YEAR II, SEMESTER III

COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
			L	T	P	CA	EE		
BBT301	Food Biotechnology	HSS	3	1	0	30	70	100	4
BBT302	Biostatistics	BSC	3	1	0	30	70	100	4
BBT303	Microbiology	BSC	3	1	0	30	70	100	4
BBT304	Biochemistry	BSC	3	1	0	30	70	100	4
BBT305	Cell Biology	BSC	3	1	0	30	70	100	4
BBT306	Analytical Techniques	PCC	3	1	0	30	70	100	4
BBT307	Plant Biology	BSC	3	1	0	30	70	100	4
BBT353	Microbiology Lab	BSC	0	0	2	15	35	50	1
BBT354	Biochemistry Lab	BSC	0	0	2	15	35	50	1
BBT355	Cell Biology Lab	BSC	0	0	2	15	35	50	1
BBT356	Analytical Techniques Lab	PCC	0	0	2	15	35	50	1
	General Proficiency	GP-301	-	-	-	50	-	50	-
TOTAL			**21**	**7**	**8**	**270**	**560**	**950**	**32**

L - Lecture, **T** - Tutorial, **P** - Practical, **CA** - Continuous Assessment, **EE** - End Semester Exam; BSC-Basic Science Course; ESC-Engineering Science Course; HSS-Humanities & Social Science Course; ; PCC-Professional Core Course; AUC-Audit Course; PS-Project work,Seminar,Internship

YEAR II, SEMESTER IV

COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
			L	T	P	CA	EE		
BBT401	Molecular Biology	PCC	3	1	0	30	70	100	4
BBT402	Bioprocess Engineering	PCC	3	1	0	30	70	100	4
BBT403	Immunology & Immunotechnology	PCC	3	1	0	30	70	100	4
BBT404	rDNA Technology	PCC	3	1	0	30	70	100	4
BBT405	Bioinformatics & Computational Biology	PCC	3	1	0	30	70	100	4
BBT406	Bioseparation Engineering	PCC	3	1	0	30	70	100	4
BBT407	Engineering Economics	PCC	2	0	0	15	35	50	2
BBT408	Environmental Science	AUC	0	0	0	0	0	0	0
BBT451	Molecular Biology Lab	PCC	0	0	2	15	35	50	1
BBT452	Bioprocess Engineering lab	PCC	0	0	2	15	35	50	1
BBT453	Immunology & Immunotechnology lab	PCC	0	0	2	15	35	50	1
BBT454	rDNA Technology lab	PCC	0	0	2	15	35	50	1
BBT455	Bioinformatics & Computational Biology lab	PCC	0	0	2	15	35	50	1
GP-401	General Proficiency		-	-	-	50	-	50	-
Total			**20**	**6**	**10**	**320**	**630**	**950**	**31**

L - Lecture, **T** - Tutorial, **P** - Practical, **CA** - Continuous Assessment, **EE** - End Semester Exam; BSC-Basic Science Course; ESC-EngineerinG Science Course; HSS-Humanities & Social Science Course; ;PCC-Professional Core Course; AUC-Audit Course; PS-Project work,Seminar,Internship

B.Tech. Biotechnology: Semester-III BBT 301: FOOD BIOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To impart knowledge about the innovations in food processing technologies and their applications. To understand changes in the composition of food and comparison with conventional cooking methods. To know packaging materials, their need according to different foods and to food quality parameters and their maintenance during storage.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Identify the conditions under which the important pathogens are commonly inactivated, killed or made harmless in foods

CO2: Understand the principles involving food processing via fermentation processes.

CO3: Understand the principles that make a food product safe for consumption

CO4: Understand the principles and current practices of preservation techniques and the effects of preservation parameters on product quality

CO5: To look for careers in Food industries.

Unit I: History of Microorganisms
History of Microorganisms in food, Historical Developments. Role and significance of microorganisms in foods. Intrinsic and Extrinsic. Parameters of Foods that affect microbial growth. Basic principles, unit operations, and equipment involved in the commercially important food processing methods and unit operations **Microorganisms** Microorganisms in fresh meats and poultry, processed meats, seafood's, fermented and fermented dairy products and miscellaneous food products. Starter cultures, cheeses, beer, wine and distilled spirits, SCP, medical foods, probiotics and health benefits of fermented milk and

foods products. Brewing, malting, mashing, hops, primary & secondary fermentation: Biotechnological improvements: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl. Beer, wine and distilled spirits.
Unit II: Nutritional boosts and flavor enhancers:
Emerging processing and preservation technologies for milk and dairy products. Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms. Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods **Food Preservation**-Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food Preservation. Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents.
Unit III: Storage Stability Food-
Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying, Indicator and Food-borne Pathogens, Other Proven and Suspected Food-borne Pathogens. Rheology of Food Production.

Suggested Readings

- Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
- Mann & Trusswell, 2007. Essentials of human nutrition. 3rd edition .oxford university press.
- Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.
- Lindsay, 1988. Applied Science Biotechnology. Challenges for the flavour and Food Industry. Willis Elsevier.
- Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology.

B.Tech. Biotechnology: Semester-III BBT 302: BIOSTATISTICS	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The course will provide understanding of the fundamentals of statistics, methodology and theory of statistics and their application for solving the problems in the field of life sciences. The objective of this course is to familiarize Students with Basics of Statistics, Permutations & Combinations, concepts of Probability, Principles of Correlation and Regression and Hypothesis Testing.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Classify various types of data and apply basic statistical concepts such as measures of central

CO2: Tendencies, measures of dispersion and sampling.

CO3: use concepts of probability, probability laws, probability distributions and apply them in solving

CO4: biological problems and statistical analysis.

