanically agitated; pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization: Upstream processing; media formulation; sterilization; aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

UNIT-III

Kinetics of Enzyme catalyzed reactions - immobilization - Kinetics of immobilized enzyme catalyzed reactions - Kinetics of balanced growth - Transient growth kinetics. Gas-liquid mass transfer in cellular systems - Aeration – Agitation - Estimation of oxygen transfer rates.

UNIT-IV

Bioseparation - filtration, centrifugation, sedimentation, flocculation; cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; reverse osmosis and ultra filtration; drying; crystallization; Storage and packaging; Treatment of effluent and its disposal. Large scale production and purification of recombinant therapeutics (streptokinase, epidermal growth factor, insulin).

Reference Books

1. Bio processing Engineering principles. 1995. P.M.Doran. Har court Brace. PP 464
2. Biochemical engineering. 1992. James.M. Lee Prentice -Hall.

3. Biochemical engineering Fundamentals, 2ed 1986 J.E. Bailey and D.F.Oilis. Me Graw-Hill Publication.
4. Chemical Process Control: An Introduction to theory and practice. 1984.G. Stephanopoulos, Prentice-hall.
5. Modeling and controlling of fermentation Process. Ed. J.R. Leigh.
6. Biochemical Engineering by S. Aiba, AE Humphery, NF Millis, University, of Tokyo Press.
7. Chemical Engineering by JM Coulson and JF Richarson, Pergamen Press.
8. Fundamentals of Biotechnology by P. Prave, U. Faust W.Sitting and DASukatsch, VCH.
9. A Text Book on Biotechnology by HD Kumar, Affliated East West Press Private Ltd.

Course outcomes:

The student will be able to

1. Handle the axenic cultures of industrially important microbes and appreciate the relevance of microorganisms from industrial context.
2. Gain an overview on design, operations and types of fermentation systems
3. Calculate yield and production rates in a biological production process, and also interpret data
4. Apply knowledge on separation and purification of end products of fermentation

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	-	-	-	1	1	-	-
CO_2	3	3	3	3	2	-	-	-	1	1	-	-
CO_3	3	3	3	3	2	-	-	-	1	1	-	-
CO_4	3	3	3	3	3	-	-	-	1	1	-	-

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 303 b	Legal, Ethical and Implications of Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To make them understand the concept of intellectual property rights and its importance in biotechnology
2. To acquaint them to identify legal and ethical issues raised in Biotechnology
3. To make them know the social and moral implications in biotechnology research.
4. To impart knowledge on pros and cons of genetically modified foods and microbes

UNIT-I

Intellectual property rights - Definition - types -patents - copy rights-trademarks: essential requirements for IPR, procedures of filing patents-provisional and complete specifications-Pan-Co-operation treaty (PCT)-application: GATT and IPR: WTO Act - Global and Indian Biodiversity Act- Indian Patent Act and their revised versions.

UNIT-II

Legal and Ethical aspects of Biotechnology -Prenatal diagnosis - Genetic screening - Surrogate mothers and exploitation of women - designing of plants and animals- gene therapy - cloning - Manipulation of human genome -Technology transfer.

UNIT-III

Social and Moral aspects of Biotechnology -Biotechnology and International trade - Privatization and patenting of Biotechnology products - Role of Government, Industries and society in promoting, accepting and regulating the rDNA research.

UNIT-IV

Environmental and Health aspects of Biotechnology - Generally engineered organisms - Introduction of novel species and natural equilibrium - Environmental security and safety - Precautionary measures - Genetically modified foods - health safety.

Reference Books

1. Gene Cloning – Brown.
2. Concepts in Biotechnology- Balasubramanyam.D.
3. Basic Biotechnology - Colin Rotledge and Kristainsen.
4. Gene Biotechnology – Jogdand.
5. From Genes to Clones, Introduction to Gene Technology-Winnacker, Ernst.L.
6. Safety, Moral, Social and Ethical issues related to genetically modified foods - Smith J.E.
7. Molecular Biology and Biotechnology - Meyer R.A.
8. Environmental Biotechnology- Forster and wase.
9. Biotechnological Innovations in Environmental Management - Leach and Van Dam-mieras.

10. Industrial Microbiology and Biotechnology- Demain and Solomon.

Course outcomes:

The student will be able to

1. Develop awareness on types IPR and patenting process
2. Understand legal and ethical controversies in biotechnological innovations
3. Apply knowledge in providing safety of food, water and environment
4. Gain overview of GM crops and microbes and their impact on environment

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	3	1	2	-	-	-	1	1	-	-
CO_2	2	2	3	1	2	-	-	-	1	1	-	-
CO_3	2	2	3	1	2	-	-	-	1	1	-	-
CO_4	2	2	3	2	2	-	-	-	1	1	-	-

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 303 c	Emerging technologies in Biotechnology	**04**	**4**
Sessional Marks: 20		**End Semester Examination Marks: 80**	

Course Objectives:

1. To impart knowledge about role of stem cells and its importance.
2. To make the student to learn about nanoscience and applications in different fields
3. To educate the student about applications of biosensors
4. To familiarize with RNAi Technology

UNIT - I

Stem cell technology: Unique properties of stem cells, embryonic stem cells, Adult stem cells: occurrence and functions, tests, cell differentiation and stem cell plasticity and transdifferntiation, medical applications of stem cells, Advantages and disadvantages of stem cell technology, Recent trends in stem cell technology.

