Evaluation Scheme & Syllabus

Of

Bachelor of Science (III Year)

(Biotechnology)

(w.e.f. Academic Session 2019)

Department of Biotechnology

INVERTIS UNIVERSITY - INVERTIS VILLAGE

Bareilly-Lucknow NH-24, Bareilly

Programme Outcomes (PO) of B.Sc Biotechnology

After completion of the program of study of B.Sc. in Biotechnology, every student will know the following attributes:

PO1: Ability to apply the **fundamentals** of **mathematics, science and engineering** for biotechnological processes

PO2: Ability to **well design a specific problem or appropriate protocol** based on review of literature or biological data so that it can be solved or reach the conclusions in the areas of Biotechnology such as bioprocess engineering, plant biotechnology, medical biotechnology, biophysics, molecular biology and environmental biotechnology.

PO3: Ability to design a system, a component or biological process within the umbrella of realistic constraints such as economic, environmental, societal, health and safety, manufacturability and sustainability.

PO4: Ready to carry out research and solve complex problems by utilizing sophisticated biotechnology tools such as NMR spectroscopy, microarray technology, crystallography, flowcytometry, next generation sequencing in different fields of biotechnology resulting in patents, journal publications and product development.

PO5: Ability to use the **conceptualized biotechnology solutions** towards the sustainable development and focus on the **environmental sustainability** such as preventing the loss of biodiversity due to Desertification and Deforestation, use of white biotechnology, Bioremediation, Biofuels, Biosensors, Biocatalyst, Biomining and other technologies to prevent continuous degradation of the environment and making its more sustainable to ideal environment.

PO6: Knowledge on different aspects of **ethics** related to biotechnology areas such as genetically modified species, patenting human biological materials, organ transplantation, diagnosis of genetic defects, and use of genetically engineered crops and uses this knowledge very professionally and legally so that it will be not hurt the moral code of the society.

PO7: Ability to **tackle** the issues effectively either as a member and/or in a heterogeneous work environment or should be able to work in **interdisplinary areas** of biotechnology to manage the project financially and effectively with their limitations.

PO8: Attend good **writing skills** (such as abstract, summary, project report) or **oral presentation** and contribute better in interdisplinary areas of biotechnology or in the society at large and to develop habit of lifelong learning with the **technological changes**.

SCHEME OF EVALUATION
B.Sc -BIOTECHNOLOGY
(Effective from the academic session 2019)

III Year								
V Semester			**Teaching Scheme**			**Marks Distribution**		
SN	**CODE**	**SUBJECT**	**L**	**T**	**P**	**ESM**	**MSM**	**Total**
1	BST501	ANALYTICAL TECHNIQUES I	3	1	0	70	30	100
2	BST502	RECOMBINANT DNA TECHNOLOGY	3	1	0	70	30	100
3	BST503	GENOMICS AND PROTEOMICS	3	1	0	70	30	100
4	BST504	BIOPROCESS TECHNOLOGY	3	1	0	70	30	100
5	BST505	PLANT PHYSIOLOGY	3	1	0	70	30	100
6	BST551	BIOTECHNOLOGY LAB V	0	0	2	35	15	50
7	BST552	SEMINAR I	0	0	2	35	15	50
Total			**15**	**5**	**4**	**420**	**180**	**600**
VI Semester								
SN	**CODE**	**SUBJECT**	**L**	**T**	**P**	**ESM**	**MSM**	**Total**
1	BST601	INDUSTRIAL BIOTECHNOLOGY	3	1	0	70	30	100
2	BST602	ANALYTICAL TECHNIQUES II	3	1	0	70	30	100
3	BST603	BIOINFORMATICS	3	1	0	70	30	100
4	BST604	FOOD TECHNOLOGY	3	1	0	70	30	100
5	BST605	FRONTIERS IN BIOTECHNOLOGY	3	1	0	70	30	100
6	BST651	BIOTECHNOLOGY LAB VI	0	0	2	35	15	50
7	BST652	SEMINAR II	0	0	2	35	15	50
Total			**15**	**5**	**4**	**420**	**180**	**600**

BST 501: Analytical Techniques I	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST102 Introduction to Biotechnology, BST151 Biotechnology Lab I

Course Objectives:

1 To give basic overview of different types of microscopic techniques.
2. To give complete knowledge of Phase contrast microscopy, Transmission Electron Microscope and Scanning Electron Microscope.
3. To explain the technique of electrophoresis and its various types.
4. To explain the importance of western blotting.
5. To explain and focus on various types of chromatographic techniques.

