

**UTTAR PRADESH TECHNICAL UNIVERSITY**

**LUCKNOW**



**Syllabus**

**for**

**B.Tech. Biotechnology  
of  
Second Year**

**(Effective from the Session: 2014-15)**

**STUDY AND EVALUATION SCHEME**  
**B.TECH. BIO-TECHNOLOGY**  
 (Effective from the session: 2014-15)

**2<sup>nd</sup> Year, Semester-III**

S. No.	Subject Code	Name of Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Assessment		ESE			
						CT	TA				Total
THEORY SUBJECT											
1	NBT-301/ NOE-031-039	Elementary Mathematics-III/ Science based Elective	3	1	0	30	20	50	100	150	4
2	NBT-302	Fluid Flow and Solid Handling	3	1	0	30	20	50	100	150	4
3	NBT-303	Biochemistry	3	1	0	30	20	50	100	150	4
4	NBT-304	Microbiology & Cell Biology	3	1	0	30	20	50	100	150	4
5	NHU-301/NHU-302	Industrial Psychology/ Industrial Sociology	2	0	0	15	10	25	50	75	2
6	NBT-305	Genetics & Molecular Biology	2	1	0	15	10	25	50	75	3
7	AUC-001/ AUC-002	Human Values & Professional Ethics/Cyber Security	2	0	0	15	10	25	50	75*	
PRACTICAL/DESIGN/DRAWING											
7	NBT-351	Fluid Flow and Solid Handling Lab	0	0	3	10	10	20	30	50	1
8	NBT-352	Biochemistry Lab	0	0	3	10	10	20	30	50	1
9	NBT-353	Microbiology & Cell Biology Lab	0	0	2	10	10	20	30	50	1
10	NBT-354	Genetics & Molecular Biology Lab	0	0	2	10	10	20	30	50	1
11	NGP-301	NGP						50		50	
		TOTAL	18	5	10					1000	25

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

TA = 10 (5 for teachers assessment plus 5 for attendance)

TA = 20 (10 for teachers assessment plus 10 for attendance)

ESE (Practical) = 30 (10 marks for practical exam. 10 marks viva. 4 marks for lab records and 6 marks for quiz)

**Science Based Open Elective:**

NOE031 Introduction to Soft Computing (Neural Network, Fuzzy Logic and Genetic Algorithm)

NOE032 Nano Sciences

NOE033 Laser Systems and Applications

NOE034 Space Sciences

NOE035 Polymer Science & Technology

NOE036 Nuclear Science

NOE037 Material Science

NOE038 Discrete Mathematics

NOE039 Applied Linear Algebra

\* Human Values & Professional Ethics will be offered as compulsory Audit Course for which passing marks are 40% in theory & 50% in aggregate. Student will be required to audit it within the period of their study. There will not be carry over facility for this course and a failed student will be required to repeat this course.

**STUDY AND EVALUATION SCHEME**  
**B.TECH. BIO-TECHNOLOGY**  
 (Effective from the session: 2014-15)

**2<sup>nd</sup> Year, Semester-IV**

S. No.	Subject Code	Name of Subject	Periods			Evaluation Scheme			Subject Total	Credit	
			L	T	P	Sessional Assessment		ESE			
						CT	TA				Total
THEORY SUBJECT											
1	NOE-041-049/ NBT-401	Science based Elective/ Elementary Mathematics-III	3	1	0	30	20	50	100	150	4
2	NBT-402	Heat & Mass Transfer	3	1	0	30	20	50	100	150	4
3	NBT-403	Enzyme Engineering	3	1	0	30	20	50	100	150	4
4	NBT-404	Immunology	3	1	0	30	20	50	100	150	4
5	NHU-402/ NHU-401	Industrial Sociology/ Industrial Psychology	2	0	0	15	10	25	50	75	2
6	NBT-405	Molecular Dynamics & Bioenergetics	2	1	0	15	10	25	50	75	3
	AUC-002/ AUC-001	Cyber Security/ Human Values & Professional Ethics	2	0	0	15	10	25	50	75*	
PRACTICAL/DESIGN/DRAWING											
7	NBT-452	Heat & Mass Transfer Lab	0	0	3	10	10	20	30	50	1
8	NBT-453	Enzyme Engineering Lab	0	0	3	10	10	20	30	50	1
9	NBT-454	Immunology Lab	0	0	2	10	10	20	30	50	1
10	NBT-455	Molecular Dynamics & Bioenergetics Lab	0	0	2	10	10	20	30	50	1
11	NGP-401	GP						50		50	
		TOTAL	18	5	10					1000	25