UNIT - II

Introduction to Nanoscience: Definition of Nanoscience and its applications, Nanotechnology – History – Kinds of nanomatter, Biosynthesis of nanomaterials. Safety aspect of Nanobiotechnology. Nano biochips and devices. Biomedical applications of Nanomaterials. Nanoparticles in food and cosmetic application.

UNIT – III

The role of transducer and its applicability. Role of antibodies in biosensing; Nano biosensors applications of biosensors in medicine, food industry and environmental monitoring.

UNIT – IV

RNAi Technology: History and discovery, Cellular mechanism- dsRNA cleavage, micro RNA, RNA induced silencing complex (RISC), activation and catalysis, transcriptional silencing, variation among organisms, biological functions, technological applications- gene knock down, functional genomics, medicine, and biotechnology

REFERENCE BOOK

1. Sasidhara R, Animal Biotechnology, MJP Publishers, Chennai, 2006.
2. M.M. Ranga, Animal Biotehnology, Student Edition, Chennai.
3. Geoferey M. Cooper, The Cell, A molecular approach, 3rd Edition, ASM press, Washington, D.C. 2004.
4. Gregory J. Hannon, RNAi – A guide to gene silencing, Cold Spring Harbor Press, 2003.

Course outcomes:

The student will be able to

1. Acquire the knowledge about recent trends in stem cell technology and medical applications of stem cells
2. Understand the Biosynthesis of nanomaterials and biomedical applications of nanomaterials.
3. Learn role of antibodies in biosensing and applications of Nano biosensors in medicine, food industry and environmental monitoring.
4. Develop understanding on RNAi Technology and its technological applications

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	2	1	1	-	-	-	-	1	1	1
CO_2	3	2	2	1	1	-	-	-	-	1	1	1
CO_3	3	2	2	1	1	-	-	-	-	1	1	1
CO_4	3	2	3	2	1	-	-	-	-	1	1	1

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 304 P	Genetic Engineering, Food and Industrial Biotechnology	**04**	**4**
Sessional Marks: 20		**End Semester Examination Marks: 80**	

Practicals: GENETIC ENGINEERING, FOOD AND INDUSTRIAL BIOTECHNOLOGY

1. Plasmid Isolation
2. Restriction digestion of DNA.
3. Elution of DNA from Agarose gel.
4. Ligation of DNA into linearized plasmid.
5. Preparation of competent Cells
6. Transformation
7. Isolation of RNA from yeast.
8. Polymerase chain reaction (PCR)
9. RFLP
10. RAPD
11. Isolation of Lactobacillus from curd.
12. Isolation of surface flora of vegetables.
13. Determination of quality of a milk sample by methylene blue reduction test.
14. Production pectinase enzyme from a pathogen.

15. Estimation of amylase activity produced by Bacillus subtilis.
16. Estimation of protein content in spirulina.
17. Estimation of vit-c from different fruit samples.

Reference Books

1. Molecular Biology, Vol. 7, 1991. E.J. Murray ed. Humana Press. Clifton, NJ. PP 439. Genes IV. 1990. B. Lewin. Oxford University Press. PP 857.
2. Guide to molecular cloning techniques: Methods in enzymology. Vol. 152. 1987. S.L. Berger and A.R. Kimmel Ed. Academic Press. PP812.
3. Methods in molecular genetics: Molecular microbiology techniques Vol.3. 1994, Kenneth W. Adolph. Ed, Academic Press. PP 2150.
4. Laboratory Manual in Molecular genetics. 1994. Z.F. Burton and J.M.Kaguni. Harcourt Brace. PP 224.
5. Methods in Molecular Genetics. Vol.5, 1994. Kenneth. W. Adolph. Harcourt Brace. PP 425.

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 305	**Skill Oriented Course** Plant Tissue Culture	**04**	**4**
Sessional Marks: 10		**End Semester Examination Marks: 90(40+50)**	

Course Objectives:

1. To impart knowledge about the organization of Plant Tissue Culture Lab.
2. To give insight of nutrient requirements and factors influencing plant tissue culture.
3. To develop skill on micropropagation of forest trees, medicinal plants and endangered plants.
4. To educate the student to learn methods to in vitro germplasm conservation and production of secondary metabolites through cell culture.

UNIT-I

Introduction to plant tissue culture: Preparatory techniques - cleaning, sterilization, sterile handling tissue culture lab requirements. Media - Composition, preparation and sterilization.
Genetic manipulation through tissue culture techniques - Concepts of differentiation and dedifferentiation. Callus - growth pattern/characteristics, Organogenesis and plant regeneration.

UNIT-II

Somatic embryogenesis. Anther, endosperm and pollen cultures, Significance and advantages of haploid plants. Production of virus-free plants by meristem tip and other tissue culture techniques.

UNIT-III

Cell culture techniques for micropropagation of elite plants - Food and fruit crops, forest trees, fiber crops, ornamental plants, medicinal plants and endangered plants. Cell culture techniques for production of useful compounds - Hairy root cultures - transformed roots using Agro bacterium rhizogenesis - Production of secondary metabolites of commercial importance - Elicitors - factors affecting their yield, immobilized cell systems, bioreactors.

