

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



**Evaluation Scheme & Syllabus**

**For**

**B.Tech. 2<sup>nd</sup> Year**

**(Bio Technology)**

**On**

**AICTE MODEL CURRICULUM**

**(Effective from the Session: 2019-20)**

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

## B.TECH (BIOTECHNOLOGY)

### SEMESTER- III

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KOE031-38/ KAS304	Engineering Science Course/Maths V	3	1	0	30	20	50		100		150	4
2	KAS301/ KVE 301	Technical Communication/Universal Human values	2	1	0	30	20	50		100		150	3
			3	0	0								
3	KBT301	Techniques in Biotechnology	3	1	0	30	20	50		100		150	4
4	KBT302	Microbiology & Immunology	3	1	0	30	20	50		100		150	4
5	KBT303	Biochemistry	3	0	0	30	20	50		100		150	3
6	KBT351	Techniques in Biotechnology Lab	0	0	2				25		25	50	1
7	KBT352	Microbiology & Immunology Lab	0	0	2				25		25	50	1
8	KBT353	Biochemistry Lab	0	0	2				25		25	50	1
9	KBT354	Mini Project or Internship Assessment*	0	0	2			50				50	1
10	KNC301/ KNC302	Computer System Security/Python Programming	2	0	0	15	10	25		50			0
11		MOOCs (Essential for Hons. Degree)											
		<b>Total</b>										<b>950</b>	<b>22</b>

\*The Mini Project or internship (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester.

**SEMESTER- IV**

Sl. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KAS404/ KOE041-48	Maths V/Engineering Science Course	3	1	0	30	20	50		100		150	4
2	KVE401/ KAS401	Universal Human Values/ Technical Communication	3	0	0	30	20	50		100		150	3
			2	1	0								
3	KBT401	Bioprocess Engineering I	3	0	0	30	20	50		100		150	3
4	KBT402	Genetics & Molecular Biology	3	1	0	30	20	50		100		150	4
5	KBT403	Enzyme Engineering	3	1	0	30	20	50		100		150	4
6	KBT451	Bioprocess Engineering I Lab	0	0	2				25		25	50	1
7	KBT452	Genetics & Molecular Biology Lab	0	0	2				25		25	50	1
8	KBT453	Enzyme Engineering Lab	0	0	2				25		25	50	1
9	KNC402/ KNC401	Python Programming/Computer System Security	2	0	0	15	10	25		50			0
10		MOOCs (Essential for Hons. Degree)											
		<b>Total</b>										<b>900</b>	<b>21</b>

## TECHNIQUES IN BIOTECHNOLOGY

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**UNIT I** Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy: TEM and SEM, Atomic force microscopy and confocal scanning laser microscopy. Differential interference contrast microscopy

**UNIT 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.

**UNIT 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 Dichroism (CD) principles, Principle and applications of Positron Emission Tomography (PET), Basics of X-Ray diffraction analysis and their application in biotechnology.

**UNIT 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.

**UNIT 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: Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors. Principle and working of Flow Cytometry and cell sorter.

### Text Books and Reference 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 S Chapadgaonkar. 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)

**UNIT 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.

**UNIT 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.

**UNIT 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.

**UNIT 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.

**UNIT V**

Applications of microbiology and Immunology: Microbiology of domestic water and waste water. Microbes in bioremediation, Microbes of industrial use, Immunity against: Bacterial disease- tuberculosis, typhoid, Protozoan disease- Malaria, Amebiasis and Viral diseases - AIDS, Dengue, Chikungunya, Vaccine's, Hypersensitivity and Immunotherapy

**Reference 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)

**UNIT 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.

**UNIT 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.

**UNIT 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 saturated & unsaturated fatty acids.  $\beta$ ,  $\alpha$ ,  $\omega$  oxidation. Formation and utilization of ketone bodies. Disorder/ diseases of lipid metabolism.

**UNIT 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. Biosynthesis of amino acids from intermediates of Citric Acid Cycle & other major pathways. Biodegradation of amino acids: Deamination, transamination. Urea Cycle, Glucose-Alanine cycle. Disorder/ diseases of amino acids metabolism.

**UNIT 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.

**Text books:**

1. Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.
2. Harper's Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange. Medical Books. 25th edition.
3. Biochemistry : S.C. Rastogi – Third Edition ; Tata McGraw Hill Education Pvt. Ltd. New Delhi.

**Reference books & web sources:**

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.

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.

**Reference book:**

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.

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)
7. Isolation of microbes from soil samples and determination of the number of colony forming units. (U.V. spectrophotometer, Colony counter etc.)
8. To determine the blood group and Rh of given blood sample.
9. To perform single radial immunodiffusion and double immunodiffusion
10. To perform rocket immune electrophoresis
11. To perform counter current immune electrophoresis
12. To perform ELISA

## Practical Books and References

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



## BIOCHEMISTRY LAB

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1. Preparation of solutions: 1)percentage solutions, 2) molar solutions, 3) normal solutions
2. Spectroscopy: determination of absorption maxima ( $\lambda_{\max}$ ) of a given solution
3. Titration of weak acid-weak base
4. Quantitative estimation of carbohydrates
5. Distinguish reducing and non-reducing sugars
6. Quantitative estimation of proteins
7. Estimation of nucleic acids
8. Isoelectric precipitation
9. Separation of sugars, fatty acids and amino acids by paper chromatography
10. Extraction of lipids from plant material
11. Thin layer chromatography
12. Gel electrophoresis