L: Lecture T: Tutorial P: Practical/Project CT: Class Test TA: Teacher's Assessment, ESE: End Semester Examination

TA = 10 (5 for teachers assessment plus 5 for attendance)

TA = 20 (10 for teachers assessment plus 10 for attendance)

ESE (Practical) = 30 (10 marks for practical exam. 10 marks viva. 4 marks for lab records and 6 marks for quiz)

**Science Based Open Elective:**

NOE-041 Introduction to Soft Computing (Neural Network, Fuzzy Logic and Genetic Algorithm)

NOE-042 Nano Sciences

NOE-043 Laser Systems and Applications

NOE-044 Space Sciences

NOE-045 Polymer Science & Technology

NOE-046 Nuclear Science

NOE-047 Material Science

NOE-048 Discrete Mathematics

NOE-049 Applied Linear Algebra

\* Human Values & Professional Ethics will be offered as compulsory Audit Course for which passing marks are 40% in theory & 50% in aggregate. Student will be required to audit it within the period of their study. There will not be carry over facility for this course and a failed student will be required to repeat this course.

## **DEPARTMENTAL ELECTIVES**

### **Elective-I:**

1. NBT-011: Nano Biotechnology
2. NBT-012: Molecular Modeling & Drug Design

### **Elective-II:**

1. NBT-021: Pharmaceutical Biotechnology
2. NBT-022: Biofuel & Alcohol Technology

### **Elective-III:**

1. NBT-031: Animal Biotechnology
2. NBT-032: Biomedical Instrumentation

### **Elective-IV:**

1. NBT-041: Waste Treatment & Management
2. NBT-042: Agriculture Biotechnology

### **Elective-V:**

1. NBT-051: Vaccine Technology & Immunoinformatics
2. NBT-052: Genomics & Proteomics

**3<sup>rd</sup> Semester B.Tech. Biotechnology**

**NBT-301: Elementary Mathematics-III**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

**Unit-I** [08]

Data and Classification: Data type, Classification and summarization of data, Diagrams and Graphs, Measures of central tendency, Measures of dispersion, Moments, Skewness, kurtosis

**Unit-II** [08]

Probability and Distributions: Introduction to probability, Laws of probability, Baye's theorem, Expectation and Random variable, Binomial distribution, Poison distribution, Normal distribution

**Unit-III** [08]

Correlation, Regression and Tests: Correlation, Pearson and Mathew correlation, Coefficient, Co-efficient of correlation, Rank Correlation, Lines of regression, Linear and Non linear regression, Multiple regression, Non-Parametric tests, Sign test, Mann-Whitene Wilcoxon test

**Unit-IV** [08]

Tests of Hypothesis and ANOVA: Hypothesis tests, Student's t-test, Chi squire test, F-test and ANOVA, One way and two way analysis of variants.

**Unit-V** [08]

Design and Quality Control: Principles of experimental design and analysis, Completely randomized design, Randomized block design, Latin square design, Statistical quality control, Types of quality control, Control chart for variables, Control chart for attributes

**Text Books:**

1. S. P. Gupta, Statistical Methods; Sultan Chand & Sons Publishers.
2. Georgr W. and William G., Statistical Methods; IBH Publication.
3. Ipsen J et al; Introduction to Biostatistics, Harper & Row Publication.
4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.

**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.Publication.
3. P. S. S. Sundar Rao; An Introduction to Biostatics; Prentice Hall.
4. Zar J; Biostatistics; Prentice Hall, London.

**NBT-302: Fluid Flow and Solid Handling**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

**Unit-I**

[08]

Properties of fluids, Fluid statics: Euler's equation, Hydrostatic Law, Fluid pressure and its measurement, Hydrostatic forces on surfaces, Transport of fluids, energy relationships, pipe fittings, major and minor losses in pipe flow.