UNIT-IV

Selection of clones for nutritional, disease resistance, salt and drought resistance. Germplasm preservation by tissue technology, artificial synthetic seeds. Protoplast culture -isolation of protoplasts, culture and fusion methods, Somatic hybrids and cybrids.

PRACTICALS: PLANT TISSUE CULTURE

1. Organizing Plant tissue culture Laboratory.
2. Preparation of Tissue Culture Media.
3. Callus Induction.
4. Shoot tip culture.
5. Embryo / Endosperm Culture.
6. Organogenesis.
7. Somatic Embryogenesis.
8. Cell suspension culture.
9. Anther and Pollen cultures.

Reference Books

1. Plant tissue culture – theory and practice by Bhojwani S.S.
2. Plant cell culture – A practical approach by Dixion R.A.
3. Plant Cell, Tissue and Organ Culture, By Reinert, J. and YPS Bajaj (Springer – Verlag).
4. Plant tissue and cell culture, by Street, HE (Blackwell).
5. Introduction to Plant Biotechnology, Chawla, H. S. (2000), Enfield, NH: Science.
6. Introduction to Plant Tissue Culture, Razdan, M. K. (2003), Enfield, NH: Science.
7. Plant Biotechnology: an Introduction to Genetic Engineering, Slater, A., Scott, N. W., & Fowler, M. R. (2008), Oxford: Oxford University Press.
8. Biochemistry & Molecular Biology of Plants, Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015), Chichester, West Sussex: John Wiley & Sons.

Course outcomes:

The student will be able to

1. Learn important milestones in the plant tissue culture and understand the concepts and principles of Plant tissue culture.
2. Learn different pathways of plant regeneration under in vitro conditions – organogenesis, somatic embryogenesis, synthetic seeds and applications.
3. Understand techniques of establishing cell suspension culture, techniques of virus elimination by meristem and shoot tip culture.

4. Acquire skill of propagation of elite medicinal and economically important plants and establish micropropagation unit for commercialization.

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	3	3	-	-	-	-	2	-	-	-
CO_2	3	2	3	3	-	-	-	-	2	-	-	-
CO_3	3	2	3	3	-	-	-	-	2	-	2	-
CO_4	3	2	3	3	-	-	-	-	2	-	2	-

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 306 a	Bioethics	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To impart knowledge about intellectual property rights
2. To make the student to learn about legal and ethical aspects of Biotechnology
3. To educate the student about Social and Moral aspects of Biotechnology
4. To train students on Environmental risk assessment and food and feed safety assessment.

UNIT-I

Intellectual property rights - Definition - types -patents - copy rights-trademarks: essential requirements for IPR, procedures of filing patents-provisional and complete specifications-Pan-Co-operation treaty (PCT)-application: GATT and IPR: WTO Act - Global and Indian Biodiversity Act- Indian Patent Act and their revised versions.

UNIT-II

Legal and Ethical aspects of Biotechnology -Prenatal diagnosis - Genetic screening - Surrogate mothers and exploitation of women - designing of plants and animals- gene therapy - cloning - Manipulation of human genome -Technology transfer.

UNIT-III

Social and Moral aspects of Biotechnology -Biotechnology and International trade -

Privatization and patenting of Biotechnology products - Role of Government, Industries and society in promoting, accepting and regulating the rDNA research.

UNIT-IV

Environmental and Health aspects of Biotechnology - Generally engineered organisms - Introduction of novel species and natural equilibrium - Environmental security and safety - Precautionary measures - Genetically modified foods - health safety.

Reference Books

1. Gene Cloning – Brown.
2. Concepts in Biotechnology- Balasubramanyam. D.
3. Basic Biotechnology - Colin Rotledge and Kristainsen.
4. Gene Biotechnology – Jogdand.
5. From Genes to Clones, Introduction to Gene Technology-Winnacker, Ernst.L.
6. Safety, Moral, Social and Ethical issues related to genetically modified foods - Smith J.E.
7. Molecular Biology and Biotechnology - Meyer R.A.
8. Environmental Biotechnology- Forster and wase.
9. Biotechnological Innovations in Environmental Management - Leach and Van Dam-mieras.
10. Industrial Microbiology and Biotechnology- Demain and Solomon.

Course outcomes:

The student will be able to

1. Acquire the knowledge on IPR and procedures for patent filing
2. Understand the Legal and Ethical aspects of gene therapy - cloning - Manipulation of human genome -Technology transfer.
3. Learn role of Government, Industries and society in promoting, accepting and regulating the rDNA research
4. Develop understanding on Environmental and Health aspects of Biotechnology

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	2	1	1	3	1	1	-	-
CO_2	2	2	3	1	2	1	1	3	1	1	-	-
CO_3	2	2	3	1	2	1	1	3	1	1	-	-
CO_4	2	2	3	2	2	1	1	3	1	1	-	-

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 306 b	Bioinformatics	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To gain working knowledge on computational tools and methods
2. To gain knowledge about various Biological databases that provide information about nucleic acids and protein
3. To get exposed to computational methods, tools and algorithms employed for Biological Data Interpretation
4. To provide knowledge about the basics of sequence alignment and analysis.

