DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

Evaluation Scheme & Syllabus

For

B.Tech. 2nd Year

BIOTECHNOLOGY

(Effective from the Session: 2023-24)

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

SEMESTER –III

SN	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit Cr
					L	T	P	CT	TA	CT+TA	TE/PE		
1	BOE3** / BAS304	Science Based Open Elective/BSC (Maths-III/Math IV/ Math V)	T	ES/BS	3	1	0	20	10	30	70	100	4
2	BVE301 / BAS301	Universal Human Value and Professional Ethics/ Technical Communication	T	VA/HS	2	1	0	20	10	30	70	100	3
3	BBT301	Techniques in Biotechnology	T	PC	3	1	0	20	10	30	70	100	4
4	BBT302	Microbiology and Immunology	T	PC	3	1	0	20	10	30	70	100	4
5	BBT303	Biochemistry	T	PC	2	1	0	20	10	30	70	100	3
6	BBT351	Techniques in Biotechnology lab	P	PC	0	0	2		50	50	50	100	1
7	BBT352	Microbiology and Immunology lab	P	PC	0	0	2		50	50	50	100	1
8	BBT353	Biochemistry lab	P	PC	0	0	2		50	50	50	100	1
10	BCC301 / BCC302	Cyber Security/Python programming	T	VA	2	0	0	20	10	30	70	100	2
11	BCC351	Internship Assessment /Mini Project*	P							100		100	2
		Total			**15**	**5**	**6**						**25**

- **Mathematics –III** for CE / ENV and allied branches
- **Mathematics-IV** for Computer/Electronics/Electrical & allied Branches, Mechanical & Allied Branches Textile/Chemical & allied Branches
- **Mathematics-V** for Bio Technology / Agriculture Engineering

SEMESTER –IV

SN	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit Cr
					L	T	P	CT	TA	CT+TA	TE/PE		
1	BAS404 / BOE4**	BSC (Maths-III/Math IV/ Math V)/Science Based Open Elective	T	BS/ES	3	1	0	20	10	30	70	100	4
2	BAS401 / BVE401	Technical Communication / Universal Human Value and Professional Ethics	T	HS/VA	2	1	0	20	10	30	70	100	3
3	BBT401	Bioprocess Engineering	T	PC	3	1	0	20	10	30	70	100	4
4	BBT402	Genetics and Molecular Biology	T	PC	3	1	0	20	10	30	70	100	4
5	BBT403	Enzyme Engineering	T	PC	2	1	0	20	10	30	70	100	3
6	BBT451	Bioprocess Engineering lab	P	PC	0	0	2		50	50	50	100	1
7	BBT452	Genetics and Molecular Biology lab	P	PC	0	0	2		50	50	50	100	1
8	BBT453	Enzyme Engineering lab	P	PC	0	0	2		50	50	50	100	1
9	BCC402 / BCC401	Python Programming/Cyber Security	P	VA	2	0	0	20	10	30	70	100	2
10	BVE451 / BVE452	Sports and Yoga - II / NSS-II	P	VA	0	0	3			100		100	0
		Total			**15**	**5**	**9**						**23**
		Minor Degree/ Honors Degree MT-1/HT-1											

*The Mini Project or internship (4 weeks) will be done during summer break after 4th Semester and will be assessed during V semester.

SYLLABUS
SEMESTER-III

BBT301- TECHNIQUES IN BIOTECHNOLOGY		
Course Outcome (CO)		**Bloom's Knowledge Level (KL)**
At the end of course , the student will be able to		
CO 1	Acquire knowledge on types of microscope and its applications in Biotechnology.	K2
CO 2	Apply the principle of chromatographic techniques for qualitative and quantitative analysis of biomolecules.	K3
CO 3	Employ various spectroscopic techniques for qualitative and quantitative analysis of Bio-Molecules/Bio-Analytes.	K3
CO 4	Employ various electrophoresis and centrifugation techniques for analysis of Bio-Molecules/Bio-Analytes.	K3
CO 5	Acquire knowledge on 3 D printing, flow cytometry and biosensors.	K2
DETAILED SYLLABUS		**3-1-0**