Detailed Syllabus

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).

Text and Reference Books

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

Course Outcomes:

After completing the course, students will be able to:

1. To state the principle and working of various types of Microscopic Techniques i.e. Simple, compound, inverted, stereo, fluorescence, dark field and bright field microscope.
2. To understand the concept of phase contrast microscopy.
3. To explain the principle and working mechanism of TEM and SEM.
4. To analyze and distinguish between different types of electrophoretic techniques.
5. To evaluate and outline the concept of western blotting.
6. To explain the principle, application, affinity, mobile phase and stationary phase, types of columns, used in various chromatographic techniques.
7. To explain the concept of Paper Chromatography, Gel filtration Chromatography, ion-exchange chromatography, affinity chromatography, High Performance Liquid Chromatography (Normal phase and reverse phase).

BST 502: Recombinant DNA Technology	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST302 Molecular Biology, BST402 Immunology

Course Objectives:

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

Detailed Syllabus

Unit-1

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.

Text and Reference Books

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

Course Outcomes:

After completing the course, students will be able to:

1. 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.
2. To understand the concept of Concept of cloning and HAT selection.

3 To apply the techniques of recombinant DNA technology for the production of transgenic plants.
4. To analyze Gene transfer mechanisms in bacteria, plants and animals i.e. transformation, conjugation, transduction, particle gun, liposome mediated and microinjection.
5. To evaluate the procedure of forming cDNA and genomic library.
6. To create edible vaccines from plants using recombinant DNA technology.
7. To explain and analyze various applications of microbial genetic engineering in biotechnology.

BST 503: Genomics and Proteomics	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST302 Molecular Biology, BST451 Biotechnology Lab IV

Course Objectives:

1 To give extensive knowledge of structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes; Human genome project.
2. To give complete knowledge about expression profiling of gene, microarray and data analysis.
3. To analyze tools for genome analysis as well as give detailed information about hybridization based assays, Polymerization based assays, Ligation based assays.
4. To explain and give an outline of a typical proteomics experiment.
5. To explain tryptic digestion of protein, peptide fingerprinting and protein-protein interactions.

Detailed Syllabus

Unit-1 Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes; Human genome project-landmarks on chromosomes generated by various mapping methods; BAC libraries and shotgun libraries preparation; Physical maps – cytogenetic map, contig map, restriction map. Human disease genes; DNA polymorphism including those involved in diseases; Hemoglobin and the nemias; Phenylketonuria (monogenic) and diabetes (multigenic) genetic disorders; 'disease' gene vs. 'susceptibility' gene; SNP detection: hybridization based assays (allele specific probes); Polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); Ligation based assays (allele specific oligonucleotide ligation).
Unit-2 Clinical aspect of expression profiling of gene, microarray and data analysis, difference in gene expression in nuclear, mitochondrial and chloroplast gene, taxonomic classification of organisms using molecular markers- 16S rRNA typing/sequencing. Tools for genome analysis – PCR, RFLP, DNA fingerprinting, RAPD, automated DNA sequencing; Linkage and pedigree analysis; construction of genetic maps; physical maps, FISH to identify chromosome landmarks.
Unit-3 Overview of protein structure-primary, secondary, tertiary and quaternary structure; Relationship between protein structure and function; Outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting. Protein-protein interactions. Yeast two hybrid system; Phage display; Protein interaction maps; Protein arrays-definition; Applications- diagnostics, expression profiling.