**Unit-II**

[08]

Fundamentals of fluid flow, Types of fluid flows, Fluid flow measurements: Orifice meter, Nozzel, Venturi meters, Rotameter and Pitot tube, Fluid flow through pipes.

**Unit-III**

[08]

Methods of finding dimensional numbers - methods of governing equations, Method of force ratios and Buckingham's method, Outline of procedure for Buckingham Pi method, Physical significance of dimensionless numbers

**Unit-IV**

[08]

Filtration: Theory, continuous and batch equipments. Flow of solids through fluids, clarification and sedimentation, Pumping and compressing: reciprocating pumps, rotary pumps, centrifugal Pumps and blowers, Introduction of fluidization

**Unit-V**

[08]

Solids Handling: Properties of solids, screening, industrial screening equipment. Determination of particle size, screen analysis, size reduction of solids, stages of reduction, operating variables, intermediate and fine size reduction, power requirement and mechanism. Power driven machines: Crushers, grinders and conveyers.

**Reference Book**

1. Introduction of Fluid Mechanics by Robert W. Fox and Slan T. McDonald, John Willey & sons, Ny. Fourth Ed.
2. Unit Operation in Chemical Engg., McCabe Smith Vth Ed.

**Text Book**

1. Hydraulics and Fluid Mechanics by Modi & Seth, Standard Book House, Delhi

**NBT-351: Fluid Flow and Solid Handling Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

1. Fluid flow measurement by Venturi meter
2. Fluid flow measurement by Orifice meter
3. Fluid flow measurement by Notches
4. Fluid flow measurement by Rotameter
5. Velocity measurement by Pitot tube
6. Experiment for justification of Bernoulli's theorem
7. Measurement of Vortex
8. Measurement of friction factor
9. Determination of equivalent length of fittings
10. Determination of pump characteristics
11. Measurement of Streamline flow

**NBT-303: Biochemistry**

L	T	P
3	1	0

**UNIT-I**

(8)

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**

(8)

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**

(8)

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. , , oxidation. Formation and utilization of ketone bodies. Disorder/ diseases of lipid metabolism.

**UNIT –IV**

(8)

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**

(8)

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.
5. <http://themedicalbiochemistrypage.org>
6. [ull.chemistry.uakron.edu/biochem](http://ull.chemistry.uakron.edu/biochem)

**NBT-352: Biochemistry Lab**

**L      T      P**  
**0      0      3**

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

**NBT-304: Microbiology & Cell Biology**

**L      T      P**  
**3      1      0**

**UNIT – I**

**(8)**

Morphology and Classification of bacteria. Culture media. Isolation and identification of microbes, culture techniques. Preservation of cultures.

**UNIT-II**

**(8)**

Physical and chemical methods for the control of microbes. Enumeration of bacteria. Microbial growth kinetics. Cell cultivation system. Strain improvement.

**UNIT-III**

**(10)**

Biological nitrogen fixation. Biofertilizers. Bacterial Photosynthesis :Photosynthetic structures, types of bacterial photosynthesis, photosynthesis pigments, photosynthetic electron transport system, photophosphorylation, dark phase of photosynthesis; CO<sub>2</sub> utilization.

**UNIT-IV**

**(8)**

Applications of microbiology. Environmental; Microbiology of domestic water and waste water. Microbes in bioremediation. Medical Microbiology: tuberculosis, typhoid, diarrhoea, amoebiosis, Rabies and Other applications.

**UNIT-V**

**(6)**

Cell organelles. Protein targeting, cell aging. Biology of cancerous cells.

**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)

**Reference books:**

1. Microbiology –an introduction by Tortora ( Pierson education Publication)
2. Industrial microbiology by Prescott and Dunn

**NBT-353: Microbiology & Cell Biology Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

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. Observation of different vegetative, capsular and spore forms of bacteria & fungus under various microscopes.
7. Isolation of microbes from soil samples and determination of the number of colony forming units. (U.V. spectrophotometer, Colony counter etc.)
8. Study of growth curve of *E. coli*
9. Microscopy
10. Identification and staining of different types of cells.
11. Measurement of various Cell Organelles.
12. Detection of Mitosis with the help of microscope.

