Evaluation Scheme & Syllabus

Of

Bachelor of Science (II 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)

II Year								
III Semester			**Teaching Scheme**			**Marks Distribution**		
SN	**CODE**	**SUBJECT**	**L**	**T**	**P**	**ESM**	**MSM**	**Total**
1	BST301	Chemistry III	3	1	0	70	30	100
2	BST302	Molecular Biology	3	1	0	70	30	100
3	BST303	Bioenergetics and Thermodynamics	3	1	0	70	30	100
4	BST304	Biotechnology – ISSUES & Ethical	3	1	0	70	30	100
5	BST305	Computer Application & Biostatistics	3	1	0	70	30	100
6	BST351	Chemistry Lab-III	0	0	2	35	15	50
7	BST352	Biotechnology Lab III	0	0	2	35	15	50
Total			**15**	**5**	**4**	**420**	**180**	**600**
IV Semester								
SN	**CODE**	**SUBJECT**	**L**	**T**	**P**	**ESM**	**MSM**	**Total**
1	BST401	Chemistry IV	3	1	0	70	30	100
2	BST402	Immunology	3	1	0	70	30	100
3	BST403	Enzymology	3	1	0	70	30	100
4	BST404	Genetics	3	1	0	70	30	100
5	BST405	Animal Physiology	3	1	0	70	30	100
6	BST451	Chemistry Lab-IV	0	0	2	35	15	50
7	BST452	Biotechnology Lab IV	0	0	2	35	15	50
Total			**15**	**5**	**4**	**420**	**180**	**600**

BST301: CHEMISTRY III	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST 101, BST151, Chemistry-I and chemistry lab BST 201 and BST 251 Chemistry

Course Objectives:

1. To give overview of concept of thermodynamics and energy.
2. To give complete knowledge of Joule's law-joule-Thomson coefficient and inversion temperature.
3. Calculation of w,q, dU, & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.
4. To describe Classification and nomenclature
5. To explain the different methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters.
6. To explain the methods of formation, chemical reactions of vicinal glycols, and pinacol-pinacolone rearrangement.

Detailed Syllabus

Unit-1

Definition of thermodynamic terms: system, surroundings etc. Types of systems, intensive and extensive properties. Thermodynamic process. Concept of heat and work. *First Law of Thermodynamics:* Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law-joule-Thomson coefficient and inversion temperature. Calculation of w,q, dU, & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Unit-2

Classification and nomenclature. Monohydric alcohols-nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols-nomenclature, methods of formation ,chemical reactions of vicinal glycols, and pinacol-pinacolone rearrangement.

Unit-3

Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and Effective atomic number.

Text and Reference Books

Reference Books:

1. A Textbook of Physical Chemistry, A. S. Negi, S. C. Anand
2. Physical Chemistry, Gilbert William Castellan
3. Physical chemistry, Walter John Moore
4. Organic Chemistry, Benjamin List, Keiji Maruoka Advanced Organic Chemistry, 4th ed. Part A: Structure and Mechanisms F. Carey and R. Sundberg, Kluwer Academic .

Course Outcomes:

After completing the course, students will be able to:

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
6. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
7. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

BST 302 : Molecular Biology Fundamentals	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST 103 cell Biology and BST 102 Introduction to Biotechnoogy, BST152 Biotechnology Lab

Course Objectives:

1. To give over view of concept of gene and chromosomes.
2. To Give complete knowledge of Structure of DNA Molecules , Bacteria Contain Chromosomes and Extrachromosomal DNA, Organelles of Eukaryotic Cells Contain DNA, DNA Supercoiling**.**
3. To describe Structure of DNA. Watson & Crick's Model, Types of DNA. Meselsen & Stahl's experiment, DNA replication with Enzymes and Protein factors in DNA Replication, genome complexity.
4. To explain the DNA Dependent synthesis of RNA, RNA Polymerases, Structure and types of RNA and their functions.
5. To explain the Genetics code, Protein synthesis: Ribosomes, tRNA, Aminoacyl-tRNA Synthetases.
6. Genetic recombination, Molecular aspects of recombination, Homologous and heterologous recombination.

