CORE COURSES (BIOTECHNOLOGY)

SEMESTER III

Semester III

BTC –C 5: (Chemistry)

THEORY

Total Lectures: 60 **Credits: 4**

Objective: *To study the concepts of chemical thermodynamics, chemical equilibrium and their applications, to study about compounds of carbon , their sources, mechanism of reactions and utility in daily life and to study concepts of stereochemistry and spectra of organic molecules.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I **(15 Periods)**

CHEMICAL THERMODYNAMICS AND CHEMICAL EQUILIBRIUM

Objectives and limitations of Chemical Thermodynamics, State functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy.

First Law of Thermodynamics : First law of thermodynamics for open, closed and isolated systems. Reversible isothermal and adiabatic expansion/compression of an ideal gas. Irreversible isothermal and adiabatic expansion. Enthalpy change and its measurement, standard heats of formation and absolute enthalpies. Kirchoff's equation.

Second and Third Law: Various statements of the second law of thermodynamics. Efficiency of a cyclic process (Carnot's cycle). Entropy. Entropy changes of an ideal gas with changes in P,V, and T. Free energy and work functions. Gibbs-Helmholtz Equation. Criteria of spontaneity in terms of changes in free energy.

Third law of thermodynamics: Absolute entropies.

Thermodynamics of Simple Mixtures: Partial molar quantities and their significance. Chemical potential and its variation with T and P. Fugacity function and its physical significance. Concept of activity and activity coefficient.

UNIT II **(15 Periods)**

Chemical Equilibrium:

General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant-Van't Hoff equation, homogeneous & heterogreneous equilibria, Le Chetalier's principle.

Compounds of carbon

Differences in chemical and physical behaviour as consequences of structure. Discussion (with mechanism) of reactions of hydrocarbons' ranging from saturated acyclic and alicyclic, unsaturated dienes and aromatic systems.

Huckel rule; as applied to 4n+2 systems. Industrial sources and utility of such compounds in daily life for medicine, clothing and shelter.

UNIT III (15 Periods)

STEREOCHEMISTRY

Structure, reactivity and stereochemistry. Configuration and conformation. Optical activity due to chirality; d,l, meso and diastereoisomerism, sequence rules. Reactions involving stereoisomerism. Geometrical isomerism – determination of configuration of geometric isomers. E & Z system of nomenclature. Conformational isomerism – conformational analysis of ethane and n- butane; conformations cyclohexane, axial and equatorial bonds, conformations of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse formula, Fischer and flying wedge formulae.

UNIT IV (15 Periods)

SPECTRA OF ORGANIC MOLECULES

Range of electromagnetic spectrum. Absorption and emission spectra. Pure rotational and vibration-rotation spectra of diatomic molecules. Rotational and vibrational Raman spectra. Electronic spectra of diatomic molecules. Introduction to Infrared, Ultraviolet/Visible and Proton NMR Spectroscopy. Use of these spectroscopic techniques in identification of various functional groups. Structure elucidation of simple organic molecules.

SUGGESTED READING

1. Mahan, B.H. (1998). *University chemistry*. New Delhi: Norosa Publishing House.
2. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2003) *Principles of Physical Chemistry*. Jalandhar, India: Vishal Publishing Co.
3. Sienko, M. J., & R.A. (1975) *Plane, chemistry principles and properties*. New York: MC Graw-Hill
4. Morrison, R. T. N., & Boyd, R. N. (1987). *Organic chemistry* (5th ed.). London: Allyn and Bacon.
5. Cotton, F.A., & Chang, W. R. (1998). *Basic inorganic chemistry* (6th ed.). New York: McGraw-Hill.
6. Lippincott, W. T., Carett, A. R., & Chemistry, F. H. (1977). *A study of matter*. New York: John Wiely
7. Dickerson, R. E., Gray, H.B., Derensburg, M. Y., & Darensbourg, D. S. (1984) *Chemical principles.* Menlo Park: Benjamin-Cummings
8. McQuarrie, D. A., & Rock, P. (1984) *General chemistry*. New York: Freeman, WH.
9. Brown, T. L., & Lemay, H. E. (1977) *Chemistry; the central science*. New Jersey: Prentice-Hall.

BTC –C 5: (Chemistry)
PRACTICALS

Credits: 2

1. Analysis of the given mixture containing six radicals with at least one interfering (PO_4 3- Oxalate, Tartarate).
2. Volumetric Analysis:
   a. Acid-Alkali/Base: Involving use of one of one indicator and two indicators.
   b. Oxidation-Reduction: $KMnO_4$/$K_2Cr_2O_7$ Titrations.