UNIT-I

Concept of programming languages, hardware and software. The basics of operating system. Windows operating systems commands to create and handle directory and files, creation of biological data bases and MS access. MS office: introduction and facilities available, shortcut bar, customizing tool bars, starting an office file, MS word, Excel, Power point

UNIT-II

Introduction to internet and biologists: Basics on internet, getting into the internet, email, file transfer protocols, gopher, www, browsing and downloading from the sites
Networking of computers and overview of networks: Virtual library I, II, III and information networks: www, http, html, URLs, EMB net, NCBI net, Virtual tourism.

UNIT-III

Primary information resources for proteins and genes, biological databases for protein and DNA sequences, Specialized genomic resources, DDBJ, Gen Bank, and EMBL public DNA sequence databases, SWISSPORT data base, information retrieval from biological data bases, the NCBI data model, submitting the DNA sequence to the database and updating.
Sequence Analysis: Wisconsin GCG, DNASIS, DNASTAR, CLONE Manager, packages for nucleotide sequence analysis, sequence alignment and database searching, practical aspects of multiple sequence alignment.

UNIT-IV

Phylogenetic analysis: phylogenetic models, multiple alignment procedures, (CLUSTAL, ALIGN, PHYLIP), tree building methods, trees evaluation, rooting trees, phylogenetic software. Predictive methods: Detecting regulatory elements in the DNA, Physical properties of proteins based on proteins based on sequences, differential protein structural motifs, RNA binding domains and folding classes, transcription factors and their DNA binding, protein structure predictions.

Reference Books

1. Robert B Northrop, Anne N Connor: Introduction to Molecular Biology, Genomics and Proteomics for Biomedical Engineers, CRC Press.
2. Brown TA, Genomes, 3rd Edition, Garland Science, 2006.
3. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006.
4. Discovering Genomics, Proteomics and Bioinformatics, 2nd edition-A. Malcolm Campbell and Laurie J. Heyer (ISBN 0-8053-4722-4)-Cold Spring Harbor Laboratory press and Benjamin Cummings, 28 Feb 2006.
5. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Benjamin Cummings, 2007.
6. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

Course outcomes:

The student will be able to

1. Develop understanding about Biological data and database search tools
2. Acquire hands on training on various computational tools and techniques employed in Biological sequence analysis
3. Learn about pathway and enzyme databases, Sequence submission tools
4. Develop understanding on protein folding and its significance

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	2	1	-	-	-	-	1	1	-	-
CO_2	2	2	2	1	-	-	-	-	1	1	-	-
CO_3	2	2	2	1	-	-	-	-	1	1	1	1
CO_4	2	2	2	1	-	-	-	-	1	1	1	1

Semester – IV

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 401	Environmental Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. Make them understand the concept, organization and energy flow in an ecosystem
2. Impart knowledge on the process of biodegradation and bioremediation
3. Equip with the knowledge on biological control and scope of bio fertilizers in agriculture
4. Educate about different types of wastes and their ecofriendly management

UNIT-I

Structure of model ecosystem - terrestrial, aquatic ecosystems - Energy flow - Degradation of ecosystem. Consequences - Ecosystem managements - Energy conservation - Alternative energy sources - Biofuels: Production of bioethanol, boibutanol from agriculture waste - Problems and perspectives - Biodiesels: mass cultivation of *Jatropa* and use of *Jatropa*, marine algae for production of biodiesel.

UNIT-II

Nature of recalcitrant compounds - Anthropogenic activities generating recalcitrant chemical waste - BHC, DDT, nitro phenols, polycyclic aromatic carbons. Biodegradation - microbial conversion of recalcitrant toxic compounds into TCA cycle intermediates eg: *Pseudomonas putida*. Bioremediation, Degradation pathways - naphthalene, BHC, and nitro phenols. Use of microbes for reconstruction of ecosystems - Genetics of biodegradation. Microbes as biosensors for detecting pollution. Superbug – cleaning of oil spills.

UNIT-III

Biological methods of pest management - Role of Juvenile hormones, pheromones and its analogues for pest management, Chromosomal manipulation and androgenesis of pest , sterile male technology, Biological control of weeds. Bacterial (BT), viral, fungal insecticides - Technology for mass production and formulation of biopesticides - Problems and prospects. Biofertilizers - Important diazotropic, microbes - mechanism of symbiotic and asymbiotic biological nitrogen fixation - Regulation of nitrogen fixing genes (Nif genes). Manipulation of Nif genes for constitutive expression of nitrogenase - Ammonia transport and its significance. Mass production of biofertilizers - *Rhizobium, Azolla.*

UNIT-IV

Waste management - Nature and classification of agriculture, domestic and industrial waste - Recycling methods. Solid waste treatment. Biological and non-biological methods of waste water treatment. Reclamation of treated waste water.

Reference Books

1. Environmental Biotechnology: Concepts and Application by Jordening H J and Winter J.
2. Environmental Biotechnology: Theory and Application by Evans G M and Furlong J C.
3. Environmental Biotechnology by Bhattacharya B C and Banerjee R.
4. Environmental Biotechnology: Basic Concepts and Applications by Indu Shekhar Thakur.
5. Environmental Biotechnology by V Kumaresan and N Arumugam.
6. Environmental Biotechnology by Perry L McCarty and Bruce E Rittmann.
7. Textbook of Environmental Biotechnology by P K Mohapatra.
8. Environmental Biotechnology by T Srinivas.