CO5: perform statistical hypothesis testing using tools such as t-test, ANOVA, Tukey test and Chisquare test

Unit 1:Basics of Statistics
Data types, classification and summarization of data, graphs and charts, Mean Median, Mode, Standard deviation, dispersion movments and moment generating function, skewness, kurtosis. **Permutations & Combinations:** Fundamental principle of counting. Factorial, Permutations and combinations, derivation of formulae and their connections, simple applications.
Unit 2:Probability
Algebra of probabilities**,** Random experiments: outcomes, sample spaces (set representation). Events: occurrence of events, 'not', 'and' and 'or' events, exhaustive events, mutually exclusive events Axiomatic (set theoretic) probability, connections with the theories of earlier classes.

Probability of an event, probability of 'not', 'and' & 'or' events. Multiplication theorem on probability. Conditional probability, independent events, total probability, Bayes theorem. Bionomial distribution, Poisson distribution, Normal distribution and Gaussian distribution.
Unit 3:Correlation and Regression
Positive and negative correlation, Pearson and rank correlation coefficients, Non Parametric tests, curve fitting of various curves by method of least square, Linear, non-linear and multiple regression. **Testing:** Hypothesis testing, Chi square test and F-tests, Variant, One way and two way analysis of variants, ANOVA, Principles of experimental design and analysis.

Suggested Readings

- N.T.J. Baily; Statistical Methods in Biology; English University Press
- R. Rangaswami; A text Book of Agricultural Statistics, New Age Int. Pub.
- Zar J; Biostatistics; Prentice Hall London
- P.S.S. Sunder Rao; An Introduction to Biostatistics; Prentice Hall
- George W. and William G; Statistical Methods, IBH Publication
- B Ipsen Jetal; Introduction to Biostatistics, Harper & Row Publication
- KR Sundaram, SN Dwivedi, V Sreenivas. Medical Biostatistics. Principle and Methods. BI Publisher. 12 Daryaganj. Delhi

B.Tech. Biotechnology: Semester-III BBT 303: MICROBIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To provide fundamental understanding of the microbial world, basic structure and functions of microbes, metabolism, nutrition, their diversity, physiology and relationship to environment and human health. To impart practical skills of isolation and manipulating conditions for their propagation.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Define the science of microbiology, its development and importance in human welfare.

CO2: Describe historical concept of spontaneous generation and the experiments performed to disprove.

CO3: Describe some of the general methods used in the study of microorganisms

CO4: Recognize and compare structure and function of microbes and factors affecting microbial growth.

CO5: Demonstrate aseptic microbiological techniques in the laboratory and check sources of microbial contamination and their control

Unit 1: Fundamentals of Microbiology
The Microbial World and Chemical Principles, Observing Microorganisms through Microscope, Functional Anatomy of Prokaryotic and Eukaryotic Cells, Microbial Metabolism, Microbial Growth, The Control of Microbial Growth, Microbial Genetics, Recombinant microbes.
Unit 2: A Survey of the Microbial World

Classification of Microorganisms, The Prokaryotes: Domains Bacteria and Archaea, The Eukaryotes: Fungi, Algae, Protozoa, and Helminths, Viruses, Viroids, and Prions.
Unit 3: Interaction between Microbe and Host
Principles of Disease and Epidemiology, Microbial Mechanisms of Pathogenicity, Antimicrobial Drugs. Microorganisms and Human Disease: Microbial Diseases of the Skin & Eyes, Respiratory System and Reproductive Systems.

Suggested Readings

- Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
- Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury,
- Massachusetts, 2006.
- Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur
- Associates, 1990.
- G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987

B.Tech. Biotechnology: Semester-III BBT 304: BIOCHEMISTRY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The Students will know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving thing.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand the chemistry of chemical bonding, atomic structure and molecular interactions
CO2: Principles of biophysical chemistry
CO3: Describe the chemistry of carbohydrates, lipids, proteins and nucleic acids
CO4: Describe the chemistry of enzymes
CO5: Identify the metabolic pathway of macro molecules

Unit 1:Basics of Biochemistry
Structure of atoms, molecules and chemical bonds. Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties)
Unit 2: Composition, structure and function of biomolecules: Carbohydrates and Lipids
: Monosaccharides, Disaccharides, Polysaccharides, Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids, Carbohydrates as Informational Molecules, Metabolism of carbohydrates, LIPIDS: Storage Lipids, Structural Lipids in Membranes, Lipids as Signals, Cofactors, Pigments, Working with Lipids. Metabolism of lipid.
Unit 3: Proteins
Amino Acids, Peptides and Proteins, Covalent Structure of Proteins, Protein Structure; Secondary, Tertiary and Quaternary; Protein Denaturation and Folding. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Metabolism of protein.
Unit 4: Nucleic acids
Nucleic Acid Structure, Nucleic Acid Chemistry, Other Functions of Nucleotides. And vitamins. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of nucleic acids.

Suggested Readings

- V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
- A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
- L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

B.Tech. Biotechnology: Semester-III BBT 305: CELL BIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The course is aimed to impart knowledge of structural and functional aspects of cells as unit of living systems. Also, it aims to understand the functions of various organelles and transport of information and matter across cell membrane.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Describe the fundamental principles of cellular biology.
CO2: Apply these principals to current biological questions of today.
CO3: Develop a deeper understanding of cell structure and how it relates to cell functions.
CO4: Understand cell movement and how it is accomplished.
CO5: Understand how cells grow, divide, and die and how these important processes are regulated. Understand cell signaling and how it regulates cellular functions. Also how its disregulation leads to cancer and other diseases.