Detailed Syllabus

Unit-1

Genes and Chromosomes: Structure of DNA Molecules , Bacteria Contain Chromosomes and Extrachromosomal DNA, Organelles of Eukaryotic Cells Contain DNA, DNA Supercoiling , Chromatin and Nucleoid Structure, DNA as the genetic material. Hershey and Chase experiment. Conrat and Senger's experiment. Structure of DNA. Watson & Crick's Model, Types of DNA. Meselsen & Stahl's experiment, DNA replication with Enzymes and Protein factors in DNA Replication, genome complexity.

Unit-2

DNA Dependent synthesis of RNA, RNA Polymerases, Structure and types of RNA and their functions, Basic Concept of RNA Processing, Transcription in prokaryotes and eukaryotes. Steps in transcription,

Translation; Genetics code, Protein synthesis: Ribosomes, tRNA, Aminoacyl-tRNA Synthetases. Comparison between prokaryotic and eukaryotic translation. Post translational processing of proteins in Eukaryotes and Prokaryotes.

Unit-3

Genetic recombination .Molecular aspects of recombination .Homologous and heterologous recombination. Holliday Model. Gene regulation: principles and protein Gene expression and organization in mitochondrion and chloroplast Regulation of expression in prokaryotes and eukaryotes. Operon concept - details of lac and tryp operon.

Text and Reference Books

1. Molecular Biology of the Gene -Lewin
2. Molecular biology JD Watson.

Course Outcomes:

After completing the course, students will be able to:

1. Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Students will be able to explore new areas of research in both molecular biology and allied fields of science and technology.
6. Research Development and Practice that is Formulate and carry out independent and collaborative research projects.
7. Students will be able to develop the communication skills in presenting their research findings through effective oral and written presentations.

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BST 303: Bioenergetics and Thermodynamics	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST 103 cell Biology and BST 102 Introduction to Biotechnoogy, BST 202 Biochemistry

Course Objectives:

1. To give over view of Principles of Bioenergetics.
2. To Give complete knowledge of **E**nergy Yielding and Energy Requiring Reactions, Equilibrium Concentrations, Oxidation-Reduction Reactions.
3. To describe Thermodynamic considerations: First and Second Law of Thermodynamics, Enthalpy and Entropy, Activation Energy.
4. To explain the Catabolism and the Generation of Chemical Energy.
5. To explain the Metabolic Strategies, General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis.
6. To explain Oxidative Phosphorylation, Electron Transport and ATP Synthesis in Bacteria.

Detailed Syllabus

Unit-1

Principles of Bioenergetics, Energy Yielding and Energy Requiring Reactions, Equilibrium Concentrations, Oxidation-Reduction Reactions, Metabolism and ATP Yield, Structure and properties of ATP. Photosynthetic Phosphorylation, Active Transport, Thermodynamic considerations: First and Second Law of Thermodynamics, Enthalpy and Entropy, Activation Energy.

Unit-2

Catabolism and the Generation of Chemical Energy. Metabolic Strategies: General Principles of Intermediary Metabolism, Regulation of Pathways, Strategies for Pathway Analysis. Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway & their regulation, Tricarboxylic Acid Cycle: Discovery of the TCA Cycle, Steps in the TCA Cycle, Stereo-chemical aspects of TCA Cycle Reactions, Thermodynamics of the TCA Cycle,

Unit-3

Mitochondria Electron Transport Chain, Oxidative Phosphorylation, Electron Transport and ATP Synthesis in Bacteria.

Text and Reference Books

Reference Books:

1. Smith and Vannes. Introduction to Chemical Engineering thermodynamics (Mcgraw Hill)
2. Y.V.C. rao. Chemical engineering thermodynamics (New age international)
3. J.B.Hawkins. Engineering Thermodynamics (University Press)
4. Spading and Cole. Engineering Thermodynamics (ELBS).
5. Biochemistry by Lehninger. McMillan publishers
6. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY

Course Outcomes:

After completing the course, students will be able to:

1. Disciplinary knowledge and understanding of biochemistry, structure and function of biological molecules.

2. Explain biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions
3. Explain the biochemical processes that underlie the relationship between genotype and phenotype
4. Demonstrate an understanding of the principles, and have practical experience of, a wide range of biochemical techniques (e.g. basic molecular biology, cell biology and microbiology methods, spectrophotometry, the use of standards for quantification, enzyme kinetics; macromolecular purification, chromatography electrophoresis, etc.).
5. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
6. Demonstrate an experiential learning and critical thinking of the structure and function of both prokaryotic and eukaryotic cells (including the molecular basis and role of sub-cellular compartmentalization)
7. Analyse biochemical data (e.g. in enzyme kinetics, molecular structure analysis and biological databases