9. Environmental Biotechnology by S K Agarwal.

Course outcomes:

The student will be able to

1. Learn the relation between biotic and abiotic factors in different ecosystem models and predict how changes in free energy availability affect ecosystems.
2. Appreciate the role of microorganisms in biodegradation and pollution detection
3. Develop skill on large scale production and applications of bio pesticides and bio fertilizers fin agriculture
4. Apply knowledge on solid waste management and reclamation of waste water

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	3	2	1	3	-	1	1	-	-
CO_2	3	2	3	3	2	1	3	-	1	1	-	-
CO_3	3	2	3	3	2	1	3	-	1	1	-	-
CO_4	3	2	3	3	2	1	3	-	1	1	-	-

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 402	Plant Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To impart knowledge about transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality
2. Impart knowledge on biosynthesis of plant compounds
3. Improve understanding on the role of algae as food, feed and medicine
4. Train in identification of plant pathogens using immunological and molecular techniques

UNIT-I

Concepts and scope of plant biotechnology -Application of genetic engineering technology for crop improvement - production of transgenic plants resistant to herbicides, pathogens, pests and abiotic stresses (drought, salt, frosts); production of transgenic plants with improved yields and nutritional quality; transgenic plants for production of viral antigens.

UNIT-II

Industry and Plant Biotechnology: Biosynthesis of plant compounds – Selection of cell lines for high yields of secondary metabolites – Enzymes from plants – Food and food additives from plants – Breeding strategies for enhancing the active principles in plants.

UNIT-III

Algae as a source of food, feed, single cell proteins, biofertilizers, industrial uses of algae. Mass cultivation of commercially valuable marine microalgae for agar agar, alginates and other products of commerce and their uses. Mass cultivation of macroalgae as a source of protein and feed. Indoor and outdoor cultivation of economic important algae – Use of algae in waste water treatment.

UNIT-IV

Nutrient film culture techniques - plant diseases – Physiology of infection in plants – disease resistance in plants - phytodiagnostics based on immunological and molecular techniques. Biological control of pests and diseases of crop plants and weeds - biopesticides - predators, parasites, insect viruses, antagonistic fungi and bacteria, antifeedants, and insecticidal activities of the compounds of Botanicals.

Reference Books

1. Molecular approaches to crop improvement. 1991. Dennnis and Li Welly eds. PP. 164.
2. Plant cell and Tissue culture. A Laboratory Manual. 1994. Reinert. J. and Yeoman, M.M. Spring.
3. Plant biotechnology, 1994. Prakash and Pierik. Oxford & IBH Publishing Co.
4. Gene transfer to plants. 1995. Potrykus-l and Spangenberg, G. Des. Springer Scan.
5. Methods in Plant Molecular Biology and biotechnology, 1993. R. Bernard Click and Joh. E.; Thompson, CRC, Press, PP. 384.
6. Genetic engineering with plant viruses. 1992. T. Michale. A. Wilson and J.W. Davies. CRC Press Inc, PP 384.
7. Plant cell Biotechnology. 1988. Borocoitzka M.A. and Borocoitzka L.J. Cambridge University Press.
8. Microaigal Biotechnology. 1988. Borocotizka M.A. and Borocoitzka L.J. Cambridge University Press.
9. Algal and Cyanobacterial biotechnology, 1989. Cresswell. R.C, Rees, T.A.V. and Shah, N.Eds. Longman Scientific and Technical, Essex, London.

Course outcomes:

The student will be able to

Students will be able to

1. Develop skill in production of transgenic plants resistant to biotic and abiotic stress

2. Apply knowledge for industrial production of plant metabolites
3. Cultivate the micro and macro algae of commercial importance on large scale
4. Identify different plant pathogens and apply biological control methods

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	3	3	-	-	-	3	-	-	-
CO_2	2	2	2	1	2	-	-	-	-	-	-	-
CO_3	1	1	-	1	1	-	2	-	-	-	-	-
CO_4	3	3	3	3	2	-	3	-	3	-	-	1

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 403 a	Animal Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:
1. Develop understanding on the structure and functions of male reproductive system and methods of contraception
2. Make them learn the principle and methods of animal cloning
3. Provide knowledge on gene cloning and production of transgenic animals
4. Impart the knowledge on role of biotechnology in health care system

UNIT-I
Structure and function of male reproductive system - Hormonal regulation of spermatogenesis and spermatogenesis; Inhibin and androgen binding proteins; Capacitation of spermatozoa. Structure and function of female reproductive system - influence of hormones on development of ovarian follicles and oogenesis; Reproductive cycles; estrus and menstrual cycle; Ovulation, atresia and corpus luteum formation; Pregnancy and lactation;

Implantation and placentation. Contraception in males and females; Hormonal and chemical; Recent advances in contraception research. Artificial insemination (AI) techniques and their development; Estrus synchronization; Semen collection, evaluation, storage, *in vitro* fertilization, Embryo transfer - ICSI and preservation of endangered species.