Unit	Topic	Proposed Lecture
I	Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy: TEM and SEM, Atomic force microscopy and con focal scanning laser microscopy. Differential interference contrast microscopy.	08
II	Principle and Operations of Chromatography, Thin layer chromatography, Ion Exchange Chromatography, High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Gel Filtration Chromatography, Affinity Chromatography.	08
III	Electromagnetic radiation and spectrum,Atomic absorption and Atomic emission spectroscopy,Principle, working and applications of UV-VIS, NMR, ESR and IR spectrometer, Principle and applications of Mass Spectroscopy, Circular Dichorism (CD) principles, Principle and applications of Positron Emission Tomography(PET), Basics of X-Ray diffraction analysis and their application in biotechnology .	08
IV	Theory of Electrophoresis, Factors affecting the migration of substances Gel electrophoresis, PAGE, SDS-PAGE, Agarose Electrophoresis of Nucleic Acid, Isoelectric Focusing of Protein Pulse Gel Electrophoresis and Western Blotting. Theory of centrifugation and sedimentation. Types of centrifuges, Preparative and analytical centrifugation; Density gradient centrifugation. Application of centrifugation for preparative and analytical purpose.	08
V	Principles of 3-D printing, 3-D Bioprinting of tissues, organs and bacteria.Ideal material properties for bioprinting, Biosensors: Principles and definition, characteristics of Ideal biosensors, Biochemical components of biosensors, Bioaffinity systems, Immunosensors. Principle and working of Flow Cytometry and cell sorter.	08

Text books:

1. Wilson, K, Walker, J., Principles and Techniques of Practical Biochemistry. 5th Ed. - Cambridge University Press,. Cambridge 1999.
2. Sabari Ghosal&Anupama Sharma Awasthi., Fundamentals of Bioanalytical Techniques and Instrumentation, PHI learning Second edition (2018)
3. Bioanalytical Techniques by A. Shourie and S SChapadgaonkar. TERI Press. 2015
4. Immunoassay and Other Bioanalytical Techniques.Jeanette M. van Emon. CRC press. 2006
5. 3D Bioprinting in Regenerative Engineering: Principles and Applications, Ali Khademhosseini&Gulden Camci-Unal, CRC Press (2018)

BBT302- MICROBIOLOGY & IMMUNOLOGY

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Understand fundamental basics of microbiology along with physiological properties and growth kinetics of bacteria and strategies to hinder development of undesirable microorganisms.	**K_2**
CO 2	Comprehend different cell capacities - eg. transformation, reproduction, transduction & conjugation and gain proficiency in bacterial electron transport system.	**K_3**
CO 3	Distinguish the major cells and tissue parts of innate and adoptive immune response along with study of immunological reaction inm response to different types of antigenic reactions.	**K_2**
CO 4	Acquire basic understanding of fundamental immunological processes and MHC along with the principle and applications of immunotechniques.	**K_3**
CO 5	Apply concepts of immunology and microbiology in disease diagnosis, industrial use, environmental applications and immunotherapy.	**K_4**
DETAILED SYLLABUS		**3-1-0**