Unit 1: The Evolution of the Cell
From Molecules to the First Cell, From Procaryotes to Eucaryotes, From Single Cells to Multicellular Organisms. Ultrastructure and function of cell and cell organalies.Membrane Structure: Physicochemical Properties; Molecular Organization – asymmetrical organization of lipids, proteins and carbohydrates. Eukaryotic cell division cycle: Different phases and molecular events. Control of cell division cycle, Transport of Small Molecules Across Cell Membranes: Types and Mechanism; Active Transport by ATP-Powered Pumps, Patch pump technique.
Unit 2: Intracellular Compartments and Protein Sorting

Structure, function and transport of proteins into mitochondria and chloroplast. Transport of proteins and RNA into and of nucleus.Transport of proteins into endoplasmic reticulum and Golgi bodies. Transport by vesicle formation: Endocytosis and Exocytosis and molecular Mechanism of vesicular transport. Cell motility and shape: Structure and functions of microfilaments, Structure and functions of microtubules and intermediate filaments. Intracellular communication through cell junctions: Occluding junctions, anchoring junctions and communicating junctions.
Unit 3: Molecular mechanism of cell-cell adhesions, Extra-cellular matrix of animals
Organization and functions. Extra-cellular matrix receptors on animal cells: integrins Cell Signaling: Signaling via G-Protein linked cell surface receptors, MAP kinase pathways and tyrosine kinase pathway: Initiation, interaction and regulation. Apoptosis: Phases and significance, Morphological and biochemical changes associated with apoptotic cells, Apoptotic pathways and regulators

Suggested Readings

- *Tortora, Microbiology –an introduction (Pierson education Publication)*
- *2. Prescott and Dunn, Industrial microbiology*
- *4. Pelczer, Microbiology (W C Brown publication)*
- *5. Stainetr, Microbiology by (Mac Millan Publication)*
- *Pawar and Dagniwala,. Microbiology (Himalaya publishing House)*

B.Tech. Biotechnology: Semester-III BBT 306: ANALYTICAL TECHNIQUES	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objectives of this course are to provide the Students with the understanding of various analytical techniques used in biotechnology based research and industry. The course will acquaint the Students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis.

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Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Apply basic principles of different analytical techniques in analytical work
CO2: Use spectroscopy and radioactivity in biotechnological applications
CO3: use microscopy, centrifugation and electrophoretic techniques.
CO4: demonstrate principle and working of various instruments.
CO5: use various techniques for solving industrial and research problems.

Unit 1: Microscopic Techniques
History, basic types of light microscopy and their applications in brief; Simple, compound, inverted, stereo, fluorescence, dark field and bright field microscope. Phase contrast microscopy: Amplitude and phase objects, wave terminology, positive or dark phase contrast and negative or bright phase contrast microscopy. Electron microscopy: Transmission Electron Microscope and Scanning Electron Microscope, sample preparation for EM, basic concept of confocal microscope.
Unit 2: Electrophoresis
Principle and types of electrophoresis. Gel electrophoresis: Agarose gel electrophoresis, Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE), Immuno electrophoresis, Capillary or tube gel electrophoresis, isoelectric focusing (IF), Two-dimensional (2D) electrophoresis. Western blotting technique.
Unit 3: Chromatographic Techniques
Principle, application, affinity, mobile phase and stationary phase, types of columns, etc. Types of chromatography: Paper Chromatography, Gel filtration Chromatography, ion-exchange chromatography, affinity chromatography, High Performance Liquid Chromatography (Normal phase and reverse phase).

Suggested Readings

- Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H.
- Freeman & Company, San Fransisco, 1982.
- Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge
- University Press, 2000.
- D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
- R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
- Selected readings from Methods in Enzymology, Academic Press.

B.Tech. Biotechnology: Semester-III BBT 307: PLANT BIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To give extensive knowledge of physiological behavior of different plant under different environmental conditions. To give complete knowledge of mechanism of trapping sun light by the plant to prepare food and other useful metabolites and the mechanism of energy consumption are the main highlights of the course. To explain the process of growth and development of plants and their movement. To explain the importance of relationship between soil, water and plants. To explain and emphasize on the common physiological processes such as diffusion, osmosis, transpiration, photosynthesis and respiration.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To define physiological mechanisms involved in the uptake and transport of water and the translocation of food by plants.

CO2: To understand the mechanisms for procurement of mineral ions by plants and mineral nutrition and the role these minerals play in organic molecule synthesis and use. To evaluate major affects on physiological and biochemical mechanisms of growth regulators (hormones) in plants.

CO3: To determine the interrelationships among plants and micro-organisms, symbiosis in nitrogen and phosphorous acquisition by plants

CO4: To analyze different factors involved in water absorption (like DPD, OP, TP etc.) and the role of environmental and plant factors in photosynthesis and influence upon carbon metabolism in plants (e.g. with respect to alternative fixation pathways photoinhibition, and photorespiration)

CO5: To explain and construct growth curve for investigating the growth pattern. To explain the electron transport chain, phosphorylation and ATP production, Comparison of photosynthetic systems of plants and bacteria. Photorespiration. Respiration; Glycolytic pathway .Citric acid cycle, glyoxylate cycle, Pentose phosphate pathway, their significance, energetics and enzymology.

Unit 1: Plant –Water Relations
Water Relations, Osmosis, and Water movement, Transpiration, Stomatal Behavior, Mineral nutrition/Absorption of minerals/Assimilation of nitrogen and sulfur, The Soil as a Nutrient Reservoir: Nutrient Uptake, Selective Accumulation of Ions by Roots, Electrochemical Gradients and Ion Movement, Electrogenic Pumps are Critical for Cellular Active Transport, Cellular Ion Uptake Processes are Interactive, Root Architecture is Important to Maximize Ion Uptake, The Radial Path of Ion Movement Through Roots, Root-Microbe Interactions.
Unit 2: Photosynthesis
Diversity of Phototrophs.Chloroplast structure. Pigments involved in photosynthesis chlorophylls, carotenoids, xanthophylls and phycobillins. Light and dark reaction. C3 and C4 pathways. Electron transport chain, phosphorylation and ATP production, Comparison of photosynthetic systems of plants and bacteria. Photorespiration. Respiration; Glycolytic pathway .Citric acid cycle, glyoxylate cycle, Pentose phosphate pathway, their significance, energetics and enzymology.
Unit 3: Hormones
Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene, and Brassinosteroids, Photomorphogenesis: Responding to Light, Tropisms and Nastic Movements: Orienting Plants in Space, Secondary Metabolites: A.K.A Natural Products, Terpenes, Glycosides, Phenylpropanoids, Alkaloids.