UNIT-II

Animal cloning and application in wild life and life stock: Overview; Challenges in human therapeutic cloning; Somatic cell nuclear transfer in humans; pronuclear early embryonic development. Nuclear transfer technology: Transfer of nuclei into eggs; development potential of transplanted nuclei; reprogramming a nucleus. Development of transgenic mice and other animal models: by injection of foreign DNA/gene into zygote; optimization of construct for *in vivo* expression. Generation of chimeric, transgenic and knockout mice and other animals and their characterization. Potential application of transgenic animals: Models for various diseases/disorders, Production of peptides and proteins of biopharmaceutical interest (molecular pharming), transgenic fishes, transgenic poultry and transgenic insects as bioreactors.

UNIT-III

Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures. The biology of stem cells – Different types of stem cells – embryonic stem cells, fetal tissue stem cells, adult stem cells; stem cell differentiation, stem cell plasticity – Differentiation versus stem cell renewal. Isolation and propagation of embryonic stem cells; chimeras; generation of knockout mice and knock-in technology.

UNIT-IV

Application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Stem cell therapies: Clinical applications of stem cell therapy; Neurodegenerative diseases-Parkinson's disease, Alzeimer's, spinal cord injury, other brain syndromes; tissue systems failures - diabetes, cardiomyopathy, kidney failure, liver failure - hemophilia, lymphoma and leukemic malignancies requiring stem cell therapy.

Reference Books

1. Culture of animal cell: A Manual of Basic techniques. 3rd ed. 1994. R.I. Reshnery, Alan R. liss. Inc. New York, NY, 397.
2. Recombinant and synthetic vaccines 1994. G.P. 1 Taiwan K.V.S. Rao, V.S. Chauhan, Eds. PP. 528. Springer Scan Publication.
3. Animal Cell Biotechnology, Vol.6, 1994, R.E. Spier, J.B. Griffiths, Eds. Harcourt Brace. PP.

Course outcomes:

The student will be able to

1. Understand the organization of reproductive organs and advances in contraception research
2. Learn the techniques of In Vitro Fertilization and artificial insemination
3. Develop skill in molecular techniques for production of transgenic animals
4. Apply knowledge on molecular farming for production of vaccines and hormones

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	1	2	1	1	-	-	-	-	1	1	-	-
CO_2	2	2	1	1	2	-	-	-	1	1	-	-
CO_3	2	2	2	1	1	-	-	-	1	1	-	-
CO_4	3	2	2	2	2	-	-	-	1	1	1	1

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 403 b	Applications of Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To provide understandng on different areas of biotechnology
2. Impart knowledge on the role of biotechnology in agriculture
3. Develop skill on the cell & tissue culture system for vaccine production
4. Give insight on the xenobiotic environmental pollution and methods of degradation of toxic compounds

UNIT-I

History and scope of Biotechnology, Definition of Biotechnology, Old *&* Modern Biotechnology, Different areas of Biotechnology.

UNIT-II

Biotechnology and Agricultural, Micro propagation, (Cell and Tissue culture) Transgenic plants, Biofertilization, organic farming, Biopesticides.

UNIT-III

Application of Biotechnology in Animal sciences, Animal cell and tissue culture, production

of transgenic animals, cloning of animals (IVF & ET) cryopreservation somatic production of animals, application of human vaccines in improving productivity.

UNIT-IV

Biotechnology and Environment: Microbial agents and Biochemical methods of xenobiotic degradation, OEMs, Waste water and solid waste management.

Reference Books

1. Gene Cloning – Brown.
2. Concepts in Biotechnology- Balasubramanyam.D.
3. Basic Biotechnology - Colin Rotledge and Kristainsen.
4. Gene Biotechnology – Jogdan.
5. From Genes to Clones, Introduction to Gene.
6. Technology- Winnacker, Ernst.L.
7. Safety, Moral, Social and Ethical issues related to genetically modified foods - Smith J.E.
8. Molecular Biology and Biotechnology - Meyer R, A.
9. Environmental Biotechnology- Forster and wase.
10. Biotechnological Innovations in Environmental.
11. Management - Leach and Van Dam-mieras.
12. Industrial Microbiology and Biotechnology- Demain and Solomon.

Course outcomes:

The student will be able to

1. Acquire the knowledge on applications of plant, animal and environmental biotechnology
2. Develop skill on organic farming and preparation of bio pesticides and bio fertilizers
3. Establish and maintain cell lines for vaccine production
4. Apply knowledge on waste management and recycling for environmental protection

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	-	-	-	-	1	-	-	-
CO_2	2	2	3	1	-	-	-	-	1	-	-	-
CO_3	2	2	1	1	-	-	-	-	1	-	-	-
CO_4	2	2	3	2	-	-	1	-	1	-	-	-

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 403 c	Pharmaceutical Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To impart knowledge on production of pharmaceutical products by biotechnological applications
2. Provide training in clinical testing of pharmaceutical products
3. Give insight on the drug designing and development
4. Explain the comprehensive overview on the conventional and recombinant vaccines and bioethical issues

UNIT-I

Definition - History of development of Pharmaceutical Products by biotechnological methods like genetic recombinant vaccines, microbial and non-microbial products - scope of biotech products and biochemical in pharmaceutical industry. Need to design a drug, drug receptor interactions, antagonisms, biological activity, efficacy and stimulus, receptors and ion channels, ion gating co-operatively effect of solvent on drug - receptor interactions, drug docking.