**Practical Books and References**

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

**NBT-305: Genetics & Molecular Biology**

<b>L</b>	<b>T</b>	<b>P</b>
<b>2</b>	<b>1</b>	<b>0</b>

**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**

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 III**

Genetic mutation, micro-deletion, Genetic syndrome, Techniques to detect mutation, Transcription, genetic code, translation, reverse transcription, mRNA processing. DNA replication process in prokaryotes & Eukaryotes, Activity of DNA polymerases and topoisomerases, Reverse transcriptase, Basic principles of gene cloning and r-DNA technology.

**UNIT IV**

Synthesizing mRNA from a DNA template, transcription unit, substrate for transcription, transcription apparatus, RNA polymerases, mechanism and regulation of transcription in prokaryotes and eukaryotes, Role of sigma factor in transcription, role of promoters and enhancers. The genetic code, properties of genetic code, wobble hypothesis, Molecular chaperones.

**Text books:**

1. Genetics a conceptual approach, 2nd Edition Benjamin A. Pierce W. H. Freeman and company, New York.
2. Benjamin Levin – Genes VIII, 8th ed.

**Reference books:**

1. Albert B, Bray Denis et al.: Molecular Biology of The Cell, latest ed.
2. Watson, Hopkin, Roberts et al.: Molecular Biology of the Gene, 4th ed.
3. Genetics- Strickberger, 2nd.
4. Baltimore- Molecular Biology of the Cell.
5. Advance Genetics by G.S. Miglani, Narosa Publishing House
6. Essentials of Molecular Biology 4th ed, Malacinski, G. M. Jones & Bartlett publishers, Boston
7. Genetics A molecular approach 2nd Edition Peter J. Russell Pearson.
8. Concepts of Genetics seventh edition William S. Klug and Michael R. Cummings, Pearson.
9. Genetics 3rd edition by Monroe W. Strickberger PHI Learning Private Ltd.

**NBT-354: Genetics & Molecular Biology Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

1. Squash preparation of polytene chromosomes from insects' salivary gland
2. How to calculate genetics and allelic frequencies numeric problem analysis
3. Estimation of DNA content in the given sample by diphenylamine method.  
(Nitrogen cylinders, -200C fridge, grinders, cooling centrifuges, etc.)
4. Estimation of RNA content by the Orcinol method.
5. Determination of T<sub>m</sub> of DNA and RNA.
6. Isolation of Plasmid DAN.
7. Isolation of bacterial/fungal genomic DNA.
8. Isolation of plant DNA.
9. Purification of DNA through columns. (Sorval, Cyclomixer, Electrophoresis units both vertical & horizontal, transilluminator, U.V. Torch, Gel documentation system, Thermal cycler etc.)
10. Polyacrylamide gel electrophoresis of DNA
11. PCR amplification of DNA and visualization by gel electrophoresis

**4<sup>th</sup> Semester B.Tech. Biotechnology**

**NBT-401: Elementary Mathematics-III**

L	T	P
3	1	0

**Unit-I** [08]

Data and Classification: Data type, Classification and summarization of data, Diagrams and Graphs, Measures of central tendency, Measures of dispersion, Moments, Skewness, kurtosis

**Unit-II** [08]

Probability and Distributions: Introduction to probability, Laws of probability, Baye's theorem, Expectation and Random variable, Binomial distribution, Poison distribution, Normal distribution

**Unit-III** [08]

Correlation, Regression and Tests: Correlation, Pearson and Mathew correlation, Coefficient, Co-efficient of correlation, Rank Correlation, Lines of regression, Linear and Non linear regression, Multiple regression, Non-Parametric tests, Sign test, Mann-Whitene Wilcoxon test

**Unit-IV** [08]

Tests of Hypothesis and ANOVA: Hypothesis tests, Student's t-test, Chi squire test, F-test and ANOVA, One way and two way analysis of variants.

**Unit-V** [08]

Design and Quality Control: Principles of experimental design and analysis, Completely randomized design, Randomized block design, Latin square design, Statistical quality control, Types of quality control, Control chart for variables, Control chart for attributes

**Text Books:**

1. S. P. Gupta, Statistical Methods; Sultan Chand & Sons Publishers.
2. Georgr W. and William G., Statistical Methods; IBH Publication.
3. Ipsen J et al; Introduction to Biostatistics, Harper & Row Publication.
4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.

