Bachelor of Science (Biotechnology Hons.)(3rd Year)

Course Structure

INVERTIS UNIVERSITY

Invertis Village, Delhi Lucknow Highway
NH-24, Bareilly, Uttar Pradesh Pin - 243
123, India

STUDY AND EVALUATION SCHEME
Bachelor of Science [Biotechnology]

(Effective from Session 2020-2021)

YEAR III, SEMESTER V

COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
			L	T	P	CA	EE		
BST501	BIOPROCESS TECHNOLOGY	CC	3	1	0	30	70	100	4
BST502	RECOMBINANT DNA TECHNOLOGY	CC	3	1	0	30	70	100	4
BST503	PLANT PHYSIOLOGY	DSE^	3	1	0	30	70	100	4
BST504	FRONTIERS IN BIOTECHNOLOGY	DSE^							
BST505	MEDICAL MICROBIOLOGY	DSE^	3	1	0	30	70	100	4
BST506	PLANT BIOTECHNOLOGY	DSE^							
BST551	BIOTECHNOLOGY LAB V	AEC	0		4	15	35	50	2
TOTAL			**12**	**4**	**4**	**135**	**315**	**450**	**18**

CC-Core Courses; AECC-Ability Enhancement Compulsory Course; GE-Generic Elective;

AEC-Ability Enhancement Course; SEC-Skill Enhancement Courses; DSE-Discipline Specific Elective

L – Lecture; T – Tutorial; P – Practical; C – Credit; CA-Continuous Assessment; EE – End Semester Exam

GE* - Elect any one from the prescribed; DSE^ - Elect any two from the prescribed

YEAR III, SEMESTER VI

COURSE CODE	COURSE TITLE	COURSE CATEGORY	HOURS			EVALUATION SCHEME		SUBJECT TOTAL	CREDIT
			L	T	P	CA	EE		
BST601	ANALYTICAL TECHNIQUES	CC	3	1	0	30	70	100	4
BST602	GENOMICS AND PROTEOMICS	CC	3	1	0	30	70	100	4
BST603	INDUSTRIAL BIOTECHNOLOGY	DSE^	3	1	0	30	70	100	4
BST604	BIOINFORMATICS	DSE^	3	1	0	30	70	100	4
BST605	ENVIRONMENTAL BIOTECHNOLOGY	DSE^	3	1	0	30	70	100	4
BST606	INTELLECTUAL PROPERTY RIGHTS	DSE^	3	1	0	30	70	100	4
BST651	BIOTECHNOLOGY LAB VI	AEC	0	0	4	15	35	50	2
TOTAL			**12**	**4**	**4**	**150**	**315**	**450**	**18**

CC-Core Courses; AECC-Ability Enhancement Compulsory Course; GE-Generic Elective;

AEC-Ability Enhancement Course; SEC-Skill Enhancement Courses; DSE-Discipline Specific Elective

L – Lecture; T – Tutorial; P – Practical; C – Credit; CA-Continuous Assessment; EE – End Semester Exam
GE* - Elect any one from the prescribed; DSE^ - Elect any two from the prescribed

B.Sc Biotechnology: Semester-V BST 501: 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.

Course Outcomes:

After completing the course, students will be able to:

CO1: To define the basic concept of fermentation and types of fermentors and bioreactors used in fermentation industry: their working mechanism.
CO2: To understand various types of fermentation like Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation
CO3: To determine the mechanisms sterilization and their types.
CO4: 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.
CO5: To evaluate the processing of major fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification.
CO6: 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.
CO7: To explain role of preservatives in food industry: Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

Detailed Syllabus::

UNIT-1 Bioreactor designs
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 downprocess.
UNIT-2 Bioseparation
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
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.

B.Sc Biotechnology: Semester-V 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.

Course Outcomes:

After completing the course, students will 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.

Detailed syllabus::

UNIT-1 Introduction of 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
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
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.

B.Sc Biotechnology: Semester-V BST 503: 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.

Course Outcomes:

After completing the course, students will 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.

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 evaluate major affects on physiological and biochemical mechanisms of growth regulators (hormones) in plants.