UNIT-II

Methods of testing products for anti-microbial potentials, pharmacological activities and biopesticidal properties -conventional and rapid enzyme inhibitor techniques; in vivo methods - use of animals models for confirmation of in vitro properties - transgenic systems - preclinical, toxicological studies, Acute, sub acute, chronic studies. Clinical trials -definition - design - specific objectives - types of clinical trials -phase I, II & II - randomized controlled clinical trials - multicentric double blind clinical trials - pharmaceutical/drug regulations for commercializing new biotech products for human use - PDA and Indian regulations.

UNIT-III

Biotech products as medicines and pharmaceutical products: Biochemical's - enzymes like proteases - chemical like ethanol, vinegar, citric acid and glutamic acid; vitamins like B12; drugs for infection and metabolic, immunomodulatory -insulin - interferon's, B-cell growth factors, Tissue plasminagen activator. r-DNA based production of regulatory proteins, blood products, hormones, vaccines, Application of RELP in forensic, disease prognosis, genetic counseling, pedigree, and variation.

UNIT-IV

Vaccines - cell culture-based vaccines - genetic recombinant vaccines - recombinant vector-based vaccines -live and subunit - their production model - fermentation technology - expression systems - guideline for the production of genetic recombinant vaccines - Eg. Hepatitis B vaccine, HIV vaccine and other vaccines in pipeline. Application of biotechnology to Animal health and disease diagnosis, Development of kits and their

application in disease diagnosis. Gene therapy, vector engineering, strategies of gene deliver, gene replacement, augmentation, gene correction, gene regulation and silencing safety and bioethical issues in biotechnology.

Reference Books

1. Biopharmaceuticals- Walsh, John Willey and Sons, New York 1998 Pharmaceutical Biotechnology- Daan J.A. Crommelin, RobestD. Sindelar, Daan JACrommelinAmazon.
2. Physical Methods to characterize Pharmaceutical Proteins- James. N.Herron, Wim Jiskoor and Daan J.A.Crommelin Amazon. Wm From clone to clinic (Developments in Biotherapy)-Daan J.A.Crommelin and H.Schellekom Amazon.Wm.
3. Hand Book of Pharmaceutical Biotechnology- Jay P.Rho, Starlonie the Haworth press.
4. Alice Sr. Bringhamtpn, NY13904 US Drug discovery, Tamas bartifai, Harold L.Dorn's The Scientific world Ltd., Newburry, U.K.

Course outcomes:

The student will be able to

1. Gain knowledge on preparation and formulations of different drugs
2. Develop skill on commercial production of pharmaceutical products for human welfare
3. Learn the techniques of drug validation and vaccine production
4. Understand the bioethical principle, values, concepts and social and judicial implications of pharmaceutical biotechnology

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	1	1	-	-	-	-	1	1	-	-
CO_2	2	2	1	1	-	-	-	-	1	1	-	-
CO_3	2	2	1	1	-	-	-	-	3	1	3	-
CO_4	3	2	3	2	2	1	1	1	1	1	-	-

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 404 P	Environmental Biotechnology,Plant Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

PRACTICALS: ENVIRONMENTAL BIOTECHNOLOGY, PLANT BIOTECHNOLOGY

ENVIRONMENTAL BIOTECHNOLOGY

1. Determination of total dissolved solids of water.
2. Determination of dissolved oxygen (DO) of water.
3. Determination of biological oxygen demand (BOD) of water.
4. Determination of chemical oxygen demand (COD) of water.
5. Determination of total bacterial population by standard plate count technique.

PLANT BIOTECHNOLOGY

1. Preparation of competent cells of E. coli for harvesting plant transformation vector.
2. Transformation of competent cells of E. coli with plant transformation vectors.
3. Mobilization of recombinant Ti plasmid from common laboratory host (E. coli) to an *Agrobacterium tumefaciens* strain.
4. Agrobacterium tumefaciens-mediated plant transformation.

Course Code	Course Title	No of Hours Per week	No of Credits
BTH 405	MOOCS/Project	**04**	**4**
End Semester Examination Marks: 100			

Marks allotted to thesis preparation-80 (40 marks for the progress performed by the student in laboratory will be awarded by project research supervisor and another 40 marks for content of the thesis) & Marks allotted to viva presentation-20

Course Objectives:

1. To impart knowledge about the various analytical and biophysical techniques.
2. To make the student to be able to carry out purification and characterization of various biomolecules.
3. To educate the student to characterize the separated biomolecules by electrophoresis and spectroscopic techniques.
4. To familiarize with the concepts and the techniques of Radioactivity

Course outcomes:

The student will be able to

5. Acquire the knowledge on classification and structure of different microorganisms
6. Understand the microbial techniques for isolation, cultivation and maintenance of pure cultures
7. Learn structure, function of gene and its transfer methods
8. Develop understanding on cause, spread and control of diseases caused by different microorganisms

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 406 a	Applications of Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To provide understanding on different areas of biotechnology
2. Impart knowledge on the role of biotechnology in agriculture
3. Develop skill on the cell & tissue culture system for vaccine production
4. Give insight on the xenobiotic environmental pollution and methods of degradation of toxic compounds

UNIT-I

History and scope of Biotechnology, Definition of Biotechnology, Old *&* Modern Biotechnology, Different areas of Biotechnology.

UNIT-II

Biotechnology and Agricultural, Micro propagation, (Cell and Tissue culture) Transgenic plants, bio fertilization, organic farming, bio pesticides.