Unit	Topic	Proposed Lecture
I	Morphology and Ultra structure of bacterial cell, Classification of bacteria, Culture media, Isolation of microbes and its identification, culture techniques, Preservation of cultures, Methods for the control of microbes. Enumeration of bacteria. Microbial growth kinetics.	08
II	Basic features of transduction, conjugation and transformation, Viruses: Classification and structure of viruses, Viral reproduction: lytic and lysogenic cycle, Overview of biological nitrogen fixation, Bacterial photosynthesis and electron transport system.	08
III	Introduction to immune system: Innate and Adaptive immunity, Humoral and Cell mediated immune response, Cells and Molecules of the immune system, Primary and Secondary lymphoid organs, T &B cell maturation and its activation , Characteristics and types of Antigens, Haptens, adjuvants and Epitopes, Antibodies: Structure, functions and characteristics of different classes of antibodies. Monoclonal antibodies.	08
IV	Antigen and antibody interactions, precipitation reactions , Serological techniques: ELISA, RIA and western blotting, Structure and Function of MHC molecules, Exogenous and Endogenous pathways of antigen processing and presentation, Overview of Complement system and cytokines, immune tolerance.	08
V	Applications of microbiology and Immunology: Mirobiology of domestic water and waste water. Microbes in bioremediation, Microbes of industrial use, Immunity against: Bacterial disease- tuberculosis, typhoid, Protozoan disease- Malaria, Amebieosis and Viral diseases - AIDS, Dengue, Chikungunya,Vaccine's, Hypersensitivity and Immunotherapy	08

Text books:

1. Microbiology by Pelczar (W C Brown publication)
2. Genral Microbiology by stainer (Mac Millan Publication)
3. Microbiology by Pawar and Dagniwala (Himalaya publishing House).
4. Immunology and immunotechnology by Ashim K. Chakravarty (Oxford university Press)
5. Immunology by C. Fatima 3. Immunology by Kuby (Free man publication)

BBT303- BIOCHEMISTRY

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course, the student will be able to		
CO 1	Understand the concept of biomolecules and their role in biological systems.	**K2**
CO 2	Apply the concepts of carbohydrates, other biopolymers, and their role in biochemical pathways.	**K3**
CO 3	Distinguish the knowledge of fats , lipids and its role in metabolism	**K_4**
CO 4	Apply the concept of protein structure, classification, bond formation and biosynthesis of amino acids	**K_3**
CO 5	Analyze and evaluate concept of biomolecules including purines and pyrimidines and their role in metabolism.	**K_4, K_5**

DETAILED SYLLABUS		**3-0-0**
Unit	**Topic**	**Proposed Lecture**
I	Water - Structure, unusual properties, non-covalent interactions, role in biological processes. Ionization of Water, pH scale, Weak Acids, and Weak Bases. Buffers and buffering mechanism, Henderson Hasselbalch equation. Buffering against pH Changes in Biological Systems: Phosphate buffer, Bicarbonate buffer, Protein buffer, Amino acid Buffer & Hemoglobin Buffer System.	08
II	Carbohydrates – classification, structure and functions of monosaccharides, disaccharides and polysaccharides. Ring structure and mutarotation, stereo isomers and structural isomers. Metabolism – Glycolysis & oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway, Oxidative phosphorylation, Disorder/ diseases of carbohydrate metabolism.	08
III	Fats and lipids – Classification, structure and function: Simple, Compound & Derived lipids, Essential fatty acids. Fatty acid synthesis, origin of acetyl-Co A for fat synthesis, Elongation & desaturation of Fatty Acids. Activation & transport of fatty acid from cytosol to mitochondria for oxidation. Oxidation of palmitic acid by β – oxidation and ATP generation. Disorder/ diseases of lipid metabolism.	08
IV	Amino acids and proteins - Classification & structure of amino acids. Essential amino acids. Peptide bond formation, Ramachandran plot, Primary, secondary, tertiary & quaternary structure of proteins. Overview of biosynthesis of amino acids from intermediates of glycolysis, Citric Acid Cycle & pentose phosphate pathway. Biodegradation of amino acids: Transdeamination. Urea Cycle. Disorder/ diseases of amino acids metabolism.	08
V	Purines and pyrimidines – Structure and properties. Metabolism of Nucleotides: Purines & Pyrimidines synthesis : de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Catabolism & salvage of Purine and Pyrimidine nucleotides. Disorder of purines and pyrimidines metabolism.	08

Textbooks:

1. Biochemistry: Stryer, W. H. Freeman
2. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA
3. Biochemistry: Zubey, WCB.
4. Biochemistry: Garrett and Grisham, Harcourt.
5. Biochemistry: Satyanaryan& Chakrapani