Semester III
BTC –C 6: (Enzymology)

THEORY

Total Lectures: 60 **Credits: 4**

Objective: *To learn the basic principles of enzymology to know how enzymes functions in the biological systems and strategies/ applications of enzyme technology in industries.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit I **(20 Periods)**

Introduction to Enzymes: Definition, historical perspectives, systematic nomenclature & classification, significance of numbering system, coenzyme, cofactors.

Specificity of enzyme action: Types of specificity, hypothesis (lock-and-key, induced fit, strain or transition-state stabilization), Investigation of active site structure: By trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with proteases and site-directed mutagenesis, by studying the effect of changing pH. Mechanism of action of serine protease, lysozyme and chymotrypsin, GPDH, aldolase, RNAse, Carboxypeptidase and alcohol dehydrogenase.

Unit II **(15 Periods)**

Enzyme kinetics: Factors affecting enzyme activity (Enzyme concentration, substrate concentration, pH, temperature and reaction time *etc.*).

Derivation of Michaelis-Menten equation for uni-substrate reactions. KM and its significance. Lineweaver-Burk plot, Eadie-Hofstee and Hanes–Woolf equation and y value. Importance of Kcat/Km. Two-substrate reactions (Random, ordered and ping-pong mechanism.

Enzyme inhibition, determination of Ki, suicide inhibitors. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid base, nucleophilic and covalent catalysis.

Unit III **(13 Periods)**

Regulation of enzyme activity: General mechanisms of enzyme regulation, product inhibition, feedback control. Reversible (phosphorylation, disulphide reduction, adenylation) and irreversible (Zymogens and their activation; proteases and prothrombin) covalent modifications of enzymes. Isoenzymes (multiple forms of enzymes): Properties, measurement and significance with special reference to lactate dehydrogenase. Monomeric enzymes, oligomeric enzymes & Multienzyme system: Occurrence, isolation & their properties; Mechanism of action and regulation of pyruvate dehydrogenase & glycine synthase complexes. Ribozymes. Measurement and expression of enzyme activity: Extraction, enzyme assay, enzyme units, enzyme turn over number and specific activity.

Unit IV **(12 Periods)**

Enzyme immobilization/modification/applications

Immobilization of microbial enzymes- Immobilized enzymes and their comparison with soluble enzymes. Methods *viz.* adsorption, entrapment & membrane confinement, covalent bonding and their analytical, health & industrial applications. Properties of immobilized enzymes. Enzyme electrodes. Site directed mutagenesis & Enzyme engineering- Adding disulfide bonds, changing asparagines to other amino acids, reducing free sulphydryl residues, increasing enzyme activity, modifying enzyme specificity (selected examples).

Artificial enzymes, degradation of unnatural substrates and catalytic antibodies.

Clinical and industrial applications of enzymes– Detergent, food, leather, dairy and medicine industries.

BTC –C 6: (Enzymology)
PRACTICALS

Credits: 2

1. Extraction of enzymes from bacteria/plants and check their activity.
2. Effect of pH on the activity of enzyme and pH stability.
3. Effect of temperature on the activity of enzyme and thermostability.
4. Effect of reaction time on the activity of enzyme.
5. Effect of metals on the activity of enzyme.
6. Calculation of kinetic parameters such as Km, Vmax, Kcat
7. Immobilization of enzymes and check their usability.
8. Differentiation of isozymes by gel electrophoresis.

SUGGESTED READING

1. Palmer, T., & Bonner, P. L. (2007). *Enzymes: Biochemistry, biotechnology, clinical chemistry*. United Kingdom: Horwood Publishing Limited.
2. Prime, N. C.. & Stevens, L. (1999). *Fundamentals of enzymology: The cell and molecular biology of catalytic proteins.* New York: Oxford University press.
3. Stryer, L. (2007). *Biochemistry* . New York: W.H. Freeman and Co.
4. Lehninger, A., Cox, M., & David, L. (2008). *Principles of biochemistry* (5th ed.). New York: Worth Publishers.
5. Campbell, M. K., & Farrell, S. O. (2005). *Biochemistry* (5th ed.). Cengage Learning,
6. Voet, D., & Voet, J.G. (2004). *Biochemistry.* New York: John Liley and Sons, Inc.

7. Plummer, D. Tj. (2004). *An Introduction to practical Biochemistry.* New Delhi: Tata McGraw Hill Publishers Co.
8. Bisswanger, H. (2005). *Practical enzymology.* Weinheim: Wiley-VCH.
9. Murray, R. K., Bender, D. A., & Kathleen, M. (2012). *Harper's Illustrated Biochemistry.* USA: McGraw-Hill.
10. Cornish-Bowden, A. (2004*). Fundamentals of Enzyme Kinetics.* London: Portland Press.