Text and Reference Books

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and
4. Bioinformatics, 2nd Edition. Benjamin Cummings 2007
5. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

Course Outcomes:

After completing the course, students will be able to:

1. To define Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes; Human genome project.
2. To understand the mechanisms for Human disease genes; DNA polymorphism including those involved in diseases; Hemoglobin and the nemias; Phenylketonuria (monogenic) and diabetes (multigenic) genetic disorders; 'disease' gene vs. 'susceptibility' gene.
3 To determine Clinical aspect of expression profiling of gene, microarray and data analysis, difference in gene expression in nuclear, mitochondrial and chloroplast gene, taxonomic classification of organisms using molecular markers- 16S rRNA typing/sequencing.
4. To analyze Tools for genome analysis – PCR, RFLP, DNA fingerprinting, RAPD, automated DNA sequencing; Linkage and pedigree analysis; construction of genetic maps; physical maps, FISH to identify chromosome landmarks.
5. To evaluate the concept of SNP detection: hybridization based assays (allele specific probes); Polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); Ligation based assays (allele specific oligonucleotide ligation).
6. To explain and give an outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis.
7. To explain Tryptic digestion of protein and peptide fingerprinting. Protein-protein interactions, Yeast two hybrid system; Phage display; Protein interaction maps; Protein arrays-definition; Applications- diagnostics, expression profiling.

BST 504: Bioprocess Technology	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST203 Microbiology, BST404 Genetics

Course Objectives:

1 To give the basic concept of fermentation and types of bioreactors in fermentation industry.

2. To give complete knowledge of various types of fermentation, sterilization and microbes used in fermentation industry.

3. To explain the process of different techniques of upstream and downstream processing.

4. To explain the importance of processing of major fermented foods and beverages.

5. To explain and emphasize the importance of food additive: colors, flavors, preservatives in food industry.

Detailed Syllabus

Unit-1

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-2

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-3

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

Text and Reference Books

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
1. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
2. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
3. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
4. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press Tokyo, 1973.
5. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry.

Course Outcomes:

After completing the course, students will be able to:

1. To define the basic concept of fermentation and types of fermentors and bioreactors used in fermentation industry: their working mechanism.
2. To understand various types of fermentation like Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation
3 To determine the mechanisms sterilization and their types.
4. To analyze different techniques of upstream and downstream processing in detail: 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.
5. To evaluate the processing of major fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification.
6. To explain the use of microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products;
7. To explain role of preservatives in food industry: Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

BST 505: Plant Physiology	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST405 Animal Physiology

Course Objectives:

1 To give extensive knowledge of physiological behavior of different plant under different environmental conditions.
2. 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.
3. To explain the process of growth and development of plants and their movement.
4. To explain the importance of relationship between soil, water and plants.
5. To explain and emphasize on the common physiological processes such as diffusion, osmosis, transpiration, photosynthesis and respiration.

Detailed Syllabus

Unit-1

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.

Text and Reference Books

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

Course Outcomes:

After completing the course, students will be able to:

1. To define physiological mechanisms involved in the uptake and transport of water and the translocation of food by plants.
2. 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.
3 To determine the interrelationships among plants and micro-organisms, symbiosis in nitrogen and phosphorous acquisition by plants
4. 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)
5. To evaluate major affects on physiological and biochemical mechanisms of growth regulators (hormones) in plants.
6. To explain and construct growth curve for investigating the growth pattern.
7. 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.

BST 551: Biotechnology Lab V	
Teaching Scheme Lab: 2 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment -15Marks External Assessment - 35Marks

Prerequisite: - BST 251 Biotechnology Lab II and BST 351 Biotechnology lab III

Course Objectives:

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

Detailed Syllabus

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.