BBT351- TECHNIQUES IN BIOTECHNOLOGY LAB

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Understand concept of precision, accuracy for principle and working of laboratory microscope.	K2
CO 2	Learn and apply the spectrophotometric techniques for identification or quantification of biomolecules.	K2
CO 3	Understand the principle and execute the different chromatographic techniques for separation of biomolecules.	K3
CO 4	Apply the electrophoresis for quantitative and qualitative analysis of biomolecules	K3
CO 5	Demonstrate the extraction and separation of biomolecules.	K2
DETAILED SYLLABUS		**0-0-2**

S No	LIST OF EXPERIMENTS
1	Demonstration of basic concept of precision and accuracy using appropriate experimental data
2	Study of Beer-Lambert's law-using UV-Visible spectrophotometer.
3	To study principle and working of laboratory microscope.
4	To analyze the isolated plant pigments using paper chromatography.
5	Separation of amino acids using thin layer chromatography.
6	Separation of a mixture of polar and non polar compounds using column chromatographic technique.
7	To study and analysis of DNA sample by agarose gel electrophoresis.
8	To study and analysis of protein sample by SDS- PAGE
9	To study the separation of compounds using liquid-liquid extraction experiments.
10	To study the separation of biological compounds using various membrane separation.

Text books:

1. Wilson and Walker, "Principles and Techniques of Practical Biochemistry" 4 Edn., Cambridge Knew pros 1997.
2. Biotechniques: Theory & Practice: Second Edition by SVS Rana, Rustogi Publications.
3. Biochemical Methods of Analysis: Saroj Dua And Neera Garg: Narosa Publishing House, New Delhi.
4. Bioanalytical Techniques : ML Srivastava; Narosa Publishing House, New Delhi.

BBT352- MICROBIOLOGY & IMMUNOLOGY LAB

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Apply different sterilization method and inoculation methods.	K2
CO 2	Demonstrate different staining procedures and culturing of microbes.	K2
CO 3	Exhibit different methodology for colony counting.	K1
CO 4	Understand the principle of blood grouping and immunodiffusion.	K3
CO 5	Apply ELISA and electrophoresis.	K2
DETAILED SYLLABUS		**0-0-2**

S No	LIST OF EXPERIMENTS
1	Preparation of nutrient agar slants, plates and nutrient broth and their sterilization. (Microwave Oven, Heating mantles, Fridge, Heating Oven, Tube racks)
2	Inoculation of agar slants, agar plate and nutrient broth (Incubators, Water bath, Laminar hood, dry heat sterilizer i.e. bead sterilizer)
3	Culture of microorganisms using various techniques. (Shakers i.e. Cooling and Open shaker).
4	Simple and differential staining procedures, endospore staining, flageller staining, cell wallstaining, capsular staining, negative staining. (Moist chambers, spirit lamps, slides, loops & microscopes, haemocytometer)
5	Bacterial colony counting. (Moist chambers, spirit lamps, slides, loops & microscopes, haemocytometer)
6	Isolation of microbes from soil samples and determination of the number of colony forming units. (U.V. spectrophotometer, Colony counter etc.)
7	To determine the blood group and Rh of given blood sample.
8	To perform single radial immunodiffusionanddoubleimmunodiffusion
9	To perform rocket immune electrophoresis
10	To perform counter current immune electrophoresis
11	To perform ELISA

Text books:

1. Lab Manual in microbiology by P Gunasekaran (New Age Int. Pub.).

BBT-353 BIOCHEMISTRYLAB

Course Outcome (CO)		Bloom's (KL)
At the end of course, the student will be able to		
CO 1	Understand the basics of molarity, normality, buffers and pH meter.	**K2**
CO 2	Demonstrate the basics of titration and carbohydrate estimation.	**K4**
CO 3	Exhibit the difference between reducing and non-reducing sugars and estimation of proteins and nucleic acids.	**K4**
CO 4	Perform the extraction method of lipids and proteins on the basis of isoelectric point.	**K4**
CO 5	Understand the significance of chromatography.	**K4**