Semester III
BTC-C 7: (Plant physiology)

THEORY

Total Lectures: 60 **Credits: 4**

Objective: *This course will deal with various processes such as plant taxonomy, water relations, mineral nutrition, photosynthesis, respiration, nitrogen metabolism and end up with growth control by hormones and plant adaptation to various stresses. Practical skills will be imparted to the students through critically designed practicals related to the subject.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I **(10 Periods)**

Anatomy

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II **(12 Periods)**

Plant water relations and micro & macro nutrients

Plant water relations: Importance of water to plant life, Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration, stomata & their mechanism of opening & closing, mechanisms of loading and unloading of photoassimilates. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT III **(20 Periods)**

Carbon metabolism and assimilation of mineral nutrients

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants, Sulphur, phosphate and cation assimilation in plants.

UNIT IV **(18 Periods)**

Growth and development

Growth and development: Definitions, phases of growth, growth curve, physiological effects and mode of action of phytohormones (auxins, cytokinins, gibberellins, abcissic acid and ethylene) Embryo development and seed germination, seed dormancy, concept of photoperiodism and vernalization.

BTC-C 7: (Plant physiology)

PRACTICALS

Credits: 2

1. Visit to Botanical garden for specimen collection of Pteridophytes, Angiosperms and Gymnosperms.
2. Preparation of stained mounts of anatomy of monocot and dicot's roots.
3. Preparation of stained mounts of anatomy of monocot and dicot's stem.
4. Preparation of stained mounts of anatomy of monocot and dicot's leaf.
5. Demonstration of plasmolysis by *Tradescantia* leaf peel.
6. Demonstration of opening & closing of stomata
7. Demonstration of guttation on leaf tips of grass and garden nasturtium.
8. TS section cutting of stems and analysis of cytoplasmic streamings.
9. Test for minerals present in plant tissues.
10. Separation of photosynthetic pigments by paper chromatography.
11. Demonstration of aerobic respiration.

SUGGESTED READING

1. Dickinson, W.C. (2000). *Integrative plant anatomy.* USA: Harcourt Academic Press.
2. Esau, K. (1977). *Anatomy of Seed Plants*. New York: Wiley Publishers.
3. Fahn, A. (1974). *Plant Anatomy*. USA & UK: Pergmon Press.
4. Hopkins, W.G., & Huner, P.A. (2008). *Introduction to Plant Physiology*. USA: John Wiley & Sons.
5. Mauseth, J.D. (1988). *Plant Anatomy*. USA: Benjammin/Cummings Publisher.
6. Nelson, D.L., & Cox, M.M. (2004). *Lehninger Principles of Biochemistry* (4th ed.). New York, USA: W.H. Freeman & Co.
7. Salisbury, F.B., & Ross, C.W. (1991). *Plant Physiology.* California: Wadsworth Publishing Co.
8. Taiz, L., & Zeiger, E. (2012). *Plant Physiology* (5th ed.). MA, USA: Sinauer Associates Inc .

SKIL ENHANCEMENT COURSES (Offered by Biotechnology Department) ***for biotechnology students only*** **SEMESTER III**

BTC-SEC 1: Molecular Diagnostics **BTC-SEC 2:** Basics of Forensic Science	**Any one in semester III**

Semester III

SKILL ENHANCEMENT COURSES (any one in semesters III)

BTC-SEC 1: (Molecular Diagnostics)

THEORY

Total Lectures: 60 **Credits: 2**

Objective: *The objective of this course is learning and understanding how molecular techniques that were studied in other classes can be developed and utilized in diagnosis and sold in diagnostic kits. Students will cover the principles of Molecular Diagnosis which is the process of identifying a disease by studying molecules, such as proteins, DNA, and RNA, in a tissue or fluid. Molecular diagnostics is a new discipline that captures genomic and proteomic expression patterns and uses the information to distinguish between two or more conditions at the molecular level.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I **(15 Periods)**

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT II **(15 Periods)**

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III **(18 Periods)**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV **(12 Periods)**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

SUGGESTED READING

1. Wilson, K., & Walker, J. (2000). *Principles and techniques of practical biochemistry.* Cambridge : Cambridge University Press.
2. Webster, J. G. (2004). *Bioinstrumentation.* New York: John Wiley & Sons.
3. van Impe, J.F., Vanrolleghem, P.A., & Iserentant, D.M. (1998). *Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes*. Dordrecht: Kluwer Academic Press
4. Ananthanarayan, R., & Paniker, C.K.J. (2005). *Textbook of Microbiology* (7th ed.). Hydrabad: University Press Publication.
5. Brooks, G.F., Carroll, K.C., Butel, J.S., & Morse, S.A. (2007). *Jawetz, Melnick and* Adelberg's *Medical Microbiology* (24th ed.). New York: McGraw Hill Publication.
6. Goering, R., Dockrell, H., Zuckerman, M., & Wakelin, D. (2007). *Mims' Medical Microbiology* (4th ed.). USA: Elsevier Press.
7. Joklik, W.K., Willett, H.P., & Amos, D.B. (1995). *Zinsser Microbiology* (19th ed.). New York: Appleton- Centuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Hoppert, M. (2006). *Microscopic Techniques in Biotechnology*. UK: Wiley-Blackwell