CO6: To explain and construct growth curve for investigating the growth pattern.

CO7: 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.

Detailed syllabus:

UNIT-1 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
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 Plant Hormones
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.

B.Sc Biotechnology: Semester-V BST 504: 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

Course Outcomes:

After completing the course, students will be able to:

CO1: 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.
CO2: To understand mutation and its types, allele specific oligonucleotides, ARMS, oligonucleotide ligation and disease diagnosis with linked genetic marker.s
CO3: To determine the concept of Micro RNA, Gene silencing and RNAi and fluorescently labeled DNA sequencing.
CO4: To analyze the concept of stem cells technology: Definition, properties, proliferation, medical applications, ethical and legal issues in use of stem cells.
CO5: To evaluate the principle of Nanotechnology, hybrid nanopracticles, smart drug delivery, biomolecule control, nanofluids, nanotechnology in medicine and biosensors.
CO6: 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.
CO7: 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

Detailed syllabus: :

UNIT-1 Genetically modified organisms
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
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 Human evolution
Meeting of human populations & its genetic imprint; Detection of admixture (based on allele frequencies& 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.

B.Sc Biotechnology: Semester- BST 505:Medical Microbiology	
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: - BST-Microbiology, BST503 Genomics and Proteomics, BST504

Course Objectives:

1 To give the basic knowledge of microbiology and diversity of microbes.

2. To give complete knowledge of various types of microbes involved in pathogenesis.

3. To explain the antibiotic resistant and sensitivity of pathogenic microbes.

4. To explain the importance of antibiotics and mechanisms of inhibitions.

Course Outcomes:

After completing the course, students will be able to:

CO1: This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.

CO2: It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.

CO3: The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.

CO4: It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.

CO5: To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.

CO6: Helps to understand the use of lab animals in medical field.

CO7: Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.

CO8: Explain the methods of microorganisms control, e.g. chemotherapy & vaccines. Solve problems in the context of this understanding.

Detailed Syllabus::

UNIT-1 General topics on Medical Microbiology
General topics on Medical Microbiology: History and development, Koch's postulates, classification of medically important bacteria. Infection: source, modes of transmission, portal of entry into the susceptible host and prevention

UNIT-2 Bacterial pathogenicity
Bacterial pathogenicity, identification of bacteria: staining methods, culture methods, biochemical tests and other recent methods. Sterilization and disinfection. Normal microbial flora, antimicrobial agents, drug resistance and drug sensitivity test
UNIT-3 Systematic Microbiology
Systematic Microbiology: Diseases caused by Gram positive and Gram Negative bacteria, pneumonia, gonorrhea, Tuberculosis, UTI, Overview of Medical Mycology, Important Fungal Diseases – Superficial, and Overview of Medical Virology, Important Viral Diseases– Herpesvirus, Poliovirus

Text and Reference Books

1. Greenwood D (2007). Medical Microbiology. I.K. International.

2. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.

3. Talaro KP and Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.

4. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.

5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.

6. Nester E.W, Anderson DG and Nester MT (2006). Microbiology. A Human Perspective. McGraw Hill.

7. Harvey, R.A., Champe, P.C. and Fisher, B.D. 2007. Lippincott’s Illustrated Reviews : Microbiology.

Lippincott Williams and Wilkins, New Delhi/New York.

B.Sc Biotechnology: Semester-V BST 506:Plant 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: - BST-Microbiology, BST503 Genomics and Proteomics, BST504

Course Objectives:

1To give the basic knowledge of plant tissue culture.

2. To give complete knowledge of various types of plant tissue culture and involved in regeneration of plants in shorter period of time.

3. To understand the utility of plant tissue culture in genetic modified plant production.

4. To understand the role of plant tissue culture in haploid plant production.

5. To understand the consepet abiotic stress tolerant plant through somaclonal variations.

Course Outcomes:

CO1: This course provides basic concepts of tissue culture**.**
CO2: Recall the basic concept of biotechnology and explain fundamental cellular events during the process of plant cell culture developments.