**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.Publication.
3. P. S. S. Sundar Rao; An Introduction to Biostatics; Prentice Hall.
4. Zar J; Biostatistics; Prentice Hall, London.

**NBT-402: HEAT AND MASS TRANSFER**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

**Unit I Conduction and Convection**

Introduction, Conduction: 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

**Unit II 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.

**Unit III Diffusion**

Molecular and turbulent diffusion, Diffusion coefficient, Fick's Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition, Diffusion in multi-component gas mixtures. Diffusion in solids: Molecular, Knudsen & surface diffusion Inter-phase mass transfer, Mass transfer coefficients, Mass transfer in fluidized bed reactor, flow past solids and boundary layers, Simultaneous heat and mass transfer system.

**Unit IV Drying and Crystallization**

Solid-gas equilibria, Different modes of drying operation, Types of batch and continuous dryer Definitions of moisture contents, Rate of batch drying, Time of drying, Mechanism of batch drying, Continuous drying. Classification of crystallizers, Equilibrium yield of crystallization, Heat and mass transfer rates in crystallization, Theories of crystallization, Factors governing nucleation and crystal growth rates, controlled growth of crystal.

**Unit V Absorption and Adsorption**

Gas-Liquid equilibrium, Henry's Law, Selection of solvents, Absorption in tray column, Graphical and analytical methods, Absorption in packed column, Design equation for packed column, HTU, NTU and HTEP concepts, Description of adsorption process and their application, Types of adsorption nature of adsorbents, Adsorption equilibrium isotherm and its kinetics, Stage wise and continuous contact adsorption operation operations, Determination of number of stages, Equipments.

**Books Recommended**

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

**Reference Books**

1. McCabe Smith: Unit Operations in Chemical Engineering, McGraw Hill
2. Foust A. S. et.al., "Principles of Unit Operations" John Wiley (1980).

**NBT-452: Heat and Mass Transfer Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

**List of Experiments**

1. To find out the thermal conductivities of Metal rod.
2. To find the thermal conductivity of Composite cylinder.
3. To find out the thermal conductivity of Insulating powder.
4. To find the thermal conductivity of liquid / gases.
5. To determine the overall heat transfer coefficient in Parallel flow heat exchanger
6. To determine the overall heat transfer coefficient in Counter flow heat exchanger
7. To determine the overall heat transfer coefficient in Shell and Tube heat exchanger
8. To determine the overall heat transfer coefficient in Plate type heat exchanger
9. Any Experiment on natural convection
10. Any experiment on determination of emissivity
11. To visualize pool boiling apparatus to find out the heat transfer coefficient of boiling
12. To determine the drying characteristics of given sample

## NBT-403: Enzyme Engineering

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### Unit-I

(8)

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  $K_m$  &  $V_{max}$ ; Multi-Substrate reaction mechanisms.

### UNIT-II

(8)

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

(8)

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

(8)

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

(8)

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

**NBT-453: Enzyme Engineering Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3</b>

1. Isolation of Enzyme from different microorganism
2. Isolation of alpha amylase from plant source
3. Determination of Enzyme activity
4. Effect of pH on Enzyme kinetics
5. Effect of temperature on Enzyme kinetics
6. Identification of Enzyme by different assay
7. Purification of enzymes by different methods
8. Immobilization of Enzyme by sodium Alginate method
9. Enzyme inhibition

**Reference books**

1. "An Introduction to Practical Enzyme Engineering" Tata McGraw-Hill.
2. <http://www.eng.umd.edu/~nsw/ench485/ench485.htm>

**NBT-404: Immunology**

**L      T      P**  
**3      1      0**

**UNIT I (8)**

Introduction to immunity, Characteristics of innate and adaptive immunity, Humoral and Cell mediated immune response, Hematopoiesis, Cells and Molecules of the immune system, Primary and Secondary lymphoid organs, Inflammation, Characteristics of T&B cell epitopes, T &B cell maturation, activation and differentiation.

**UNIT II (8)**

Characteristics and types of Antigens, Factors affecting the immunogenicity, Haptens and adjuvants, ABO blood group antigens, Epitopes, Structure, functions and characteristics of different classes of antibodies, Antigenic Determinants on Immunoglobulins.