BST304: BIOTECHNOLOGY –ISSUES & ETHICAL	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: BST 206 Ecology & Environment Biotechnology

Course Objectives:

1. To give overview of Genetic screening for any predisposition symptoms.
2. To Give complete knowledge of Social issue, public opinions against the molecular technologies.
3. To describe ethical issues against the molecular technologies.
4. To explain the Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc.
5. To explain biomedical practice to biotechnology, ethical conflicts in biotechnology.
6. To explain Intellectual Property Rights

Detailed Syllabus

Unit-1

Molecular technologies – an overview of Genetic screening for any predisposition symptoms, Cancer screening, Cloning, Gene therapy, DNA fingerprinting,(Paternity and Forensics) in vitro fertilization, surrogate motherhood, PGD, transgenic organisms, xenotransplantation, GMOs, Social issues - public opinions against the molecular technologies. Legal issues – legal actions taken by countries for use of the molecular technologies. Ethical issues – ethical issues against the molecular technologies.

Unit-2

Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc., biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, bioethics vs. business ethics, Necessity of Bioethics, different paradigms of Bioethics – National & International.

Unit-3

Intellectual Property Rights – Why IPR is necessary, TRIPS & IPR, IPR – national &international scenario, IPR protection of life forms, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and the world. Role of patent in pharmaceutical industry, computer related Innovations, Case studies Rice, Haldi, neem, etc. and challenges ahead

Text and Reference Books

Reference Books:

1. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
2. Intellecutla property rights – Ganguli – Tata McGrawhill
3. Intellectual property right – Wattal – Oxford Publishing House.

Course Outcomes:

After completing the course, students will be able to:

1. Students will gain knowledge about to Know the various statistical methods to solve different types of problems.
2. Students will gain knowledge to Operate various statistical software packages .
3. This course will provide complete package to the students to identify activities and constitute IP

infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development
4. Students will be able to clearly communicate and Appreciate the importance of Computer in hospital and Community Pharmacy
5. Students will be able to explore new areas of research allied fields of science and technology.
6. Students will Appreciate the statistical technique in solving the pharmaceutical problems
7. Apply the knowledge of mathematics and computing fundamentals to pharmaceutical applications for any given requirement and design and develop solutions to analyze pharmaceutical problems using computers.

BST305: COMPUTER APPLICATION & BIOSTATISTICS	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST106 computer fundamental

Course Objectives:

1. To give overview of Introduction of computer science in biotechnology
2. To Give complete knowledge of Computer software's & hardware.
3. To describe ethical issues against the molecular technologies.
4. To explain the Planning a program: Algorithm, Flowchart, Pseudo code, Plan of logic computer program
5. To explain Common terms, notions and Applications; Statistical population and Sampling Methods
6. To explain Fundamental principle of counting.

Detailed Syllabus

Unit-1

Introduction of computer science in biotechnology, Computer software's & hardware's, Relationship between hardware, system software, application software and user of a computer, ways of accruing software, steps involved in software development, Firmware & middleware. Planning a program: Algorithm, Flowchart, Pseudo code, Plan of logic computer program, Commonly used program for planning. Basic of Computer Language: Machine, Assembly and High Level Languages.

Unit-2

Introduction to Biostatistics, Common terms, notions and Applications; Statistical population and Sampling Methods; Diagrammatic and graphical presentation, Measures of Central Tendency (Mean, Median, Mode), Measures of dispersion (Range, Mean Deviation, Standard Deviation, Standard error, Quartile Deviation), combined mean and variance, covariance, Coefficient of variation.

Unit-3

Fundamental principle of counting. Factorial, Permutations and combinations, derivation of formulae and their connections, simple applications, Hypothesis testing, Chi square test and F-tests, Variant, One way and two way analysis of variants, ANOVA, Principles of experimental design and analysis.