Detailed syllabus:

UNIT-1 Tissue Culture:
Historical benchmarks of plant cell and tissue culture; Culture media components and modifications; Sterilization techniques; Various types of culture: callus, suspension, nurse, root.
UNIT-2 In vitro differentiation:
In vitro differentiation: Organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration. Synthetic seeds; In vitro fertilization; Embryo rescue in wide hybridization; Endosperm culture, cryopreservation
UNIT-3 Micropropagation

Micropropagation; Anther and microspore culture; Somaclonal variation; In vitro mutagenesis; Production of secondary metabolites; Protoplast isolation, culture and regeneration; Somatic hybridization: cybrids, asymmetric hybrids; In vitro germplasm conservation

Text and Reference Books:

1. Bhojwani SS &Razdan MK. 1996. Plant Tissue Culture: Theory and Practice. Elsevier.
2.Debergh PC & Zimmerman RH. 1991. Micropropagation: Technology and Application. Kluwer Academic.
3.Chawla H.S. Introduction to Plant Biotechnology
4. Dey Kumar K. Plant Tissue Culture. New Central Book Agency (P) Ltd. Reference Books: 5.Dixon RA & Gonzales RA. Plant Cell Culture: A Practical Approach. Oxford University press.
5.George EF, Hall MA & Klerk GJD. 2007. Plant Propagation by Tissue Culture. 3rd Ed. Volume 1. Springer Science & Business Media Exercise No

B.Sc Biotechnology: Semester-V BST551: Biotechnology Lab V	
Teaching Scheme Lectures: 0 hrs/Week Tutorials: 0 hrs/Week Practicals: 4 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment - 15Marks External Assessment- 35 Marks End Semester Exam – 50 Marks

Prerequisite: - BST 103 cell biology, BST102 Introduction to biotechnology, BST 202 Biochemistry, BST203 Microbiology

Course Objectives:

1. To give Overview of immune system - Innate Immunity and Adaptive Immunity.
2. To Give complete knowledge of Immunity Barriers, phagocytosis, inflammation, Specificity, Diversity, Immunologic memory.
3. Cells and organs of the immune system: Hematopoiesis - B lymphocytes, T Lymphocytes, NK Cells and Macrophages.
4. To describe Lymphoid Organs: Primary (thymus, bone marrow) and secondary lymphoid organs (Lymph nodes, spleen).
5. To explain Antigen recognition by T cells and B cells.
6. To explain Structure, functions and characteristics of different classes of antibodies.
7. To explain the elementary idea about types of hypersensitivity reactions.

Course Outcomes:

After completing the course, students will be able to:

CO1: Students will understand the basic concept of innate and acquired immunity.
CO2: Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
CO3: Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
CO4: Students will be able to clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.
CO5: The main goal of the course is to provide basic understanding of immunology and immune responses in response to various infectious and non infectious diseases.
CO6: Students will gain knowledge about immunoglobulin structures and diversity of antibodies, morphology and functions of various immune cells such as dendritic cells, macrophages, neutrophils and their association with MHC molecules will be studied.
CO7: This study will make the students to understand the basic mechanisms of

hypersensitivity responses and their associations with different diseases.

Detailed Syllabus:

UNIT1: Biotechnology Practical's
1. Preparation of metaphase chromosome 2. DNA isolation and digestion by restriction enzymes 3. SDS PAE 4. Agarose gel electrophoresis 5. Competent cell preparation and transformation 6. Blue white selection 7. DNA ligation reaction

B.Sc Biotechnology: Semester-VI BST 601: Analytical Techniques	
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.

Course Outcomes:

After completing the course, students will be able to:

CO1: 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.
CO2: To understand the concept of phase contrast microscopy.
CO3: To explain the principle and working mechanism of TEM and SEM.
CO4: To analyze and distinguish between different types of electrophoretic techniques.
CO5: To evaluate and outline the concept of western blotting.
CO6: To explain the principle, application, affinity, mobile phase and stationary phase, types of columns, used in various chromatographic techniques.
CO7: To explain the concept of Paper Chromatography, Gel filtration Chromatography, ion-exchange chromatography, affinity chromatography, High Performance Liquid Chromatography (Normal phase and reverse phase).