Course Outcomes:

After completing the course, students will be able to:

1. To learn the working of microscope by preparing and observing the slide of onion root tip for metaphase chromosome under a microscope.
2. To learn various types of chromatographic techniques and practically demonstrate the separation of protein pigments with the help of paper chromatography
3 To confirm the presence of protein in a sample with the help of biuret test.
4. To analyze and demonstrate the process of sugar fermentation.
5. To evaluate the effect of pH on microbial growth.
6. To demonstrate the technique of agarose gel electrophoresis.
7. To explain the technique of SDS PAGE.

BST 601: Industrial Biotechnology	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST403 Enzymology, BST504 Bioprocess Technology

Course Objectives:

1 To develop an understanding of the various aspects of Bioprocess Technology
2. Understand principles underlying design of Fermentor, Fermentation Process and downstream processing
3. To develop skills associated with screening of Industrially Important Strains.
4. To explain the importance of fermentative productions like Enzymes, antibiotics, vitamin, beverages.
5. To explain and emphasize on the recovery and purification of biomolecules.

Detailed Syllabus

Unit-1

Introduction to industrial bioprocess: Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

Unit-2

Production of primary metabolites: Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols. Production of secondary metabolites: Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

Unit-3

Production of enzymes and other bio-products: Production of Industrial Enzymes, Bio-pesticides, Bio-fertilizers, Bio-preservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation. Production modern biotechnology products: Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

Text and Reference Books

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. "A Textbook on Biotechnology" 2 nd Edition. Affiliated East West Press Pvt. Ltd., 1998.
3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt.Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2 nd Edition Cambridge University Press, 2001.
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand& Co. Ltd., 2006.

Course Outcomes:

After completing the course, students will be able to:

1. To define the basics of fermentation technology.
2. To understand the traditional as well as modern methods of fermentation technology.
3 To determine the basic concepts of Upstream and Downstream processing.

4. To analyze Fermentative productions like Enzymes, antibiotics, vitamin, beverages.
5. To evaluate the production of primary and secondary metabolites.
6. To explain and learn the concept of producing industrial Enzymes, Bio-pesticides, Bio-fertilizers, Bio-preservatives, Biopolymers Biodiesel.
7. To create recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.enzymology.

BST 602: Analytical Techniques II	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST501 Analytical techniques I, BST 551 Biotechnology Lab V

Course Objectives:

1 To give basic overview of Centrifugal force, sedimentation and basic principles of sedimentation.

2. To give complete knowledge of different types of centrifuges.

3. To explain the technique of spectroscopy and mass spectrometry.

4. To explain the concept of X-ray diffraction and X-ray Crystallography

5. To explain and focus on various Types of Elastic scattering, Small-angle X-ray scattering (SAXS), Wide-angle X-ray scattering (WAXS), Resonant inelastic X-ray scattering (RIXS).

Detailed Syllabus

Unit-1

Centrifugation techniques: Centrifugal force, sedimentation and basic principles of sedimentation. Types of centrifuge: refrigerated high-speed preparative centrifuges, analytical ultracentrifuges, preparative ultracentrifuges, micro centrifuge, refrigerated centrifuge, differential centrifugation, density gradient centrifugation, analytical cntrifugation, etc. Safety aspects of centrifugation, types of rotors and nomograph.

Unit-2

SPECTROSCOPY: Behavior and nature of light, The Electromagnetic Spectrum, Classes of spectra (continous& discrete). UV and visible spectroscopy, Infrared and Atomic absorption spectroscopy, fluorescence spectroscopy. MASS SPECTROMETRY: Ionozation techniques; Electron impact ionisation, Chemical ionisation, Electrospray ionisation. Mass Analyzers; Quadrupole Mass Spectrometry, Ion trap mass spectrometry, Nanospray and on-line tandem mass spectrometry, Magnetic sector analyser, MALDITOF.DETECTORS; Electron multipliers, conversion dynode, Mass precision, mass measurement accuracy, mass resolution, ionization energy and appearance energy. Nuclear Magnetic Resonance.

Unit-3

X-ray diffraction and X-ray Crystallography and their application, Types of Elastic scattering, Small-angle X-ray scattering (SAXS), Wide-angle X-ray scattering (WAXS), Resonant inelastic X-ray scattering (RIXS).