Text and Reference Books

Reference Books:

1. N.T.J. Baily; Statistical Methods in Biology; English University Press
2. R. Rangaswami; A text Book of Agricultural Statistics, New Age Int. Pub.
3. Zar J; Biostatistics; Prentice Hall London
4. P.S.S. Sunder Rao; An Introduction to Biostatistics; Prentice Hall

Course Outcomes:

After completing the course, students will be able to:

1. Students will gain knowledge about to Know the various statistical methods to solve different types of problems.
2. Students will gain knowledge to Operate various statistical software packages.
3. This course will provide complete package to the students to identify activities and constitute IP

infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development
4. Students will be able to clearly communicate and Appreciate the importance of Computer in hospital and Community Pharmacy
5. Students will be able to explore new areas of research allied fields of science and technology.
6. Students will Appreciate the statistical technique in solving the pharmaceutical problems
7. Apply the knowledge of mathematics and computing fundamentals to pharmaceutical applications for any given requirement and design and develop solutions to analyze pharmaceutical problems using computers.

BST351: CHEMISTRY Lab III	
Teaching Scheme Lab: 2 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment -15Marks External Assessment - 35Marks

Prerequisite: - BST 101, BST151, Chemistry-1 and chemistry lab BST 201 and BST 251 Chemistry

Course Objectives:

1. To give over view of concept of thermodynamics and energy.
2. To Give complete knowledge of Joule's law-joule-Thomson coefficient and inversion temperature.
3. Calculation of w,q, dU, & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.
4. To describe Classification and nomenclature
5. To explain the different methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters.
6. To explain the methods of formation ,chemical reactions of vicinal glycols, and pinacol-pinacolone rearrangement.
7. To explain the Properties of the elements of the first transition series, their binary compounds and complexes.

Detailed Syllabus

1. Determination of water equivalent of calorimeter (cooling curve).
2. Determination of strength of acid and base pH metrically.
3. Heat of solution (NH_4NO_3 , $CaCl_2$).
4. Basicity of an acid by thermo chemical method.
5. Redox titration : (a) Fe^{2+} / $K_2Cr_2O_7$

Course Outcomes:

After completing the course, students will be able to:

1. Students will learn common laboratory techniques including pH measurement, acid/base titrations, UV/Visible spectroscopy in emission and absorption mode, calorimetric, and colorimetric.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
6. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
7. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

BST 352 : Biotechnology Lab-III	
Teaching Scheme	**Examination Scheme**
Lab: 2 hrs/Week	Internal Assessment-15Marks
Credits: 2	External Assessment - 35Marks

Prerequisite: - BST 103 cell Biology and BST 102 Introduction to Biotechnoogy, BST152 Biotechnology Lab

Course Objectives:

1. To give over view of concept of gene and chromosomes.
2. To Give complete knowledge of Structure of DNA Molecules , Bacteria Contain Chromosomes and Extrachromosomal DNA, Organelles of Eukaryotic Cells Contain DNA, DNA Supercoiling.
3. To describe Structure of DNA. Watson & Crick's Model, Types of DNA. Meselsen & Stahl's experiment, DNA replication with Enzymes and Protein factors in DNA Replication, genome complexity.
4. To explain the DNA Dependent synthesis of RNA, RNA Polymerases, Structure and types of RNA and their functions.
5. To explain the Genetics code, Protein synthesis: Ribosomes, tRNA, Aminoacyl-tRNA Synthetases.
6. Genetic recombination, Molecular aspects of recombination, Homologous and heterologous recombination.

Detailed Syllabus
1. Preparation of serum protein from blood
2. Preparation of nutrient agar slants, plates and nutrient broth and their sterilization.
3. Inoculation of agar slants, agar plate and nutrient broth
4. Culture of microorganisms using soil sample
5. Culture of microorganisms using soil sewage water
6. Simple and differential staining procedures, endospore staining, flageller staining, cell wall staining, capsular staining, negative staining.
7. Bacterial colony counting.
8. Isolation of DNA from blood samples.
9. Isolation of RNA from leaves

Course Outcomes:

After completing the course, students will be able to:

1. Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3.Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Students will be able to explore new areas of research in both molecular biology and allied fields of science and technology.
6. Research Development and Practice that is Formulate and carry out independent and collaborative research projects.
7. Students will be able to develop the communication skills in presenting their research findings through effective oral and written presentations

BST401: CHEMISTRY IV	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST 101, BST151, Chemistry-1 and chemistry lab BST 201 and BST 251 Chemistry

Course Objectives:

1. To give over view of Werner's coordination theory and its experimental verification.
2. To Give complete knowledge of valence bond theory of transition metal complexes.
3. Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides.
4. To describe Mechanisms of esterfication and hydrolysis.
5. To explain Migration of ions and Kohlrausch law.
6. To explain the Ostwald's dilution law its uses and limitations.
7. To explain the Applications of conductivity measurements: determination of degree of dissociation.