Suggested Readings

- Maheswari P. Introduction to Embryology of Angiosperms
- Datta, S. C. (1989) Plant Physiology , Central Book Depot, Allahabad.
- Hopkins,W.G.(1999) Introduction to Plant Physiology,John Wiley &SonInc. New York
- Levitt, J.(1969) Introduction to plant physiology , C.V.Koshy Co. Tokyo.
- Malik, C.P. (1980) Plant Physiology, Kalyani Publishers, New Delhi.

B.Tech. Biotechnology: Semester-III BBT 353: MICROBIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
Credits: 2	End Semester Exam – 50 marks

Course Objective

The objective of this laboratory course is to provide the students practical skills on basic microbiological techniques.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Ability to isolate, characterize and identify common bacterial organisms.
CO2: Determine bacterial load of different samples.
CO3: Perform antimicrobial sensitivity test.
CO4: Preserve bacterial cultures.

Experiment Details

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Identification and culturing of various microorganisms.
3. To study antimicrobial susceptibility testing using an octadisc.
4. To determine minimal inhibitory concentration (MIC) of an antibiotic using an E-test.
5. To perform sterility testing of a sample.
6. To isolate fungi present in soil samples and calculate their relative abundance and frequency of occurrence.
7. To determine BOD and COD of water samples from different sources.

Suggested Readings

- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Tools and Techniques-Wilson and Walker.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-III BBT 354: BIOCHEMISTRY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	Internal Assessment – 15 Marks
Credits: 2	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

The objective of this laboratory course is to provide the students practical skills on basic laboratory techniques. To understand the basics of Biochemistry and learn about biomolecules To have complete knowledge of spectrophotometric analysis.To understand biochemical profiling.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Isolate enzymes from various sources
CO2: Determine the Km and Vmax of the enzymatic reactions.
CO3: Perform ELISA & Blotting techniques
CO4: Purify and preserve enzymes

Experiment Details

1. Study of mitosis by microscopic technique.
2. Quantitative estimation of proteins by spectrophotometer.
3. Spectrophotometric estimation carbohydrate.
4. Analysis of affinity difference by paper chromatography

Suggested Readings

- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Tools and Techniques-Wilson and Walker.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-III BBT 355: CELL BIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	Internal Assessment – 15 Marks
Credits: 2	External Assessment – 35 Marks End Semester Exam – 50 marks

Course Objective

To give an overview of biomolecules and their significance.To give basic knowledge function of Macromolecules (Carbohydrates, Proteins and Lipids).To have an overview of Microorganism and their Types.To explain about the media prepapration and sterilization.To explain the DNA,Blood and saliva.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Understand various applications of Biotechnology
CO2: Analyze various biomolecules and their significance, structure and function
CO3: Identify different types of microbes and their importance
CO4: Understand the concept of DNA
CO5: Knowledge of Genes, Cellular components and their impact

Experiment Details

1. Visualization of cells histology
2. Isolation of nucleus from cells
3. Protein estimation by folin lowery method
4. Protein estimation by Bragg ford method
5. To study in detail the mitosis and meiosis

Suggested Readings

- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Tools and Techniques-Wilson and Walker.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-III BBT 356: ANALYTICAL TECHNIQUE LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	Internal Assessment – 15 Marks
Credits: 2	External Assessment – 35 Marks End Semester Exam – 50 marks

Course Objective

To give overview of basic concepts of instruments used in biotechnology laboratory.To give complete knowledge of chromatography, its principles, working mechanism and types.To learn about the basic microscopy techniques.To describe the functions of restriction enzymes and their use in gene cloning experiments.To give complete knowledge of various types of fermentation, sterilization and microbes used in fermentation industry.To explain and give an outline of a typical proteomics experiment.To explain the technique of electrophoresis and its various types.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To learn the working of microscope by preparing and observing the slide of onion root tip for metaphase chromosome under a microscope.

CO2: To learn various types of chromatographic techniques and practically demonstrate the separation of protein pigments with the help of paper chromatography

CO3: To confirm the presence of protein in a sample with the help of biuret test.

CO4: To analyze and demonstrate the process of sugar fermentation

CO5: To evaluate the effect of pH on microbial growth. To demonstrate the technique of agarose gel electrophoresis. To explain the technique of SDS PAGE.

Experiment Details

1. To prepare the slide of onion root tip and observe the mitotic stages under a microscope.
2. To separate protein pigments with the help of paper chromatography.
3. To demonstrate the technique of agarose gel electrophoresis.
4. To study the effect of pH on microbial growth.
5. To demonstrate the process of sugar fermentation.
6. To learn the technique of SDS PAGE.

Suggested Readings

- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Tools and Techniques-Wilson and Walker.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-IV BBT 401: MOLECULAR BIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To understand storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems. The course also aims to make Students understand intricate molecular mechanisms of carcinogenesis and apoptosis and their applications.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Explain the properties of genetic materials and storage and processing of genetic information.

CO2: Apply mechanisms of DNA replication, damage and repair in applied molecular genetics.

CO3: Explain mechanisms involved in gene expression.

CO4: Explain molecular basis of complex metabolic diseases.

Unit 1: DNA Replication and repair
Mechanism of Prokaryotic and Eukaryotic DNA replication, Enzymes and accessory proteins involved in DNA replication, DNA repair Mechanism. **Transcription:** Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements.
Unit 2: Modifications in RNA
5'-cap formation, transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability. **Translation:** Prokaryotic and Eukaryotic translation, the translation Machinery; Mechanisms of initiation, elongation and termination, regulation of translation, co-and post-translational modifications of proteins.
Unit 3: Regulation of Gene Expression in prokaryotic and eukaryotic systems

Lac operon, Ara operan, regulation in Eukaryotes

Antisense and Ribozyme technology : Molecular mechanism of antisense molecules, inhibition of spilicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of Ribozyme; Hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

Suggested Readings

- *Concepts of Genetics, W.S. Klug, and M.R. Cummings 2004, Pearson Education*
- *Genome, T.A. Brown, John Willey & Sons Inc.*
- *Molecular Biology of the Cell. B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson, Garland Publishing*
- *Gene VIII, Benjamin Lewin 2005, Oxford University Press*
- *Molecular Cell Biology, H. Lodish, A.Berk, S. Zipursky, P Matsundaira, D.Baltimore and J.E. Barnell, W.H. Freeman and Company.*
- *Molecular Cloning: A Laboratory Manual (3-Vilcume set), J. Sambrook, E.F. Fritsch and T. Maniatis, Cold spring Harbor Laboratory Press.*
- Molecular Biology of the Gene, J.D. Watson, A.M. Weiner and N.H. Hopkins, Addison-Wesley Publishing.