DETAILED SYLLABUS

S. No	LIST OF EXPERIMENTS
1	Preparation of solutions: (i) Percentage solutions, (ii) Molar solutions, (iii) Normal solutions
2	Titration of weak acid-weak base
3	To perform quantitative estimation of carbohydrates
4	To distinguish reducing and non-reducing sugars
5	To perform quantitative estimation of proteins
6	To estimate nucleic acids
7	To perform isoelectric precipitation
8	To separate sugars, fatty acids and amino acids by paper chromatography
9	To extract lipids from plant material
10	To perform thin layer chromatography

Text books:

1. Wilson and Walker, "Principles and Techniques of Practical Biochemistry", 4 Edn., Cambridge Knew pros 1997.
2. Plummer DT, "An Introduction to Practical Biochemistry", III Edn., Tata McGraw hill.

SEMESTER-IV

BBT401- BIOPROCESS ENGINEERING

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Comprehend the concept of media preparation, microbial growth and the associated parameters.	K_2
CO 2	Demonstrate the concepts of sterilization necessary for proper bioreactor operation.	K_2
CO 3	Discuss the basics of ideal bioreactor operations and the kinetics of microbes.	K_3
CO 4	Apply the concept of mass transfer, medium optimization and stoichiometric based calculations in bioprocessing.	K_4
CO 5	Analyze the concept of bioreactor control mechanism and identify suitable control system.	K_5, K_6
DETAILED SYLLABUS		3-1-0

Unit	Topic	Proposed Lecture
I	Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.	08
II	Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Estimation of sterilizer efficiency, Continuous heat sterilization of liquids, Sterilization of air: Methods &Mechanism, Design of depth filter and estimation of its efficiency. Stoichiometric calculations, Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis.	08
III	Ideal Reactor Operation: Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor.	08
IV	Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.	08
V	Bioreactor control mechanism, Physical, Chemical and Biological environment of bioreactor, Manual control system, Role of physical, chemical & biological sensors, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and artificial neural network based Controllers. Basic concepts of computer modeling and optimization in bioprocess applications.	08

Text books:

1. Principles of Microbe and cell cultivation- S. John Pirt, Butterworth Publication.
2. Bioprocess Engineering Principles – P. M. Doran, 5th ed.
3. Hand Book Of Bioengineering- Skalak R & Shu Chien, 4th ed.
4. Biochemical Engg. Bailly &Ollis, Academic Press
5. Introduction to Chemical Engg. Series, MCH Int. Series.
6. Biochemical & Biological Engg. Science, N. Blakebraugh, Academic Press
7. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.

BBT402- GENETICS AND MOLECULAR BIOLOGY

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Understand the fundamental principles of genetics.	K_2
CO 2	Understand genome organization in prokaryotes and eukaryotes as well as genome organization of cellular components.	K_2
CO 3	Discuss the process of DNA replication & different repair mechanisms.	K_2
CO 4	Comprehend mutation, its causes and translation in detail.	K_2, K_3
CO 5	Discuss translation, recombinant DNA technology and enzymes involved in this process.	K_2, K_3

DETAILED SYLLABUS		3-1-0
Unit	**Topic**	**Proposed Lecture**
I	Fundamental principles of genetics, gene interaction, multiple alleles, complementation, linkage, recombination and linkage mapping, extra-chromosomal inheritance, chromosomes basis of heredity, Sex determination, sex linked, sex limited and sex, influenced inheritance.	08
II	Genome organization: Genome organization in prokaryotes and eukaryotes - special features of eukaryotic gene structure and organization, genome organization in mitochondria and chloroplast, DNA content and C-value paradox. Methods to measure DNA content variation - Various types of DNA sequences (simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites).	08
III	Gene structure, DNA & RNA as a genetic material, packaging of DNA as chromosome, central dogma of molecular biology, DNA replication, DNA repair. Linkage and recombination, crossing over and genetic mapping, gene mapping by two point and three point test crosses, Cell cycle regulation and apoptosis.	08
IV	Genetic mutation, micro-deletion, Genetic syndrome, Techniques to detect mutation, Transcription in prokaryotes and eukaryotes, genetic code, reverse transcription, mRNA processing. Role of sigma factor in transcription, role of promoters and enhancers, mechanism and regulation of transcription in prokaryotes and eukaryotes.	08
V	DNA replication process in prokaryotes & Eukaryotes, Activity of DNA polymerases and topoisomerases, Reverse transcriptase, Translation in prokaryotes and eukaryotes Basic principles of gene cloning and r-DNA technology, genetic code, properties of genetic code, wobble hypothesis, Molecular chaperones.	08