Detailed syllabus::

UNIT-1 Microscopic Techniques
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
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
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.

B.Sc Biotechnology: Semester-VI BST 602: 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

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

Course Outcomes:

After completing the course, students will be able to:

CO1: To define Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes; Human genome project.
CO2: 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.
CO3: 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.
CO4: 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.
CO5: To explain and give an outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis.
CO6: 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.

Detailed syllabus:

UNIT-1 Structure and organization of prokaryotic and eukaryotic genomes
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
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
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.

B.Sc Biotechnology: Semester-VI BST 603: 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

Course Outcomes:

After completing the course, students will be able to:

CO1: To define the basics of fermentation technology.
CO2: To understand the traditional as well as modern methods of fermentation technology.
CO3: To determine the basic concepts of Upstream and Downstream processing.
CO4: To analyze Fermentative productions like Enzymes, antibiotics, vitamin, beverages.
CO5: To evaluate the production of primary and secondary metabolites.
CO6: To explain and learn the concept of producing industrial Enzymes, Bio-pesticides, Bio-fertilizers, Bio-preservatives, Biopolymers Biodiesel.
CO7: To create recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture. Enzymology.

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. v
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand& Co. Ltd., 2006.

B.Sc Biotechnology: Semester-VI BST 604: 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.

Course Outcomes:

After completing the course, students will be able to:

CO1: To give practical and hands-on experience with common bioinformatics tools and databases like as BLAST, ClustalX, MEGA, Pymol, RASMOL, CHIME.

CO2: 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.

CO3: To determine and execute basic competences in the use of bioinformatics tools.

CO4: To analyze and compare different bioinformatics tools.

CO5: To evaluate information networks and bioinformatics tools on the internet.

CO6: To explain and the knowledge of bioinformatics tools for computer Aided drug designing, ORF prediction, Gene prediction and analysis.

CO7: To explain the concept of homology modeling, molecular docking and protein-protein interaction.

Detailed syllabus:

UNIT-1 Introduction of Bioinformatics
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 Sequence alignment
BLAST, ClustalX, MEGA, Sequence alignment (pairwise and multiple, global and local), Phylogenetic analysis. Extraction of phylogenetic data set. Tree building methods and tree evaluation. 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
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)

B.Sc Biotechnology: Semester-VI BST 605: Environmental 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: BST203 Microbiology, BST404 Genetics

Course Objectives:

After the completion of the subject the student will able to understand about the

1. To develop the basis knowledge of environment, ecology and ecolsystem.
2. To develop the basic knowledge of environmental pollution and serious effects on living organisms.
3. To develop the basic concept of the bioremediation and biorestoration.
4. To develop the basic information of the waste water treatments by conventional and advanced treatment technology.

Course Outcomes:

After completing the course, students will be able to:

CO1: Classify microbes according to energy source and carbon source and evaluate energy outcome of the energy metabolism according to electron acceptor and electron donor usage.

CO2: Apply Monods kinetics and basic chemostat theory to determine microbial growth rates, biomass yield, and substrate concentration and removal rate.

CO3: Carry out an experiment with nitrification in a continuous lab-scale bioreactor for ammonia removal.

CO4: Outline the principles of methods for quantification of organic carbon in wastewater and calculate the theoretical oxygen demand (ThOD) for simple organic compounds

Detailed syllabus:

Unit-1 Introduction to Environment
Introduction to Environment: Concept of ecology and ecosystem, environmental pollution (Water, soil and air) noise and thermal pollution, their sources and effects. Environmental laws and policies. Bioremediation and Biorestoration: Reforestation through micropropagation, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.
Unit-2 Sewage and waste water treatments

Sewage and waste water treatments anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic, and fermentative bacteriatechnical process and conditions, emerging biotechnological processes in waste-water treatment.

Solid waste management: Landfills, composting, earthworm treatment, recycling and processing of organic residues. Biodegradation of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

Unit-3 Environmental Biotechnology

Environmental Biotechnology in Agriculture: Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides Biofuel: Plant derived fuels, Energycrops, Biogas, Bioethanol, biohydrogen Environmental genetics: degradative plasmids,release of genetically engineered microbes in environment.