UNIT-III

Application of Biotechnology in Animal sciences, Animal cell and tissue culture, production of transgenic animals, cloning of animals (IVF & ET) cryopreservation somatic production of animals, application of human vaccines in improving productivity.

UNIT-IV

Biotechnology and Environment: Microbial agents and Biochemical methods of xenobiotic degradation, OEMs, Waste water and solid waste management.

Reference Books

1. Gene Cloning – T.A. Brown.
2. Concepts in Biotechnology- Balasubramanyam.D.
3. Basic Biotechnology - Colin Rotledge and Kristainsen.

4. Gene Biotechnology – Jogdan.
5. From Genes to Clones, Introduction to Gene Technology- Winnacker, Ernst.L.
6. Safety .Moral, Social and Ethical issues related to genetically modified foods - Smith J.E.
7. Molecular Biology and Biotechnology - Meyer R, A.
8. Environmental Biotechnology- Forster and wase.
9. Biotechnological Innovations in Environmental Management - Leach and Van Dam-mieras.
10. Industrial Microbiology and Biotechnology- Demain and Solomon.

Course outcomes:

The student will be able to

1. Acquire the knowledge on applications of plant, animal and environmental biotechnology
2. Develop skill on organic farming and preparation of bio pesticides and bio fertilizers
3. Able to establish and maintain cell lines for vaccine production
4. Apply knowledge on waste management and recycling for environmental protection

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	-	-	-	-	1	-	-	-
CO_2	2	2	3	1	-	-	-	-	1	-	-	-
CO_3	2	2	1	1	-	-	-	-	1	-	-	-
CO_4	2	2	3	2	-	-	1	-	1	-	-	-

Course Code	**Course Title**	**No of Hours Per week**	**No of Credits**
BTH 406 b	Tools in Biotechnology	**04**	**4**
Sessional Marks: 20			**End Semester Examination Marks: 80**

Course Objectives:

1. To improve understanding on replication initiation point mapping.
2. To gain knowledge on use of DNA microarrays to analyze origin activation patterns
3. To build knowledge on Electron microscopic methods for identifying DNA replication intermediates.
4. To give insight on replication dynamics of gene

UNIT-I

Replication initiation point mapping: Approach and implications, purification of restriction fragments containing replication intermediates, Topological analysis of plasmid DNA

replication intermediates, Analysis of telomeric DNA replication using neutral alkaline 2D gel electrophoresis, chromatin immunoprecipitation of replication factors moving with replication fork, density transfer as a method to analyze the progression of DNA replication fork, High resolution mapping of points of site specific replication, DNA replication in nucleus

UNIT-II

Chip-chip to analyze the binding of replication proteins to chromatin using oligonucleotides DNA microarrays, analyzing origin activation patterns by changing experiments. Detection of replication origins using comparative genomics and recombination ARS assay. Isolation of restriction fragments containing origin of replication from complex genomes. Application of alkaline sucrose degradation and analysis of DNA replication after DNA damage.

UNIT-III

Isolation of recombinant DNA elongation proteins *In vitro* assays for studying helicase activities, the use of two amino fluorescence to study DNA polymerase function, Single molecule observation of prokaryotic DNA replication, The FAST-HALO assay for the assessment of DNA damage for the single cell level. Electron microscopic methods for studying In vivo DNA replication intermediates.

UNIT-IV

Visualization of DNA replication sites in mammalian nuclei, measuring of DNA content by flow cytometry in Fission Yeast. Assays used to study replication check point in Fission Yeast. Use of DNA combining to study SNA replication in genus and in human cell free systems. Determining the replication dynamics of specific gene loci by single molecule analysis of replicated DNA.

Reference Books

1. DNA replication methods and protocols in Methods in Molecular Biology Edited by John N walker coedited by Soniya and Jacob Gelgard 2009. Humana press, New York.
2. General biochemistry and biophysics methods books.

Course outcomes:

The student will be able to

1. Acquire the knowledge on analysis of DNA replication to map site specific points of replication
2. Learn to apply DNA microarrays to detect replication origins
3. Understand the functions of helicase and polymerase in DNA replication
4. Acquire knowledge on sophisticated programmed of genome replication

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	1	1	1	-	-	-	-	-	-	-
CO_2	2	2	2	1	1	-	-	-	-	-	-	-
CO_3	1	1	1	1	1	-	-	-	-	-	-	-
CO_4	2	1	1	1	1	-	-	-	-	-	-	-

M.Sc. Biotechnology:: Model Question paper

Semester I/II/III/IV Paper

Time 3 Hrs **Max marks 80**

Attempt any five from part A (4 x 5=20 marks) and all from part B (4 x 15=60 marks)

PART A (5 x 4=20 marks)

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

PART B (4 x 15=60 marks)

9. Unit 1 A or B
10. Unit 2 A or B
11. Unit 3 A or B
12. Unit 4 A or B

SRI VENKATESWARA UNIVERSITY
DEPARTMENT OF BIOTECHNOLOGY

Eligibility criteria for Open elective offering in Department of Biotechnology

Semester	**Title of the Paper - Open Elective**	**Eligibility**
III	6a Bioethics	Students of all biological Science departments
	6b Bioinformatics	
IV	6a Applications of Biotechnology	
	6b Tools in Biotechnology	