Detailed Syllabus

Unit-1

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

Unit-2

Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substituion. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterfication and hydrolysis (acidic and basic).

Unit-3

Migration of ions and Kohlrausch law, Arrehenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law its uses and limitations. Debye-Huckel-Onsagar's equation for strong electrolytes (elementary treatment only). Transport number,definition and determination by Hittorf method and moving boundary method. Applications of conductivity measurements: determination of degree of dissociation.

Text and Reference Books

Reference Books:

1. A Textbook of Physical Chemistry, A. S. Negi, S. C. Anand
2. Physical Chemistry, Gilbert William Castellan
3. Physical chemistry, Walter John Moore
4. Organic Chemistry, Benjamin List, Keiji Maruoka
5. Advanced Organic Chemistry, 4th ed. Part A: Structure and Mechanisms F. Carey and R. Sundberg, Kluwer Academic

Course Outcomes:

After completing the course, students will be able to:

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

3.Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
6. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
7. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

BST402: IMMUNOLOGY	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 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.

Detailed Syllabus

Unit-1 Historical perspectives of Immune System. Overview of immune system - Innate Immunity and Adaptive Immunity. Immunity Barriers, phagocytosis, inflammation, Specificity, Diversity, Immunologic memory, Self / nonself recognition. Antigenicity and immunogenicity. Immune dysfunction and Its Consequences.
Unit-2 Cells and organs of the immune system: Hematopoiesis - B lymphocytes, T Lymphocytes, NK Cells and Macrophages. Lymphoid Organs: Primary (thymus, bone marrow) and secondary lymphoid organs (Lymph nodes, spleen). Antigens and epitopes: immunogenicity and antigenicity. Haptens and adjuvants. Antigen recognition by T cells and B cells, Properties of B-cell epitopes and T-cell epitopes, Blood group antigens.
Unit-3 Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins. Basic idea of monoclonal antibody. Antigen antibody interaction - Precipitation Reactions, Agglutination Reactions. Major histocompatibility systems: MHC I and II molecule. Hypersensitivity, elementary idea about types of hypersensitivity reactions.
Text and Reference Books **Reference Books:** **Reference Books:** 1. Immunology (V Edition),- Richard A.Goldsby, Thomas. J. Kindt, A. Osborne, Janis Kuby, 2003. W.H. Freeman and company 2. Immunology, Ivan Roitt, 2001. Harcourt publishers, ltd. 3. Immunology - An Introduction, Tizard.

Course Outcomes:

After completing the course, students will be able to:

1. Students will understand the basic concept of innate and acquired immunity..

2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3.Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. 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.
6. 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.
7. This study will make the students to understand the basic mechanisms of hypersensitivity responses and their associations with different diseases.

BST403: ENZYMOLOGY	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST303: Bioenergetics and Thermodynamics BST103: cell biology, BST102:Introduction to biotechnology, BST202:Biochemistry, BST203 Microbiology

Course Objectives:

1. To give Overview of a brief introduction; Mechanisms of Enzyme Action.
2. To Give complete knowledge of Acid Base Catalysis; Covalent catalysis, Metal ion Catalysis.
3. Arrhenius Law; Transition State Theory; Kinetics of single substrate reactions; turnover number.
4. To describe Random Sequential Bi Bi mechanism; Ordered Sequential Bi Bi mechanism, and Ping Pong Bi Bi mechanism.
5. To explain Antigen recognition by T cells and B cells.
6. To explain Types of Inhibition- kinetic models: Competitive, Uncompetitive and Non-Competitive.
7. To explain the Enzyme Purification and their methods of characterization of enzymes.