BTC-SEC 2: (Basics of Forensic Science)
THEORY

Total Lectures: 60 **Credits: 2**

Objective**:** *The objective of the paper is to introduce the scientific principles involved in forensic science and to understand techniques of identifying various physical evidences found at crime scenes such as firearms, ammunition, handwriting and DNA fingerprinting.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit I (15 Periods)

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II (15 Periods)

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III **(15 Periods)**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV **(15 Periods)**

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. Washington: ASM Press.
2. Nanda, B.B., & Tiwari, R.K. (2001). *Forensic Science in India: A Vision for the Twenty First Century*. New Delhi: Select Publishers.
3. Bhasin, M.K., & Nath, S. (2002). *Role of Forensic Science in the New Millennium.* Delhi, India: KRE publishers.
4. James, S.H., & Nordby, J.J. (2005). *Forensic Science: An Introduction to Scientific and Investigative Techniques* (2nd ed). Boca Raton: CRC Press.
5. Eckert, W.G., & Wright, R.K. (1997). *Introduction to Forensic Sciences* (2nd ed.). Boca Raton: CRC Press.
6. Saferstein, R. (2004). *Criminalistics* (8th ed.). New Jersey: Prentice Hall.
7. Tilstone, W.J., Hastrup, M.L., & Hald, C. (2013). *Fisher's Techniques of Crime Scene Investigation*. Boca Raton: CRC Press.

GENERIC ELECTIVE SUBJECT
(*Offered by Biotechnology Department) ***for students of other departments***
SEMESTER III

BTC-GE-5*: IPR, Bioethics and Biosafety

Semester III
BTC-GE 5: (I.P.R., Bioethics & Biosafety)
THEORY

Total Lectures: 60 **Credits: 4**

Objective: *This course will also make the students aware of the a) law pertaining to biotechnology, how to apply for national/international patent, Biotech agreements between various countries etc.(b) ethical issues concerned with the field of Biotechnology, (c) bioterrorism and (d) ways to handle/dispose-of biohazard material.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT-I **(15 Periods)**

Ownership of Tangible and Intellectual Property. Basic requirements of patentability, patentable subject matter, novelty and the Public Domain; Non obviousness. Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. WTO agreement and TRIPS, Patent Cooperation treaty, Intellectual/Industrial property and its legal protection in research, design and development.

UNIT II **(20 Periods)**

Patenting in Biotechnology, economic, ethical and depository considerations. Compulsory licensing, Patent infringements and revocation, Patents: Disclosure Requirements, Collaborative research, competitive research, Patent Litigation: Substantive Aspects of Patent Litigation, Procedural Aspects of Patent Litigation, Recent Development in Patent System, Budapest treaty

UNIT III **(10 Periods)**

Biosafety – Introduction to biosafety and health hazards concerning biotechnology, The Cartagena protocol on biosafety. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

UNIT IV **(15 Periods)**

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. Bioterrorism, Social and ethical implication of biological weapons

BTC-GE 5: (I.P.R., Bioethics & Biosafety)
PRACTICALS **Credits: 2**

1. Searching of Patent databases
   a. Indian Patent office
   b. USPTO
   c. WIPO

2. Drafting and filing of Patent
   application. a. In India
   b. In USA
   c. Under PCT

3. Case studies on the patent infringements and revocations
4. Case studies on compulsory licensing.
5. Understanding the Structure and working of Biosafety and Bioethical committees.
6. Drafting and filing application for biosafety and bioethical clearance.

SUGGESTED READING

1. Gupta, P.K. (2004). *Elements of Biotechnology.* India: Meerut Rastogi Publications.
2. Subbaram. (2003). *What everyone should know about patents?* Hyderabad: NPharma book Syndicate.
3. Watal, J. (2001). *Intellectual Property rights in the WTO and Developing countries.* New Delhi: Oxford University Press.
4. Intellectual Property Bulletin.
5. Sateesh, M. K. (2010). *Bioethics and Biosafety.* New Delhi: I. K. International Pvt Ltd.
6. Krishna, S.V. (2007). *Bioethics and Biosafety in Biotechnology.* New Delhi: New age international publishers.