Text books:

1. Genetics a conceptual approach, 2nd Edition Benjamin A. Pierc WH freeman and, company, New York.
2. Benjamin Levin – Genes VIII, 8 th ed. Bioprocess Engineering Principles – P. M. Doran, 5th ed.
3. Albert B, Bray Denis et al.: Molecular Biology of The Cell, latest ed.
4. Watson, Hopkins, Roberts et al.: Molecular Biology of the Gene, 4 th ed.
5. Genetics- Strickberger, 2nd.
6. Baltimore- Molecular Biology of the Cell.
7. Advance Genetics by G.S. Miglani, Narosa Publishing House.

BBT403- ENZYME ENGINEERING

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Understand the concepts of enzyme and their kinetics.	K_2
CO 2	Explain the factors affecting enzymatic reactions and role of inhibitors.	K_3
CO 3	Perform the extraction, purification & characterization of different enzyme from different source.	K_3
CO 4	Understand the concept of enzyme immobilization and its applications.	K_4
CO 5	Apply knowledge of enzyme in developing biosensors and bioreactors.	K_3

DETAILED SYLLABUS		3-0-0
Unit	**Topic**	**Proposed Lecture**
I	Introduction to enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substratelock and key model, induced fit model. Features of active site, activation energy, enzyme specificity and types. IUB system of classification and nomenclature of enzymes. Kinetics of single substrate reactions; Derivation of Michaelis - Menten equation, turnover number; determination of Km and Vmax (LB plot, ED plot), Importance of Km &Vmax; Numerical related to enzyme kinetics, Multi-Substrate reaction mechanisms.	08
II	Factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators. Enzyme inhibition: irreversible; reversible (competitive, uncompetitive and non competitive inhibition); Substrate and Product inhibition, Allosteric regulation of enzymes, concerted & sequential model; Deactivation Kinetics.	08
III	Extraction of crude enzyme from plant, animal and microbial source; some case study. Purification of enzymes by the help of different methods. Methods of characterization of enzymes; criteria of purity. Unit of enzyme activity - definition and importance. Development of enzyme assays.	08
IV	Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, Covalent binding and their examples; Advantages and disadvantages of different immobilization techniques. Structure & stability of immobilized enzymes, kinetic properties of immobilized enzymes- partition effect, diffusion effect. Overview of applications of immobilized enzyme systems.	08
V	Enzyme Biosensors: elements of biosensors, three generations of biosensors, Types of biosensors: calorimetric, potentiometric, amperometric, optical and piezoelectric. Design of enzyme electrodes and their applications as biosensors in industry, health care and environment. Design of Immobilized Enzyme Reactors- Stirred tank reactors(STR), Continuous Flow Stirred Tank Reactors (CSTR), Packed- bed reactors (PBR), Fluidized-bed Reactors (FBR); Membrane reactors.	08

Text 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. Biochemical engineering fundamentals, second edition. James E Bailey, David F., Ollis, McGraw Hill Intl. Edition

BBT451- BIOPROCESS ENGINEERING LAB

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Demonstrate the growth pattern and death kinetics of E. coli.	K3
CO 2	Discuss the upstream and downstream bioprocessing for product formation	K3
CO 3	Analyze the mass transfer concepts in bioprocess.	K3
CO 4	Perform immobilization of enzymes and microbial cell.	K2
CO 5	Develop computational design for fermentative production.	K4
		0-0-2

