VINAYAKA MISSIONS RESEARCH FOUNDATION
DEEMED UNIVERSITY

(VINAYAKA MISSIONS UNIVERSITY)
SALEM, TAMILNADU, INDIA.

FACULTY OF ENGINEERING AND TECHNOLOGY

M.Tech- BIOTECHNOLOGY
PART TIME (WEEKEND)
CURRICULUM-REGULATION-2015

Duration of the Course: 3 years

Total number of credits to be earned for the award of degree: 75

DEPARTMENT OF BIOTECHNOLOGY

VINAYAKA MISSION'S KIRUPANANDA VARIYAR ENGINEERING COLLEGE

PERIYA SEERAGAPADI, SALEM - 636 308

CURRICULUM

I SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Advanced Biochemistry	Biotechnology	3	0	0	3
2		Bioengineering Mathematics	Mathematics	4	0	0	4
3		Principles of Chemical Engineering	Biotechnology	4	0	0	4
Practical							
4		Advanced Biochemistry Lab	Biotechnology	0	0	3	2
			TOTAL	**11**	**0**	**3**	**13**

II SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Microbial Technology	Biotechnology	3	0	0	3
2		Stem Cell Biology	Biotechnology	3	0	0	3
3		Elective I	Biotechnology	4	0	0	4
Practical							
4		Microbiology Lab	Biotechnology	0	0	3	2
			TOTAL	**10**	**0**	**3**	**12**

III SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Research Methodology	Biotechnology	3	0	0	3
2		Immunotechnology	Biotechnology	3	0	0	3
3		Elective II	Biotechnology	4	0	0	4
Practical							
4		Immunotechnology Lab	Biotechnology	0	0	4	2
			TOTAL	**10**	**0**	**4**	**12**

IV SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Genetic Engineering	Biotechnology	3	0	0	3
2		Advanced Bioprocess Engineering	Biotechnology	4	0	0	4
3		Elective III	Biotechnology	3	0	0	3
Practical							
4		Genetic Engineering Lab	Biotechnology	0	0	4	2
5		Advanced Bioprocess Lab	Biotechnology	0	0	4	2
			TOTAL	**10**	**0**	**7**	**14**

V SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Bioindustries and Entrepreneurship	Biotechnology	3	0	0	3
2		Elective IV	Biotechnology	3	0	0	3
Practical							
3		Project Work- Phase I & Viva Voce	Biotechnology	0	0	12	6
			TOTAL	**06**	**0**	**12**	**12**

VI SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Practical							
1		Project Work- Phase II & Viva Voce	Biotechnology	0	0	24	12
			TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS: 75

ELECTIVE LIST

S. No.	Course Code	Course Title	Dept. Offering the course	L	T	P	C
THEORY							
1		Bioinstrumentation	Biotechnology	4	0	0	4
2		Protein Engineering	Biotechnology	4	0	0	4
3		Enzyme Technology and Industrial Applications	Biotechnology	4	0	0	4
4		Biopharmaceutical Technology	Biotechnology	4	0	0	4
5		Nano Science and its applications	Biotechnology	4	0	0	4
6		Metabolic Engineering	Biotechnology	4	0	0	4
7		Bioreactor Engineering	Biotechnology	4	0	0	4
8		Marine and Aquaculture Biotechnology	Biotechnology	4	0	0	4
9		Plant and Animal Tissue Culture	Biotechnology	3	0	0	3
10		Food Science and Technology	Biotechnology	3	0	0	3
11		Medical Biotechnology	Biotechnology	3	0	0	3
12		Environmental Biotechnology	Biotechnology	3	0	0	3
13		Applied Bioinformatics	Biotechnology	3	0	0	3
14		Genomics and Proteomics	Biotechnology	3	0	0	3
15		Molecular Diagnostics and Therapeutics	Biotechnology	3	0	0	3
16		Biology Of Cancer Cells And Therapy	Biotechnology	3	0	0	3

I SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Advanced Biochemistry	Biotechnology	3	0	0	3
2		Bioengineering Mathematics	Mathematics	4	0	0	4
3		Principles of Chemical Engineering	Biotechnology	4	0	0	4
Practical							
4		Advanced Biochemistry Lab	Biotechnology	0	0	3	2
			TOTAL	**11**	**0**	**3**	**13**

I YEAR / I SEM	ADVANCED BIOCHEMISTRY	L	T	P	C
		3	0	0	3

AIM

To understand the basic concepts of biochemistry. This will be a prerequisite for the courses offered in the subsequent semesters.