Detailed Syllabus

Unit-1 Enzyme commission (E. C.) nomenclature, a brief introduction; Mechanisms of Enzyme Action: General Acid Base Catalysis; Covalent catalysis, Metal ion Catalysis. Mechanism of Chymotrypsin catalysis (Serine Proteases), Specificity of enzyme action: Active Site, Stereospecificity, Lock and Key and Induced Fit Models. Arrhenius Law; Transition State Theory; Kinetics of single substrate reactions; turnover number; Importance of KM, estimation of Michaelis-Menton parameters. Lineweaver Burk plot; Multi-substrate reaction mechanisms and kinetics: Random Sequential Bi Bi mechanism; Ordered Sequential Bi Bi mechanism, and Ping Pong Bi Bi mechanism.
Unit-2 Types of Inhibition- kinetic models: Competitive, Uncompetitive and Non-Competitive. Regulation of enzymes activity: Allosteric Modification-Sigmoidal kinetics, Feed Back Inhibition and Covalent Modification. Factors affecting the kinetics Enzyme catalysed reactions; Physical and Chemical techniques for enzyme Immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding - examples; Biosensor; Glucose Biosensor
Unit-3 Advantages and disadvantages of different Immobilization techniques; Overview of applications of immobilized enzyme systems, Applications of enzymes in analysis; Design of enzyme electrodes and their applications as biosensors in industry, health care and environment. Enzyme Purification and their methods of characterization of enzymes; development of enzymatic assays- ONPG Assay (colorimetric assay), Coupled kinetic Assay and RIA of enzymes

Text and Reference Books

Reference Books:

1. Fundamentals of enzymology by Nicolas C. price and Lewis stevens . Oxford University Press
2. Enzymes by Trevor palmer, East west Press
3. Enzyme Technology by Messing
4. Enzymes : Dixon and Webb.(IRL Press)
5. Enzyme technology by Chaplin and Bucke. Cambridge Univerity Press
6. Alan Fersht, Structure and Mechanism in Protein Science.

Course Outcomes:

After completing the course, students will be able to:

1. Students will understand the basic concept of enzymes and their activity.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3.Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Basic knowledge of structure and functions of major bio-molecules will make the students to understand and implement the acquired knowledge in future.
6. Students will gain the understanding of metabolic pathways (catabolism as well as anabolism), their diversity and how these are specifically regulated and interrelated in different cells.
7. This study will make the students for Practical knowledge and hands on tools and techniques for the characterization of bio-molecules that will help the students in advanced research programs

BST404: GENETICS	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST103: cell biology, BST102:Introduction to biotechnology, BST302 Molecular Biology.

Course Objectives:

1. To give Overview of a Genetics and Scientific Methods.
2. To Give complete knowledge of Mendelian principle: Principles of segregation, monoclonal cross, dominance, co dominance
3. Meiosis and Mendel's principles, Probability & Statistics.
4. To describe Sex determination and linkage.
5. To explain balanced concept of sex determination in Drosophila.
6. To explain Principles of linkage; Crossing over
7. To explain Cytological demonstration of crossing over.

Detailed Syllabus

Unit-1 Genetics and Scientific Methods: History, Area; Mendelian principle: Principles of segregation, monoclonal cross, dominance, co dominance, semiominance, lethal genes, Principles of independent assortment: dihybrid rations, Trihybrid ratios, gene interaction, epitasis, multiple alleles. Meiosis and Mendel's principles, Probability & Statistics.

Unit-2

Sex determination and linkage: Mechanisms of sex determination: Simple mechanisms, One or a few genes, identification of sex Chromosomes, XX-XY mechanism, Y Chromosome and sex determination in mammals, balanced concept of sex determination in Drosophila, haploidy and sex determination in hymenoptera, Mosaics and gynandromorphy, environmental factors in sex determination, sex differentiation sex influenced dominance. Sex limited gene expression, sex linked inheritance, Pedigree Analysis: Penetrance & expressivity, Family tree etc.

Unit-3

Principles of linkage; Crossing over ,cytological basis of crossing over, Diploid Mapping: Two-three point cross, Cytological demonstration of crossing over, Haploid Mapping (Tetrads Analysis): Phenotypes of Fungi, Unoorded Spores (Yeast), Ordered Spores (*Neurospora*), Somatic Crossing Over, Human Chromosomal Maps: X-Linkage, Autosomal Linkage.

Text and Reference Books

Reference Books:

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
3. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.

Course Outcomes:

After completing the course, students will be able to:

1. Students will understand the basic concept of the chromosome structure, chromatin organization and variation.

2. Students will be able to learn the concepts of Linkage concept of sex determination and sex linked inheritance.
3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. To gain knowledge about the organellar inheritance. And to understand the gene expression and regulation in Prokaryotes & Eukaryotes
6. Students will gain the better knowledge in both Prokaryotes•& Eukaryotes about the Gene Mutation, Repair Mechanisms, Nuclear Genome Organization, Genes and gene numbers. .
7. Students will become familiar with the tools and techniques of genetic engineeringDNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.