Text and Reference Books

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

Course Outcomes:

After completing the course, students will be able to:

1. To state the principle of various analytical instruments used in life sciences for analysis of different biological samples.
2. To understand the basic concept of Centrifugal force, sedimentation and basic principles of sedimentation.
3 To determine and demonstrate various types of rotors as well as various types of centrifuges used.
4. To analyze and predict the principle of different spectroscopic techniques such as UV and visible spectroscopy, Infrared and Atomic absorption spectroscopy, fluorescence spectroscopy.
5. To evaluate and monitor the working of mass spectrometer and different mass analyzers.
6. To explain the working mechanism of nuclear magnetic resonance.
7. To explain the concept of X-ray diffraction and X-ray Crystallography and their applications.

BST 603: Bioinformatics	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST302 Molecular Biology, BST403 Enzymology

Course Objectives:

1 To give basic overview of databases and tools used in bioinformatics.
2. To give complete knowledge of DNA and protein sequencing techniques.
3. To explain the concept of different bioinformatic tools such as BLAST, ClustalX, MEGA, Pymol, RASMOL, CHIME.
4. To explain the importance of homology modeling and molecular docking.
5. To explain and emphasize on the concept of computer Aided drug designing, ORF prediction, Gene prediction and analysis.

Detailed Syllabus

Unit-1

Introduction of Bioinformatics and its role in biotechnology, NCBI, EBI, PDB, Searching and retrieval of DNA and protein, protein structure (PDB), DNA sequencing (chemical chain termination, Dideoxy chain termination method, Automatic sequencer), Generation and analysis of biological data and their submission. Protein sequencing (Edmand degradation method).

Unit-2

BLAST, ClustalX, MEGA, Sequence alignment (pairwise and multiple, global and local), Phylogenetic analysis. Extraction of phylogenetic data set. Tree building methods and treeevaluation. Comparative genome analysis. Reconstruction of metabolic pathways. Computationaltools for expression analysis. Prediction and designing of primers & probes for diagnosis and analysis, Prediction of RNA secondary structure, codon optimization, computer Aided drug designing, ORF prediction, Gene prediction and analysis.

Unit-3

Identification of target protein for disease, identification and analysis of epitope, identification of promoter, transcription factor, gene designing, prediction and analysis of protein structure (primary, secondary and tertiary), Homology modeling, protein threading, *In silico* protein validation, protein folding and activity, Basic of molecular docking, Structure visualization methods (Pymol, RASMOL, CHIME etc.), protein-protein interaction, construction of metabolic gene network, drug target, vaccine designing.

Text and Reference Books

1. Bioinformatics: Principles and applications by Ghosh and Mallick (oxford) university press)
2. Bioinformatics by Andreas D Boxevanis (Wiley Interscience)
3. Fundamental concept of bioinformatics by Dan e. krane
4. Introduction to bioinformatics by Attwood and Parry Smith (Pierson educationPublication)
5. Instant notes in Bioinformatics by Westhead, parish and Tweman (Bios scientific publishers)

Course Outcomes:

After completing the course, students will be able to:

1. To give practical and hands-on experience with common bioinformatics tools and databases like as

BLAST, ClustalX, MEGA, Pymol, RASMOL, CHIME.
2. To understand basic theory and application of programs used for database searching, protein and DNA sequence analysis, prediction of protein function, and building phylogenetic trees.
3. To determine and execute basic competences in the use of bioinformatics tools.
4. To analyze and compare different bioinformatics tools.
5. To evaluate information networks and bioinformatics tools on the internet.
6. To explain and the knowledge of bioinformatics tools for computer Aided drug designing, ORF prediction, Gene prediction and analysis.
7. To explain the concept of homology modeling, molecular docking and protein-protein interaction.