OBJECTIVES

At the end of the course, the students would have learnt about

- Carbohydrates and lipids.
- Proteins and nucleic acids.
- Metabolic pathways.
- Bioenergetics.
- Vitamins.

UNIT I **9**

BIOMOLECULES

Biochemistry: The molecular logic of life, Buffering in biological systems, Types of biomolecules, Chemical nature and biological role, Bioenergy – Thermodynamic quantities and laws, Applications of free energy functions, ATP as the main carrier of free energy in biochemical systems, Biological oxidation - reduction reactions, Oxidative phosphorylation, Vitamins and coenzymes.

UNIT II **9**

CARBOHYDRATES

Carbohydrates – Classification, Structure and Properties (Monosaccharides, Disaccharides, Oligosaccharides and Polysaccharides), Metabolism of Carbohydrates – Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, Pentose Phosphate Shunt. Clinical Correlation – Glycogen storage disease, Diabetes mellitus, Galactosuria, Fructosuria.

UNIT III **9**

LIPIDS

Lipids – Classification, Structure and Properties (Fatty acid, Glycerolipids, Phospholipids, Glycolipids, Sphingolipids, Steroids), Biosynthesis and degradation of lipids – Fatty acid synthesis and oxidative degradation, Triacylglycerol and Phospholipids biosynthesis and degradation, Cholesterol biosynthesis and regulation. Clinical Correlation – Hypercholesterolemia, Atherosclerosis, Fatty Liver, Gaucher’s Disease, Niemann – Pick Disease, Refusme Disease.

UNIT IV **9**

PROTEINS

Proteins – Classification, Structure and Properties (Amino acids, Polypeptides, Conjugated proteins, Glycoproteins and Lipoproteins), Urea cycle and its inherited disorder, Biosynthesis of Gly, Ser, and Cys, Biosynthesis, degradationand disorders of six essential amino acids (Met, Thr, Lys, Ile, Val, Leu).

UNIT V **9**

NUCLEIC ACIDS

Nucleic acids – Classification, Structure and Properties (Purines, Pyrimidines, Nucleosides, Nucleotides, Ribonucleic acids, Deoxyribonucleic acids and Nucleoproteins), Biosynthesis of nucleotides, *de novo* and salvage pathways for purines and pyrimidines, Regulatory mechanisms : Degradation of nucleic acid by exo and endo nucleases. Clinical Correlation – Gout , Lesch – Nyhan Syndrome, Orotic Aciduria. **Total : 45 hours**

TEXT BOOKS

1. Ambika Shanmugham. Text Book of Biochemistry for Medical Students.
2. Sathyanarayana, U. and Chakrapani, U., 2006. Biochemistry. 3rd Edn., *Uppala Author Publishers Interlinks*.
3. Jain, J.L., Sunjay Jain and Nitin Jain. Fundamentals of Biochemistry.
4. Rastogi, S.C. Biochemistry.
5. Chatterjea, M.N. and Rana Shinde, 2000. Text Book of Medical Biochemistry. 4th Edn., *Jaypee Brothers Medical Publishers Pvt. Ltd*.
6. Narayanan, L.M., Nallasingam, K., Arumugam, N., Dulsy Fathima, Meyyan Pillai, R.P. and Prasanna Kumar, S. Biochemistry.
7. Powar - Chatwal. Biochemistry.
8. Mallikarjuna Rao, M., 2002. Medical Biochemistry. *New Age International (P) Ltd. Publishers*

REFERENCES

1. David L. Nelson and Michael M. Cox, 1982. Lehninger Principles of Biochemistry. *W. H. Freeman and Company*, 4th Edn.
2. Jeremy M. Berg, John L. Tymoczke and Lubert Stryer, 2001. Biochemistry. *W. H. Freeman and Company*, 5th Edn.
3. Murray, R.K, Granner, B.K, Mayes, P.A, Rodwell, V.W. and Harper. Biochemistry.
4. Donal Voet and Judith G. Voet, 2004. Biochemistry. *John Wiley and Sons*.
5. Zubay, G., 1998. Biochemistry. *Brown Publishers*.
6. Geoffrey, A. F., Beckett, J., Halker, S. H. and Rae, P. H., 2004. Lecture Notes on Clinical Biochemistry. *Blackwell Science*, UK.

I YEAR / I SEM	BIOENGINEERING MATHEMATICS	L	T	P	C
		4	0	0	4

AIM

To impart knowledge on the fundamental concepts of Bioengineering Mathematics enabling them to do calculations in chemical engineering and biological science.