B.Tech. Biotechnology: Semester-IV BBT 402: BIOPROCESS ENGINEERING	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To understand the basic of fermentation, different bioreactor design, different media used for the fermentation of product, overview of product produced by biotechnological industries.To learn the different instrumentation used for the downstream processing of different products.To learn and have complete knowledge of type of enzymes and different fermented food products of different industries. To understand how downstream processing instrumentation works or they can use like crystallization, during, liquid-liquid extraction, centrifugation, chromatography etc.To learn the enzyme kinetics, microbial kinetics, thermal kinetics and the application of these in fermentation.To expertise in the process involved in the effluents or waste of fermentation industries by latest technologies involved in treatment of waste like, Activated sludge process, Rotating Disk Biological Contractor (RBC) etc.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand various types of fermentation mode of operation and their kinetics.
CO2: Analyze the effect of various fermentation and downstream processes involved in the synthesis of products.
CO3: Understand the enzyme production and their application involved in modern world.
CO4: Understand the instrumentation involved in the downstream processing of products produced by different pharmaceutical and biotechnological industries.
CO5: Evaluate performance of different fermentation processes i.e., whose work in batch and continuous mode of operation.
CO6: Will understand the production and application of some enzymes used in food and biotechnological industries.

Unit 1: ***Basic principle of Biochemical engineering***
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 2: ***Concepts of basic mode of fermentation processes***
Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization.
Unit 3: ***Downstream processing***
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.
Unit 4: ***Applications of enzymes in food processing***
Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

Suggested Readings

- Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
- Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engel wood Cliffs, 2002.
- Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997
- Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co.,
- New York, 1986.
- Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
- Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

B.Tech. Biotechnology: Semester-IV BBT 403: IMMUNOLOGY AND IMMUNOTECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objective of this course is to provide Students with detail understanding of different cells of the immune system and their role in immune protection as well as application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of cancer, autoimmune disease, AIDS and different infectious diseases.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Explain the role of immune cells and their mechanism in body defense mechanism.
CO2:. Apply the knowledge of immune associated mechanisms in medical biotechnology research
CO3: Demonstrate immunological techniques.
CO4: Interpret association of immune system with cancer, autoimmunity, transplantation and infectious disease.
CO5: Generate new vaccine target and develop strategy to design novel vaccine

Unit 1: Introduction to immunity
Characteristics of innate and adaptive immunity, Humoral and Cell mediated immune response, Hematopoiesis, Cells and Molecules of the immune system, Primary and Secondary lymphoid organs. Inflammation, Characteristics of T&B cell epitopes, T & B cell maturation, activation and differentiation. Characteristics and types of Antigens, Factors affecting the immunogenicity. Haptens and adjuvants. ABO blood group antigens, Epitopes. Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins.
Unit 2: *Antigen Processing and presentation*
Structure and Function of MHC molecules, Exogenous and Endogenous pathways of antigen processing and presentation, Complement system, Structure, function and application of cytokines, regulation of immune

response, immune tolerance.
Unit 3: Antigen and antibody interactions
Cross reactivity, precipitation reactions, serological techniques, ELISA, RIA and western blotting. Production and application of monoclonal antibodies, dose of antigens, Vaccines. Immunity against infectious diseases (virus, bacteria and protozoan), Hyper-sensitivity, Autoimmunity, Cancer, AIDS and Transplantation immunology.

Suggested Readings

- Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
- Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing.
- Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
- Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
- Goding, Monoclonal antibodies, Academic Press. 1985.

B.Tech. Biotechnology: Semester-IV BBT 404: rDNA TECHNOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

To give brief introduction about Recombinant DNA Technology .To give complete knowledge about the construction of genomic and cDNA library.To explain the process of gene transfer mechanism in bacteria, plants and animals.To explain the importance of edible vaccines.To explain and emphasize on the production of monoclonal antibody production and its applications.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To remember Restriction enzymes their types and properties, properties of a Cloning vehicles , plasmids as cloning vectors , viruses (phage lambda and mu) as a cloning vectors.

CO2: To understand the concept of Concept of cloning and HAT selection.

CO3: To apply the techniques of recombinant DNA technology for the production of transgenic plants.

CO4: To analyze Gene transfer mechanisms in bacteria, plants and animals i.e. transformation, conjugation, transduction, particle gun, liposome mediated and microinjection.

CO5: To evaluate the procedure of forming cDNA and genomic library.

CO6: To create edible vaccines from plants using recombinant DNA technology.

CO7: To explain and analyze various applications of microbial genetic engineering in biotechnology.

Unit 1: Introduction to RDT
Introduction of RDT, Restriction enzyme, DNA manipulative enzymes and DNA modifying enzymes, concept of cloning, properties of cloning vehicle, plasmid as cloning vectors, viruses (phage, lambda and mu) as cloning vectors, insertion of a DNA molecule in cloning vector, expression of cloned genes,

recombinant selection and screening , genomic and cDNA libraries.
Unit 2: Gene transfer mechanisms in bacteria
Principles and applications of transformation, conjugation, transduction, particle gun, liposome mediated and microinjection. Applications of microbial genetic engineering in biotechnology.
Unit 3: Gene transfer mechanism in plants
Agrobacterium mediated. Applications of transgenic plants, edible vaccines from plants. Gene transfer mechanism in animals: transfection of animal cell lines, HAT selection. Selectable markers and transplantation of cultured cells. Expression of cloned proteins in animal cells – expression vectors.