Text and Reference Books:

1. Environmental Biotechnology by Alan Scragg (1999); Longman.

2. An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Press.

B.Sc Biotechnology: Semester-VI BST 606:Intellectual Property Right	
Teaching Scheme Lectures: 3 hrs/Week Tutorials: 1 hr/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment – 6 Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - Basic knowledge of biological system

Course Objectives:

1. To give basic overview of knowledge of intellectual property right of the novel rese
2. To give complete knowledge about of patent of biological material or novel isolate
3. To give the complete knowledge of copyright of the research.
4. To give the complete knowledge of Concept of inventive Step in Biotechnological Inventions.

Course Outcomes:

After completing the course, students will be able to:

CO1: Apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyse the social impact of intellectual property law and policy.

CO2: Analyse ethical and professional issues which arise in the intellectual property law context.

Detailed Syllabus:

Unit-1 Intellectual property right (IPR)
Introduction and the need for intellectual property right (IPR). IPR in India –Genesis and Development. Some important examples of IPR. Macro-economic impact of the patent system. Patent and kind of inventions protected by a patent. Patent document. How to protect your inventions? Granting of patent. Rights of a patent. How extensive is patent protection? Why protect inventionsby patents? Searching a patent. Drafting of a patent. Filing of a patent
Unit-2 Copyright

What is copyright? What is covered by copyright? How long does copyright last? Why protect copyright? Related rights: What are related rights? Distinction between related rights and copyright. Rights covered by copyright. Definition of trademark. Rights of trademark. Kinds of signs that can be used as trademarks. Types of trademark. Function that a trademark performs. How is a trademark protected? How is a trademark registered? How long is a registered trademark protected for? How extensive is trademark protection? What are well-known marks and how are they protected? Domain name and how does it relate to trademarks?
Unit-3 Intellectual Property Protection in biotechnology
Rationale for Intellectual Property Protection in biotechnology. Concept of Novelty in Biotechnological Inventions. Concept of Inventive Step in Biotechnological Inventions. Microorganisms as Biotechnological Inventions. Patenting biological inventions. Patenting microorganisms. Patenting other biological processes and products. Protection of new varieties of plants. Justification for Protection. Biotechnology and International Treaties such as Convention on Biological Diversity and TRIPs, WTO, GATT Agreement, and Biosafety

Text and Reference Books

1. T. M Murray, M.J. Mehlman. 2000. Encyclopaedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons
2. P.N. Cheremisinoff , R.P. Ouellette and R.M. Bartholomew.1985. Biotechnology Applications and Research, Technomic Publishing Co., Inc. USA.
3. D. Balasubramaniam, C.F.A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman, 2002. Concepts in Biotechnology, University Press (Orient Longman Ltd.).
4. Bourgagaize, Jewell and Buiser. 2000. Biotechnology: Demystifying the Concepts, Wesley Longman, USA.
5. AjitParulekar, Sarita D' Souza. 2006. Indian Patents Law –Legal & Business Implications; Macmillan India.

B.Sc Biotechnology: Semester-VI BST 651: Biotechnology Lab VI	
Teaching Scheme Lectures: 0 hrs/Week Tutorials: 0 hrs/Week Practicals: 4 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment - 15Marks External Assessment- 35 Marks End Semester Exam – 50 Marks

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 Bioproces 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.

Course Outcomes:

After completing the course, students will be able to:

CO1: To learn the working of spectrophotometer while demonstrating beer lamberts law.

CO2: To understand the working of centrifugation while doing protein separation from leaves with the help of lysis buffer.

CO3: To check the quality of milk with MBRT test.

CO4: To analyze the anti bacterial property of natural agents.

CO5: To test the susceptibility of microbial species against different antibiotic agents ampicillin and tetracyclin.

CO6: To identify the class of bacteria using gram staining technique.

CO7: To collect industrial water and estimate the colony forming unit.

Detailed Syllabus:

UNIT1: Biotechnology Practical's:
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