BST 604: Food Technology	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST203 Microbiology, BST504 Bioprocess Technology, BST202 Biochemistry

Course Objectives:

1 To give a brief overview of food biotechnology.
2. To give knowledge about the role of Food additives, flavor enhancers and supplements – probiotics, health care products, vitamins and antibiotics.
3. To explain various aspects of Dairy Technology.
4. To explain the importance of modification of microbes/enzymes–Strain improvement, enzyme/ cofactor engineering and microbial inactivation.
5. To explain and classify various types of Food Preservation techniques.

Detailed Syllabus

Unit-1

Food Biotechnology; Introduction; History; Importance; Applications of biotechnology infood processing; Significant advances; Recent developments; Risk factors; Safety regulations etc. Microbial enzymes in food processing; Industrial production of enzymes - proteases and cellulases; Food and beverage fermentation- alcoholic and non alcoholic beverages; Food additives and supplements –probiotics, health care products, vitamins and antibiotics; Fuels and industrial chemicals- Alkanes, industrial ethanol etc.

Unit-2

Modification of microbes/enzymes–Strain improvement, enzyme/ cofactor engineering; Technologies for microbial inactivation; Applications in product development/improvement. Microbes exploited commercially- Saccharomyces, *Lactobacillus,Penicillium*, *Acetobactor*, *Bifidobacterium*, *Lactococcus*, *Streptococcus etc*; Product development; Dairy fermentation and fermented products. Nutritional boosts and flavor enhancers: Emerging processing and preservation technologies for milk and dairy products, Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods.

Unit-3

Food Preservation Using Irradiation, Characteristics of Radiations, Principles Underlying the Destruction of Microorganisms by Irradiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents. Storage Stability, Food Preservation with Low and high Temperatures, Preservation of Foods by Drying, Indicator and Food-borne Pathogens, Other Proven and Suspected Food-borne Pathogens.

Text and Reference Books

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

Course Outcomes:

After completing the course, students will be able to:

1. To state the brief introduction, history, importance and applications of biotechnology in food processing.
2. To understand the role of Food additives, flavor enhancers and supplements –probiotics, health care products, vitamins and antibiotics; Fuels and industrial chemicals- Alkanes, industrial ethanol etc.
3 To determine Microbial enzymes in food processing; Industrial production of enzymes - proteases and cellulases; Food and beverage fermentation- alcoholic and non alcoholic beverages.
4. To analyze the Microbial production of fermented food viz. cheese, bread etc.
5. To evaluate the techniques for modification of microbes/enzymes–Strain improvement, enzyme/ cofactor engineering and microbial inactivation.
6. To explain various aspects of Dairy Technology and Dairy Industry.
7. To explain and classify various types of Food Preservation techniques such as Using Irradiation, Radappertization, Radicidation, and Radurization, Low and high Temperatures, Drying.

BST 605: Frontiers in Biotechnology	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST302 Molecular Biology, BST503 Genomics and Proteomics, BST504 Bioprocess Technology

Course Objectives:

1. To give knowledge of key technologies and their applications to the study of human and model organism genomes.
2. To give complete knowledge of closely related areas of functional, structural and comparative genomics.
3. To explain the current state of expression, cell map and modular proteomics.
4. To explain Geo-Genomics and Human migrations, High throughput screening in genome for drug discovery, Pharmacogenetics and drug development.
5. To explain the concept of Stem cell technology and Nanotechnology.

Detailed Syllabus

Unit-1 Genetically modified organisms: Genetically modified food crops, food animals - examples and mode of production in brief.Future goals in GM food crops and animals, scientific evaluation of public concerns, legal requirements in production of GMO. Biotechnology Commercial products: Insulin, Golden rice, BT Cotton etc.
Unit-2 Human molecular medicine: Gene mutation, point mutation, allele specific oligonucleotides, ARMS, oligonucleotide ligation, disease diagnosis with linked genetic markers, fluorescently labeled DNA sequencing. Micro RNA, Gene silencing and RNAi. Stem cells technology: Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells. Nanotechnology: Introduction & definition, hybrid nanopracticles, smart drug delivery, biomolecule control, nanofluids, nanotechnology in medicine. Biosensors.
Unit-3 Meeting of human populations & its genetic imprint; Detection of admixture (based on allelefrequencies & DNA data); Y Chromosome& mitochondrial DNA markers in genealogical studies; Peopling of continents (Europe, Africa, Asia): Geo-Genomics and Human migrations; Culture and human evolution: High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