Suggested Readings

- OLD, R.W AND PRIMROSE S.B 1994. Principles of gene manipulation – An introduction to genetic engineering. Fifth edition. Blackwell Scientific Publication.
- T.A BROWN. Gene cloning and DNA analysis. Sixth Introduction. Wiley and Blackwell.
- Recombinant DNA 2nd edition. Watson, James D. and Gilman, M. (2001) W.H Freeman Company, New York.
- An introduction to genetic Engineering 2nd edition Desmond Nicholl S.T (2002) Cambridge University Press.
- Sambrook. Fritsch E.F and Maniatis. 1989. Molecular Cloning – A laborartory.

B.Tech. Biotechnology: Semester-IV BBT 405: BIOINFORMATICS AND COMPUTATIONAL BIOLOGY	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objective is to describe relational data models and database management systems with an emphasis on biologically important techniques to store various data on DNA sequencing structures genetic mapping etc.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Implement solutions to basic bioinformatics problems

CO2: Discuss the use of bioinformatics in addressing a range of biological questions

CO3: describe how bioinformatics methods can be used to relate sequence, structure and function discuss the technologies for modern high-throughput DNA sequencing and their applications

CO4: use and describe some central bioinformatics data and information resources

Unit 1:Introduction
Primary and secondary databases. Specialized sequence databases of EST, TFB Sites, SNP's, gene expression. Pfam, PROSITE, BLOCK (Secondary databases). Data retrieval with ENTREZ, SRS, DBGET Principles of DNA sequencing (chemical chain termination, Dideoxy chain termination method, Automatic sequencer). RNA sequencing . Protein sequencing (Edmand degradation method) Sequence alignment (pairwise and multiple, global and local). Sequence alignment algorithm (FAST , BLAST, Needleman and Wunsch, Smith Waterman). Database similarity searches (BLAST, FASTA and PSI BLAST). Amino acid substitution matrices (PAM BLOSUM)
Unit 2: Structure prediction
Protein structure prediction (Chou Fasman method) : Secondary and tertiary structures. Homology Modelling, ORF prediction, Gene prediction, Micro array data analysis. Profiles and motifs.

Unit 3: Structure visualization
Structure visualization methods (RASMOL, CHIME etc.) . Protein Structure alignment and analysis. Application of Bioinformatics in drug discovery and drug designing.

Suggested Readings

- *Bioinformatics : Principles and applications by Ghosh and Mallick (oxford) university press)*
- *Bioinformatics by Andreas D Boxevanis (Wiley Interscience)*
- *Fundamental concept of bioinformatics by Dan e. krane*
- *instant notes in Bioinformatics by Westhead, parish and Tweman (Bios scientific publishers)*
- *Advance Genetics by G.S. Miglani, Narosa Publishing House.*

B.Tech. Biotechnology: Semester-IV BBT 406: BIOSEPERATION ENGINEERING	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

Course Objective(s): It is intended to impart basic undergraduate level knowledge in the area of separation technologies for the biomolecules. Students would be able to understand workflow for the separation of DNA, RNA, proteins, secondary metabolites etc. They would also be able to assimilate recent research findings, advancement and development in the relevant subject.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Understand various types of fermentation mode of operation and their kinetics.

CO2: Analyze the effect of various fermentation and downstream processes involved in the synthesis of products.

CO3: Understand the enzyme production and their application involved in modern world.

CO4: Understand the instrumentation involved in the downstream processing of products produced by different pharmaceutical and biotechnological industries.

CO5: Evaluate performance of different fermentation processes i.e., whose work in batch and continuous mode of operation.

CO6: Will understand the production and application of some enzymes used in food and biotechnological industries.

Unit 1: Introduction
Introduction to separation of biomolecules and its importance in Biotechnology, Working principles of centrifugation, centrifugation-based methods for separation of the cell organelles and biomolecules (DNA, RNA, Proteins and secondary metabolites),
Unit 2: Seperation of Biomolecules

Separation of different types of DNA from cells, Separation of the different types of RNA from biological samples, Basics of chromatography and its use in separation of biomolecules, TLC, HPLC, GC etc., Methods for separation of the proteins based on size, charge and chemical nature of the proteins,
Unit 3: Isolation and Bioseperation
Isolation and separation of biolipids, Membrane and Rotating Membrane in Bioseparation, TCL for separation of the lipids, Ultrafiltration methods and separation of biomolecules, Polymer beads for immobilization of biomolecules, Magnetic Beads for Bio-separation, Cell Sorting, Microfluidics based separation.

Suggested Readings

- Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
- Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engel wood Cliffs, 2002.
- Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997
- Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co.,
- New York, 1986.
- Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
- Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

B.Tech. Biotechnology: Semester-IV BBT 407: ENGINEERING ECONOMICS	
Teaching Scheme	**Examination Scheme**
Lectures: 2 hrs/Week	Class Test -6 Marks
Tutorials: 0 hr/Week	Teachers Assessment – 6 Marks
Credits: 2	Attendance – 3 Marks
	End Semester Exam – 35 marks

Course Objective

This course aims at providing the student with advanced concepts of engineering economic analysis and its role in engineering decision making. Additionally, the course also covers topics such as depreciation, after tax analysis, replacement analysis, uncertainty, inflation, deflation, and estimation of future events.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: Describe the role of economics in the decision making process and perform calculations in regard to interest formulas.

CO2: Estimate the Present, annual and future worth comparisons for cash flows.

CO3: Calculate the rate of return, depreciation charges and income taxes.

CO4: Enumerate different cost entities in estimation and costing.