### Reference 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

### Bioprocess Engineering –I

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**Unit I:** Fluid Properties: Viscosity, Newton's Law of viscosity, Kinematic Viscosity, Rheological Diagram, Euler Equation and its application, Derivation of Bernoulli Equation from Euler Equation, Applications of Bernoulli's Theorem, Pascal's Law, Hydrostatic Law. Measurement of Pressure: Definition of Gauge and Absolute Pressure, Barometer, Various Manometers (Piezometer, U-tube manometer, Single column manometers, U-tube & Inverted U-tube differential manometers) & their industrial applications. (10)

**Unit II:** Flow Measuring Equipment: Head Flow Meters, Nozzle Meter, Orifice Meter, Venturi Meter, Area Flow Meters, Rotameter, Pitot Tube & Applications of these equipments. Pipe fittings, major and minor losses in pipe flow, Calculation of Pressure Drop in a Pipe, Equivalent Length & 'K' factor, Methods of finding dimensional numbers - methods of governing equations, Method of force ratios and Buckingham's  $\pi$  method. Reciprocating pump & its applications. Centrifugal Pumps and its applications. (10)

**Unit III:** Conduction and Convection Introduction. Basic concepts of conduction in solids, liquids and gases, One and two dimensional heat conduction. Critical and optimum insulation thickness. Introduction to unsteady state heat transfer. Principles of convection, Equations of forced and free convection, Heat flow due to conduction & convection. Radiation: Basic laws of heat transfer by radiation, black body and gray body concepts, solar radiations, combined heat transfer coefficients by convection and radiation. Heat Transfer Equipments: Double pipe, Shell & tube and Plate type heat exchanger, Evaporator, Condenser (8)

**Unit IV : Diffusion:** Fick's Law, steady state diffusion: Rectangular, cylindrical, spherical (1-D); diffusion with reaction, both at surfaces, and in the bulk medium. **Transient conduction and diffusion:** Basics of Fourier analysis, unsteady state conduction and diffusion (1-D), transient conduction/diffusion with generation/reaction.(6)

**Unit V :** Mass transfer coefficients, Mass transfer in fluidized bed reactor, flow past solids and boundary layers, Simultaneous heat and mass transfer system. Mass transport in Biomedical and Biological Engineering: Haemodialysis, Diffusion and uptake of ligands by cells, oxygen transport in tissue and capillaries.(6)

#### **Reference Books:**

1. Introduction of Fluid Mechanics by Robert W. Fox and S. T. McDonald, John Wiley & sons, Ny. Fourth Ed.
2. Unit Operation in Chemical Engg., McCabe Smith 5th Ed.
3. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980)

#### **Books Recommended**

1. Holman, J.P.: "Heat Transfer" 9th ed. McGraw Hill (1989).
2. Treybal, R "Mass Transfer Operations", 3rd ed. New York: McGraw-Hill, (1980).

## UNIT 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.

## UNIT 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)

## UNIT 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.

## UNIT 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.

## UNIT 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.

### Text books:

1. Genetics a conceptual approach, 2<sup>nd</sup> Edition Benjamin A. Pierc WH freeman and, company, New York.
2. Benjamin Levin – Genes VIII, 8<sup>th</sup> ed.

### Reference books:

1. Albert B, Bray Denis et al.: Molecular Biology of The Cell, latest ed.
2. Watson, Hopkins, Roberts et al.: Molecular Biology of the Gene, 4<sup>th</sup> ed.
3. Genetics- Strickberger, 2<sup>nd</sup>.
4. Baltimore- Molecular Biology of the Cell.
5. Advance Genetics by G.S. Miglani, Narosa Publishing House.

## UNIT I

Introduction to enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate-lock 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  $K_m$  and  $V_{max}$  (LB plot, ED plot), Importance of  $K_m$  &  $V_{max}$ ; Numerical related to enzyme kinetics, Multi-Substrate reaction mechanisms.

## UNIT 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.

## UNIT 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.

## UNIT 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.

## UNIT 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.

### 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

### Reference books:

1. Enzymes: Dixon and Webb. (IRL Press)
2. Enzyme technology by Chaplin and Bucke. Cambridge University Press
3. Biochemical engineering fundamentals, second edition. James E Bailey, David F., Ollis, McGraw Hill Intl. Edition

# Bioprocess Engineering Lab-I

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1. To find the thermal conductivity of liquid / gases
2. To determine the local velocity pressure with the help of pilot tube
3. To find out the thermal conductivities of Metal rod
4. To study the characteristics of a centrifugal pump.
5. To determine the viscosity of a given viscous liquid by capillary tube flow method.
6. To differentiate between laminar and turbulent flow using Reynolds experiment.
7. To determine velocity through orifice meter, venture meter
8. To determine the overall heat transfer coefficient in Parallel flow heat exchanger/counter flow heat exchanger
9. To determine the drying characteristics of given sample
10. To determine the minimum fluidization velocity in a fluidized bed and verify experimentally

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 T<sub>m</sub> 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*.

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 cross-linking.
10. Strain improvement techniques- physical, chemical and genetic manipulation methods.
11. Formulation of enzyme stability.
12. Enzyme inhibition

## Reference books

1. “An Introduction to Practical Enzyme Engineering”, Tata McGraw-Hill.
2. R. Eisinger and M.J. Danson, “Enzyme Assays –A Practical Approach”, IRL Press, Oxford University Press, Oxford, 1993