**UNIT III (8)**

Structure and Function of MHC molecules, Exogenous and Endogenous pathways of antigen processing and presentation, Complement system, Structure, function and application of cytokines, regulation of immune response, immune tolerance.

**UNIT IV (8)**

Antigen and antibody interactions, cross reactivity, precipitation reactions, serological techniques – ELISA, RIA and western blotting Production and application of monoclonal antibodies, Vaccines.

**UNIT V (8)**

Immunity against infectious diseases (virus, bacteria and protozoan), Hyper-sensitivity, Autoimmunity, Cancer, AIDS and Transplantation immunology.

**Text books:**

1. Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
2. Immunology by C. Fatima
3. Immunology by Kuby (Free man publication)

**Reference books:**

1. Essentials of immunology by Roitt ( Blackwell scientific publication)
2. Immunology by Benacera

**NBT-454: Immunology Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

1. To determine the blood group of given blood
2. To determine the Rh factor of given blood
3. To perform single radial immunodiffusion
4. To perform double immunodiffusion
5. To perform rocket immune electrophoresis
6. To perform counter current immune electrophoresis
7. To perform Sand-witch ELISA
8. To perform Indirect ELISA
9. To perform Competitive ELISA
10. To prepare the blood smear and stain with leishman stain
11. To identify the blood cells/ immune cell with the help of leishman stain
12. To perform differential count (DLC) of given sample

**Reference books**

1. Handbook of Experimental Immunology, Vol. I & II, IV- Blackwell Scientific Publications.
2. Practical Immunology- Hudson L. and Hay H. C. Blackwell Scientific Publications.
3. Hybridoma Techniques: A Lab Course- Muthukkaruppan Vr, Basker S and F. Singilia. Macmillan India Ltd.

**NBT-405: Molecular Dynamics & Bioenergetics**

**L      T      P**  
**2      1      0**

**Unit-I**

(8)

Biological membrane: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na<sup>+</sup>/ K<sup>+</sup>, glucose and amino acid transport; Organization of transport activity in cell; Active potentials; Role of transport in signal transduction processes, Signal Transduction.

**Unit II**

(8)

Cell Movement: Structure and organization of Actin Filament. Association of actin filament with Plasma Membrane. Protrusions of cell surface Actin, Myosin and Cell Movement, Muscle Contraction, Cell Crawling

**Unit III**

(10)

Metabolism and bioenergetics; Generation and utilization of ATP; Metabolism of Nitrogen containing compounds, nitrogen fixation, amino acids and nucleotides; Energetics of Metabolic Pathways; Electron- Transferring Reactions, Energy Coupling (ATP & NADH).

**UNIT IV**

(14)

Stoichiometry and energetic analysis of Cell Growth and Product Formation, Electron Flow as source of ATP Energy, Site of Oxidative Phosphorylation, ATP synthetase, Electron- Transferring Reactions, Standard Oxidation, Electron Carrier, electron transport, Complexes Incomplete reduction of Oxygen, Mechanism of Oxidative Phosphorylation

**Text books to be used:**

- 1-Cell – A molecular approach: Geoffrey M. Cooper.
- 2-Biochemical Engineering Fundamentals: Bailey & Ollis, Tata McGraw –Hill.

**Reference books & web sources:**

1. Biochemistry: Stryer, W. H. Freeman
2. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA
3. Cell: Bruce Albert.
4. Biochemistry: Garrett and Grisham, Harcourt.
5. <http://themedicalbiochemistrypage.org>
6. [ull.chemistry.uakron.edu/biochem](http://ull.chemistry.uakron.edu/biochem)

**NBT-455: Molecular Dynamics & Bioenergetics Lab**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

1. Selective Permeability of an Artificial Membrane.
2. Demonstration of the process of Active Transport.
3. To study the Demonstration of osmosis.
4. Effect of molecular size on permeability of the cell membrane.
5. Observation of osmosis under microscope.
6. Identifying the conditions needed for photosynthesis.
7. To study the extraction of starch. by green leaves.
8. Investigating factors affecting the rate of photosynthesis.
9. Investigating the light dependent reaction in photosynthesis.
10. To study the Isolation of Chloroplasts from spinach Leaves.
11. To study the structure & Function of refrigerated centrifuge
12. To study the structure & Function of Phase contrast microscope.