S No	LIST OF EXPERIMENTS
1	Determine the growth patterns and specific growth rate of *E.coli*.
2	Determine the effect of peptone concentration on *E.coli*growth .
3	Determination of specific thermal death rate constant (Kd) for *E.Coli*.
4	Determine the effects of temperature & pH on *Psuedomonasputida*
5	Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillusniger*.
6	Citric acid production from whey with glucose as supplementary carbon source by *Aspergillusniger.*
7	Upstream and Downstream of bioprocess for the production of α amylase
8	Estimation of volumetric liquid mass transfer coefficient (KLa) using sodium sulphite method.
9	Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
10	Computational Design of Fermentative Process for L-lysine production.

Text books:

1. Practical Manual on Fermentation Technology by S. Kulandaivelu, S. Janarthanan 2012
2. J.Jayaraman , "Laboratory Manual in Biochemistry", New Age International Publications 2007
3. Eisenthal, R. &Danson N.J. (Eds) Enzyme Assays: "A Practical Approach", IRI Press, Oxford, UK 1992.

BBT452- GENETICS AND MOLECULAR BIOLOGYLAB

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Calculate the allelic frequencies of numeric problems.	K2
CO 2	Isolate DNA from plant cell, plasmid DNA and bacterial genomic DNA from.	K4
CO 3	Determine the Tm of DNA and analyze the concentration of DNA in a given cell using spectrophotometer.	K4
CO 4	Purify the DNA using electrophoresis and its visualization under transilluminator.	K4
CO 5	Separate DNA using PAGE and amplification of DNA using polymerase chain reaction.	K4
DETAILED SYLLABUS		0-0-2

S No	LIST OF EXPERIMENT
1	How to calculate genetics and allelic frequencies numeric problem analysis.
2	Isolation of Plasmid DNA.
3	Isolation of Plant DNA.
4	Estimation of DNA content in the given sample by spectrophotometer.
5	Determination of Tm of DNA.
6	Isolation of bacterial genomic DNA.
7	Purification of DNA through Electrophoresis & visualization under UV transilluminator.
8	Polyacrylamide gel electrophoresis of DNA.
9	PCR amplification of DNA and visualization by gel electrophoresis.
10	Isolation and study of polytene chromosome in Drosophila.

Text books: Molecular Biology A Practical Manualby PVGK Sharma, 2021.

BBT453- ENZYME ENGINEERING LAB

Course Outcome (CO)		Bloom's Knowledge Level (KL)
At the end of course , the student will be able to		
CO 1	Exhibitthe extraction of enzyme and its enzyme activity	K2
CO 2	Perform purification and characterization of enzyme	K2
CO 3	Identity enzyme by enzyme assays	K3
CO 4	Perform enzyme immobilization and strain improvement for increased production	K2
CO 5	Comprehend the concept of enzyme inhibition.	K3
DETAILED SYLLABUS		0-0-2

S No	LIST OF EXPERIMENTS
1	Production of commercially important enzymes from microbial sources.
2	Isolation of alpha amylase from plant source
3	Determination of enzyme activity and specific activity.
4	Partial purification of isolated enzymes.
5	Method of checking the purity of the enzyme -SDS-PAGE
6	Characterization of enzymes-effect of pH , temperature and inhibitors on enzyme activity etc.
7	Identification of Enzyme by different assay
8	Purification of enzymes by different methods
9	Immobilization of enzymes –Different Techniques such as adsorption, entrapment, encapsulation and crosslinking.
10	Strain improvement techniques- physical, chemical and genetic manipulation methods.
11	Formulation of enzyme stability.
12	Enzyme inhibition

Text books:

"An Introduction to Practical Enzyme Engineering", Tata McGraw-Hill.

R. Eisenthal and M.J. Dansen, "Enzyme Assays –A Practical Approach", IRL Press, Oxford University Press, Oxford, 1993