OBJECTIVES

To understand the concept involved in

- Matrices and Vectors.
- Calculus and its application.
- Differential Equations.
- Numerical Methods.
- Statistics.

UNIT I **9**

MATRICES AND VECTORS

Definitions, Types of matrices, Operation of Matrices - Addition, Subtraction and Multiplication, Inverse of a Matrix, Rank of a matrix, Solution of simultaneous equations using matrix inverse and Cramer's rules, Eigen Values and Vectors of real matrix, Properties of Eigen values, Application of Cayley – Hamilton Theorem, Vector Algebra – Gradient, Divergence, Curl (Definitions and Simple problems).

UNIT II **9**

CALCULUS REVIEW

Calculus : Review of Limits, Continuity, Differentiability, Mean Value Theorem. Taylor's Theorem, Maxima and Minima, Fundamental Theorem of Calculus, Improper Integrals, Applications to Area, Volume, Convergence of Sequences and Series, Power Series, Partial Derivatives, Gradient and Directional Derivatives, Chain Rule, Maxima and Minima.

UNIT III **9**

ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

First order differential equations : Exact equations, Integrating factors and Bernoulli equations, First order and second order Partial Differential equations - Application to biology, Lagrange's method and Charpits method.

UNIT IV **9**

NUMERICAL METHODS

Finite Differences – Newton's Forward and Backward differences formula, Lagrangian Interpolation (Problems only), Algebraic and transcendental methods, False position, Newton Raphson's method, Solutions of Linear simultaneous equations, Gauss Elimination Method, Gauss Jordan Method and Gauss - Jacobi method (Problems only).

UNIT V **9**

STATISTICS, PROBABILITY AND SAMPLING

Measures of central tendency – Mean, Median, Mode, Measures of dispersion – Moment, Skewness and Kurtosis, Correlation coefficient, Rank correlation, Regressions Lines, Definitions of probability – Samples space, Events, Addition law of probability, Multiplication law and conditional probability, Bays theorem (Without proof) – Simple problems, Definitions of sampling, Student t-test, F-test and Chi square test, Analysis of variance.

Total : 45 Hours

TEXT BOOKS

1. Grewal, B. S,, 2006. High Engineering Mathematics. *Khanna Publishers*, New Delhi.
2. Murugesan, C. Engineering Mathematics.
3. Engineering Mathematics. *Anuradha Agency.*

REFERENCES

1. Subramaniam, N. Bioengineering Mathematics. *S. C. M. Publishers*.
2. Narayanan, S., Manicavachagam Pillay, T. K. and Ramanaiah, G. Advanced Mathematics for Engineering Students. *Viswanathan Printers and Publishers*
3. Thilagavathy, K and Gunavathy, K, 2000. Engineering Mathematics. Volume I, *S. Chand and Co.*, New Delhi, 4th Edn.

I YEAR / I SEM	PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	C
		4	0	0	4

AIM

To understand the basic Principles of chemical engineering.

OBJECTIVES

- To study about the unit operations in chemical industry.
- To know about the concept of Thermodynamics, material and energy balance Calculations.
- To understand about the basic concepts of fluid mechanics.
- To study in detail about the methods of transportation of fluids.
- To understand the fundamentals of heat and mass transfer.

UNIT I **9**

INTRODUCTION

Role of chemical engineering in design and analysis of chemical processes, Historical and more recent developments in Chemical engineering and its role in Biological processes. Overview of unit operations and processes in the chemical industry. Units and conversion factor, Introduction to dimensional analysis (Pi – theorem).

UNIT II **9**

THERMODYNANICS, MATERIAL AND ENERGY BALANCES

Concepts of chemical thermodynamics, Relation to Vapour Liquid Equilibrium (VLE), Solution thermodynamics. Stoichiometry – Overall and component material balances, Material balances without chemical reactions, Conversion and yield, Material balance calculations with chemical reactions, Recycle operations, Energy balances – Entropy, Latent heat, Combustion calculations.

UNIT III **9**

FLUID MECHANICS

Classification and Properties of fluids, Fluid statics - forces at fluid surfaces, Pressure and measurement of pressure differences, Fluid flow concepts and basic equations of fluid flow – Continuity equation and Bernoulli’s equation, Shear stress relationship and viscous effects in

fluid flow – Non - Newtonian fluids, Significance of dimensionless groups in fluid flow operations.

UNIT IV **9**

TRANSPORTATION OF FLUIDS

Different types of pumps, Compressors and valves, Measurement of fluid flow using hydrodynamic methods, Direct displacement method, Types of agitators, Flow patterns in agitated vessels, Calculation of power consumption, Applications in bioreactor design.