Unit 1: Introduction
Introduction: Definition – Nature – Scope and Significance of Economics for Engineers. Demand and Supply: Demand – Types – Determinants – Law of Demand – Elasticity of Demand – Types – Significance – Supply – Market price determination – Case Study in Demand Forecasting –- Meaning – Methods – Consumer Survey – Trend Projections – Moving average.
Unit 2: Cost and Revenue
Concepts – Classifications – Short run and long run cost curves –Revenue – Concepts – Measurement of Profit (Case Study).Market Structure: Perfect Competition – Characteristics – Price and output determination in short run and long run – Monopoly – Price Discrimination –Monopolistic Competition – Product Differentiation – Oligopoly and Duopoly.
Unit 3: Market Failure

Causes – Type of Goods – Rivalrous and Non-rivalrous goods – Excludable and Non-excludable goods – Solutions – Government Intervention. Money and Banking: Money – Functions – Quantity theory of money – Banking – Commercial Banks – Functions – Central Bank (RBI) – Functions – Role of Banks in Economic Development.
Unit 4: Foreign Exchange
Balance of Payments – Exchange rate determination – Methods of foreign payments – International Institutions – IMF, IBRD.Business Cycle and National Income: Meaning –Phases of business cycle - Inflation– Causes – Control measures - Deflation - National Income – Concepts – Methods of calculating national income – Problems in calculating national income.

Suggested Readings

- Premvir Kapoor, "Sociology & Economics for Engineers", Khanna Publishing House,
- 2018.
- Dewett. K.K., Navalur M. H., "Modern Economic Theory", S. Chand and Company Ltd,
- New Delhi, 24th Edn., 2014.
- Lipsey& Chrystal, "Economics", Oxford University Press, 2010.
- **References:**
- Paul A Samuelson & William, "Economics", Tata McGraw Hill, New Delhi, 2012.
- Francis Cherinullem "International Economics", McGraw Hill Education, 2011.
- William A McEachern and Simrit Kaur, "Micro ECON", Cengage Learning, 2013.
- William A McEachern and Indira A., "Macro ECON", Cengage Learning, 2014.

B.Tech. Biotechnology: Semester-IV BBT 408: ENVIRONMENTAL SCIENCE	
Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Class Test -12 Marks
Tutorials: 1 hr/Week	Teachers Assessment – 6 Marks
Credits: 4	Attendance – 12 Marks
	End Semester Exam – 70 marks

Course Objective

The objective is to learn about the environment and its surroundings; why to keep the environment clean; how to manage alternative energy sources etc.

Course Learning Outcomes

After completing the course, the student shall be able to:
CO1: Scope & Importance, Need For Public Awareness.
CO2: Environment definition, Ecosystem – Types & Factors of Ecosystem,
CO3: Environmental Pollution and their effects
CO4: Environmental Protection- Role of Government, Legal aspects, Initiatives by Non-governmental Organizations (NGO),

Unit 1: Introduction
Definition, Scope & Importance, Need For Public Awareness- Environment definition, Eco system – Types & Factors of Ecosystem, Food chain, Food-web, Ecological pyramids, Laws of Thermodynamics, Energy flow, Trophic levels, Human activities – Food, Shelter, Economic and Socialsecurity. Effects of human activities on environment- Housing, Industry, Mining and Transportation activities.
Unit 2: Natural Resources
Water Resources - Water borne diseases, Water induced diseases,. Mineral Resources, Forest Wealth, Material cycles- Carbon, Nitrogen and Water Cycle Energy – Different types of energy, Conventional and Non-Conventional sources – Hydro Electric, Fossil Fuel based, Nuclear, Solar, Biomass and Bio-gas. Hydrogen as an alternative future source of energy.
Unit 3: Environmental Pollution
Environmental Pollution and their effects. Water pollution, Land pollution. Noise pollution, Public Health aspects, Air Pollution, Solid waste management.
Unit 4: Current Environmental Issues of Importance
Population Growth, prevention of AIDS & other communicative diseases, Climate Change and Global warming- Effects, Urbanization, Automobile pollution. Acid Rain, Ozone Layer depletion, Animal Husbandry.
Unit 5: Current Environmental Issues of Importance

Environmental Protection- Role of Government, Legal aspects, Initiatives by Non-governmental Organizations (NGO), Environmental Education, Women Education. Abuses of Child Labor
Unit 6: Project Work
Collection of data regarding incineration plants in Govt. & Private hospitals of the region. Project Reports- Air pollution area, water pollution area, noise pollution area, land pollution area. Projects regarding alternatives of fossil fuel.

Suggested Readings

- Environmental Studies , Benny Joseph; Tata McgrawHill,2005
- Environmental Studies, Dr. D.L. Manjunath; Pearson Education-2006
- Environmental studies, R. Rajagopalan; Oxford Publication – 2005
- Text book of Environmental Science & Technology, M. Anji Reddy, BS Publication, Revised edition.

B.Tech. Biotechnology: Semester-IV BBT 451: MOLECULAR BIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	
Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

To give overview of basic concepts of instruments used in biotechnology laboratory. To give complete knowledge of chromatography, its principles, working mechanism and types. To learn about the basic microscopy techniques.To describe the functions of restriction enzymes and their use in gene cloning experiments. To give complete knowledge of various types of fermentation, sterilization and microbes used in fermentation industry. To explain and give an outline of a typical proteomics experiment. To explain the technique of electrophoresis and its various types.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To learn the working of microscope by preparing and observing the slide of onion root tip for metaphase chromosome under a microscope.
CO2: To learn various types of chromatographic techniques and practically demonstrate the separation of protein pigments with the help of paper chromatography
CO3: To confirm the presence of protein in a sample with the help of biuret test
CO4: Understand the concept of DNA
CO5: To analyze and demonstrate the process of sugar fermentation.
CO6: To evaluate the effect of pH on microbial growth.
CO7: To demonstrate the technique of agarose gel electrophoresis and to explain the technique of SDS PAGE.

Experiment Details

1.To prepare the slide of onion root tip and observe the mitotic stages under a microscope.
2.To separate protein pigments with the help of paper chromatography.
3.To demonstrate the technique of agarose gel electrophoresis.
4.To study the effect of pH on microbial growth.
5.To demonstrate the process of sugar fermentation.
6.To learn the technique of SDS PAGE.