BST405: Animal Physiology	
Teaching Scheme Lectures: 4 hrs/Week Credits: 4	**Examination Scheme** Class Test -12Marks Teachers Assessment - 6Marks Attendance – 12 Marks End Semester Exam – 70 marks

Prerequisite: - BST103: cell biology, BST102: Introduction to biotechnology, BST302 Molecular Biology

Course Objectives:

1. To give Overview of a Movement of water and solutes between the fluid compartments
2. To Give complete knowledge of Body fluid compartments and the ionic composition of body fluids
3. Concept of homeostasis and Structure of biological membranes
4. To describe Organization structural and functional organization of the nervous system.
5. To explain Synaptic neurotransmission.
6. To explain central and peripheral nervous systems
7. To explain principles of sensory physiology.Vision physiology.Hearing physiology

Detailed Syllabus

Unit-1 Body fluid compartments and the ionic composition of body fluids. Movement of water and solutes between the fluid compartments. The concept of homeostasis, including set point, negative and positive feedback loops, and compensatory responses.
Unit-2 Structure of biological membranes. Function of biological membranes including the role of membrane proteins in catalysis, recognition, and transport. Intracellular and extracellular communication systems. Organization structural and functional organization of the nervous system, including the central and peripheral nervous systems, the autonomic nervous system, and the enteric nervous system
Unit-3 The resting membrane potential.The action potential, action potential propagation along the axon.Chemical messenger molecules of the nervous system, including classical and non-classical neurotransmitters.Synaptic neurotransmission.Basic principles of sensory physiology.Vision physiology.Hearing physiology. Structure and function of skeletal muscle, including excitation-contraction coupling, sliding
Text and Reference Books **Reference Books:** Anatomy and Physiology of Animals, Ruth Lawson Animal Physiology (Looseleaf), Third Edition, Richard W. Hill Gordon A Wyse Margaret Anderson

Course Outcomes:

After completing the course, students will be able to:

1: Define the body fluids, Nerves and Cell Membrane.
2: To understand the cell membrane composition, nerve fibres and key feature of membrane functions and signalling.

3: To apply the principle of homeostasis, nervous system and the methods used by the body to maintain this
4: To differentiate how the parts of the body are linked into a functioning whole.
5: To evaluate the different practical knowledge of physiological techniques
6: To create the hypothesis about physiological topics
7: 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.

BST451: CHEMISTRY IV	
Teaching Scheme Lab: 2 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment -15 Marks External Assessment- 35Marks

Prerequisite: - BST 101, BST151, Chemistry-1 and chemistry lab BST 201 and BST 251 Chemistry

Course Objectives:

1. To give over view of Werner's coordination theory and its experimental verification.
2. To Give complete knowledge of valence bond theory of transition metal complexes.
3. Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides.
4. To describe Mechanisms of esterfication and hydrolysis.
5. To explain Migration of ions and Kohlrausch law.
6. To explain the Ostwald's dilution law its uses and limitations.
7. To explain the Applications of conductivity measurements: determination of degree of dissociation.

Detailed Syllabus
1. Viscosity-composition curve for a binary liquid mixture.
2. Surface tension-composition curve for a binary liquid mixture.
3. Determination of indicator constant - colorimetry.
4. Determination of pH of a given solution using glass electrode.
5. Determination of conductivity of solvents.

Course Outcomes:

After completing the course, students will be able to:

1. Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistries.
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3.Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.
6. Students will appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.
7. Students will be able to explain why chemistry is an integral activity for addressing social, economic, and environmental problems.

BST452: BIOTECHNOLOGY LAB IV	
Teaching Scheme Lab: 2 hrs/Week Credits: 2	**Examination Scheme** Internal Assessment -15Marks External Assessment - 35Marks

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.

Detailed Syllabus

1. Different types of antigen –antibody cross reaction
2. Isolation, purification and identification of immunoglobulin from goat blood.
3. Double diffusion techniques for identification of antigen-antibody samples
4. SDS - PAGE
5. Agarose gel electrophoresis.
6. ELISA (Enzyme linked Immunosorbent Assay)
7. Isolation of DNA from plant cell
8. Isolation of DNA from animal cells
9. Plasmid isolation from bacteria

Course Outcomes:

After completing the course, students will be able to:

1. Students will understand the basic concept of innate and acquired immunity..
2. Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.
3.Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
4. 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.
5. 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.
6. 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.
7. This study will make the students to understand the basic mechanisms of hypersensitivity responses and their associations with different diseases.