Text and Reference Books

1. The Cell - A molecular Approach, Geoffrey M. Cooper and Robert E. Hausman, ASM Press
2. Molecular Biology and Biotechnology, 4th Edn, J.M Walker and R. Rapley, Panima Books
3. Cell Biology, David. E. Sadava, Panima Books, Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
4. Environmental Microbiology, 2nd Edition, Ian L .Pepper and Charles P. Gerba, Elsevier Pub.
5. Environmental Biotechnology–Concepts and Application, Hans–Joachim Jordening and Jesefwinter – Wiley – VCH
6. Affinity Biosensors: Techniques and Protocols, K.R. Rogers and A. Mulchandani, Humana Press.
7. Biosensors and their Applicatrions, V.C. Yang and T.T. Ngo, Plenum Publishing Corporation.

Course Outcomes:

After completing the course, students will be able to:

1. To define Genetically modified food, plants and animals in brief, future goals in GM food crops and animals as well as biotechnology Commercial products: Insulin, Golden rice, BT Cotton etc.
2. To understand mutation and its types, allele specific oligonucleotides, ARMS, oligonucleotide ligation and disease diagnosis with linked genetic marker.s
3 To determine the concept of Micro RNA, Gene silencing and RNAi and fluorescently labeled DNA sequencing.
4. To analyze the concept of stem cells technology: Definition, properties, proliferation, medical applications, ethical and legal issues in use of stem cells.
5. To evaluate the principle of Nanotechnology, hybrid nanopracticles, smart drug delivery, biomolecule control, nanofluids, nanotechnology in medicine and biosensors.
6. To explain Meeting of human populations & its genetic imprint; Detection of admixture (based on allele frequencies & DNA data); Y Chromosome & mitochondrial DNA markers in genealogical studies.
7. To explain Geo-Genomics and Human migrations; Culture and human evolution: High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.

BST 651: Biotechnology Lab VI	
Teaching Scheme Lab: 2 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment -15Marks External Assessment - 35Marks

Prerequisite: - BST 451 Biotechnology Lab IV and BST 551 Biotechnology lab V

Course Objectives:

1. To give overview of basic concepts of instruments used in biotechnology laboratory.
2. To give complete knowledge of centrifugation, its principles, working mechanism and types.
3. To learn about the basic spectroscopic techniques and mass spectrometry.
4. To describe the importance of various bioinformatics tools.
5. To develop an understanding of the various aspects of Bioprocess Technology.
6. To give knowledge about the role of Food additives, flavor enhancers and supplements –probiotics, health care products, vitamins and antibiotics
7. To state the brief introduction, history, importance and applications of biotechnology in food processing.

Detailed Syllabus

1. To identify the class of bacteria using gram staining technique.
2. To extract protein from leaves with the help of centrifuge.
3. To demonstrate beer lamberts law.
4. To check the anti bacterial property of natural agents.
5. To test the susceptibility of microbial species against different antibiotic agents ampicillin and tetracyclin.
6. To check the quality of milk with MBRT test.

Course Outcomes:

After completing the course, students will be able to:

1. To learn the working of spectrophotometer while demonstrating beer lamberts law.
2. To understand the working of centrifugation while doing protein separation from leaves with the help of lysis buffer.
3 To check the quality of milk with MBRT test.
4. To analyze the anti bacterial property of natural agents.
5. To test the susceptibility of microbial species against different antibiotic agents ampicillin and tetracyclin.
6. To identify the class of bacteria using gram staining technique.
7. To collect industrial water and estimate the colony forming unit.