Suggested Readings

- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Tools and Techniques-Wilson and Walker.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-IV BBT 452: BIOPROCESS ENGINEERING LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	
Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

To give overview of basic concepts of instruments used in biotechnology laboratory. To give complete knowledge of chromatography, its principles, working mechanism and types. To learn about the basic microscopy techniques.To describe the functions of restriction enzymes and their use in gene cloning experiments. To give complete knowledge of various types of fermentation, sterilization and microbes used in fermentation industry. To explain and give an outline of a typical proteomics experiment. To explain the technique of electrophoresis and its various types.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: The students will learn how to separate and purify to homogeneity molecules and biological macromolecules of interest using different technologies.

CO2: The course will also introduce how to scale up the separation in a cost effective manner.

CO3: To confirm the presence of protein in a sample with the help of biuret test

CO4: Understand the concept of DNA

CO5: To analyze and demonstrate the process of sugar fermentation.

CO6: To evaluate the effect of pH on microbial growth.

CO7: To demonstrate the technique of agarose gel electrophoresis and to explain the technique of SDS PAGE.

Experiment Details

1. Isolation of the plant cell organelles using centrifugation methods.
2. Isolation and separation of the DNA, RNA and proteins using centrifugation and biochemical methods.
3. Separation of the proteins with suitable chromatography methods.
4. Apply filtration and ultrafiltration method for separation of proteins.

5. Use TLC for separation of the biolipids.
6. Isolation of the photosynthetic pigments using centrifugation methods

Suggested Readings

- Molecular Cloning - Sambrook Russel - Vol. 1, 2, 3. 2.
- Tools and Techniques-Wilson and Walker.
- Fat Detection: Taste, Texture, and Post Ingestive Effects.
- Montmayeur JP, le Coutre J, editors. Boca Raton (FL): CRC Press/Taylor & Francis; 2010.
- Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL. New York: W H Freeman; 2002. Course

B.Tech. Biotechnology: Semester-IV BBT 453: IMMUNOLOGY & IMMUNOTECHNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	
Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired. How the immune system recognizes self from non-self. B and T cell maturation and specific responses. Other topics covered will include the genetic basis of diversity of immune responses in mammals.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To promote critical thinking among students
CO2: To provide students with a foundation in immunological processes
CO3: To provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology
CO4: Be able to clearly state the role of the immune system
CO5: Be able to compare and contrast the innate versus adaptive immune systems

Experiment Details

1. Different types of antigen –antibody cross reaction
2. Isolation, purification and identification of immunoglobulin from goat blood.
3. Double diffusion techniques for identification of antigen-antibody samples
4. Immunoelectrophoresis techniques.
5. ELISA (Enzyme linked Immunosorbent Assay)
6. Immunoblotting using ELISA-dot or Western blot techniques.

Suggested Readings

- *Handbook of Experimental Immunology, Vol. I & II, IV- Blackwell Scientific Publications.*
- *Practical Immunology- Hudson L. and Hay H. C. Blackwell Scientific Publications.*
- *Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India Ltd.*

B.Tech. Biotechnology: Semester-IV BBT 454: rDNA TECHNOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	
Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

This course includes a detailed description of the immune response made in humans to foreign antigens including microbial pathogens. A description of cells involved in the immune response either innate or acquired. How the immune system recognizes self from non-self. B and T cell maturation and specific responses. Other topics covered will include the genetic basis of diversity of immune responses in mammals.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: To learn the working of microscope by preparing and observing the slide of onion root tip for metaphase chromosome under a microscope.

CO2: To learn various types of chromatographic techniques and practically demonstrate the separation of protein pigments with the help of paper chromatography

CO3: To confirm the presence of protein in a sample with the help of biuret test.

CO4: To analyze and demonstrate the process of sugar fermentation.

CO5: To demonstrate the technique of agarose gel electrophoresis.

Experiment Details

1. To prepare the slide of onion root tip and observe the mitotic stages under a microscope.
2. To separate protein pigments with the help of paper chromatography.
3. To demonstrate the technique of agarose gel electrophoresis.
4. To study the effect of pH on microbial growth.
5. To demonstrate the process of sugar fermentation.
6. To learn the technique of SDS PAGE

Suggested Readings

- *Handbook of Experimental Immunology, Vol. I & II, IV- Blackwell Scientific Publications.*
- *Practical Immunology- Hudson L. and Hay H. C. Blackwell Scientific Publications.*

B.Tech. Biotechnology: Semester-IV BBT 455: BIOINFORMATICS & COMPUTATIONAL BIOLOGY LAB	
Teaching Scheme	**Examination Scheme**
Practicals: 2 hr/Week	
Credits: 2	Internal Assessment – 15 Marks
	External Assessment – 35 Marks
	End Semester Exam – 50 marks

Course Objective

The aim is to provide practical training in bioinformatics methods including accessing the major public sequence databases, use of the different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages. It also provides a step by step, theoretical and practical introduction to the development of useful tools for automation of complex computer jobs, and making these tools accessible on the network from a Web browser.

Course Learning Outcomes

After completing the course, the student shall be able to:

CO1: The students will be able to describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge

CO2: The students will be able to explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise

CO3: Sequence alignment by dynamic programming

CO4: The students will be able to predict the secondary and tertiary structures of protein sequences.

Experiment Details

1. Construction of database for specific class of proteins/enzymes, genes/ ORF/ EST/Promoter sequences/ DNA motifs or protein motifs using oracle.
2. Access and use of different online protein and gene alignment softwares
3. Gene finding related search for a given nucleotide sequence in order to predict the gene
4. ORF prediction for different proteins out of some given nucleotide sequences.
5. Exon identification using available softwares for a given nucleotide sequences
6. Secondary structure prediction for amino acid sequences of a given protein.

Suggested Readings

- *Handbook of Experimental Immunology, Vol. I & II, IV- Blackwell Scientific Publications.*
- *Practical Immunology- Hudson L. and Hay H. C. Blackwell Scientific Publications.*
- *Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India Ltd.*