UNIT V **9**

FUNDAMENTALS OF HEAT AND MASS TRANSFER

Heat Transfer : Mechanism of heat transfer – Conduction, Convection, Radiation, One Dimensional Steady state conduction – flat wall and cylinder, Convection – Forced and Natural Convection, Heat transfer by forced convection in laminar, turbulent flow - Empirical Equations, Heat transfer coefficients calculations, General equipments of heat transfer.

Mass Transfer : Molecular and Eddy diffusion, Role of diffusion in bioprocessing, Mass transfer theories, Liquid - solid mass transfer operations - Batch and Fixed bed adsorption, Gas - liquid mass transfer operations - Principles of Absorption, Industrial absorbers.

Total: 45 Hours

TEXT BOOKS

1. Bhatt, B. I. and Vora, S. M., 1977. Stoichiometry. *Tata McGraw Hill Publication*, 3rd Edn.
2. Anatharaman. Process calculations
3. Hougen, O. A. and Watson, K. M. Chemical Process Principles. *C. B. S Publication*, Volume I.
4. Geankoplis, C. J., 2003. Transport Processes and Unit Operations. *Prentice – Hall*, India, 3rd Edn.

REFERENCES

1. Himmelblau, D., 1994. Basic Principles and Calculations in Chemical Engineering. *Prentice Hall India Ltd.,* India, 5th Edn..
2. McCabe, W. L., Smith, J. C. and Harriot, P., 2004. Unit Operations in Chemical Engineering. *Tata McGraw Hill Internation Publication,* 7th Edn.
3. Treybal, R.E., 1981. Mass Transfer Operations. 3rd Edn., *Mc Graw Hill*.

I YEAR / I SEM	ADVANCED BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	2

AIM

To develop the skills of the students by providing hands on training in various biochemical analysis.

OBJECTIVES

At the end of this laboratory course, the students would have learnt about the

- Qualitative analysis.
- Biochemical analysis.
- Enzyme assay.
- Chromatography.

EXPERIMENTS

I. Qualitative Analysis

(i) Carbohydrates

(ii) Lipids

(iii) Proteins

(iv) Normal and abnormal constituents of urine.

II. Quantitative Analysis

(i) Estimation of glucose by ortho - Toluidine method

(ii) Estimation of blood urea by Nessler's method

(iii) Estimation of cholesterol by Zak's method

(iv) Estimation of bilirubin by Malloy and Erelyn method

(v) Estimation of protein by Lowry's method

(vi) Estimation of nucleic acids by spectrophotometric method

(vii) Estimation of haemoglobin by Shali's method.

(viii) Determination of Erythrocyte Sedimentation Rate by using Westergren Pipette

III. Chromatography

(i) Separation of sugars and amino acids by Paper chromatography

(ii) Extraction of lipids and analysis by TLC.

IV. Enzyme assay

(i) Determination of serum LDH activity

(ii) Determination of Serum Glutamate Oxaloacetate Transaminase (SGOT) by Mohn and Cook method.

(iii) Determination of Serum Glutamate Pyruvate Transaminase (SGPT) by IFCC Method

II SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Microbial Technology	Biotechnology	3	0	0	3
2		Stem Cell Biology	Biotechnology	3	0	0	3
3		Elective I	Biotechnology	4	0	0	4
Practical							
4		Microbiology Lab	Biotechnology	0	0	3	2
			TOTAL	**10**	**0**	**3**	**12**

I YEAR / II SEM	MICROBIAL TECHNOLOGY	L	T	P	C
		3	0	0	3

AIM

To know the fundamentals of microbiology by studying the characteristic structural organisation and replication of microorganisms, microscopy, microbial nutrition and metabolism, effects of microbes and control.

OBJECTIVES

- To have knowledge about the World of microorganisms and microscopy.
- To study the structure and replication concepts of microorganisms.
- To know the requirements of microbial nutrition for growth of microorganisms and the impact of environment on its growth.
- To understand the mechanism of microbial metabolism and the clinical importance of microorganisms.
- To evaluate the control of microorganisms and its environmental applications.

UNIT I **9**

MICRORGANISMS AND MICROSCOPY

Characteristics of microorganisms, Historical review of the foundation of microbiology, Taxonomy methods of studying microorganisms, Microscopy – Light, Electron, Phase contrast and Laser optics systems, Micrometry, Scope of Microbiology.

UNIT II **8**

STRUCTURAL ORGANISATION AND REPRODUCTION OF MICROORGANISMS

Structure, Organization and Reproduction of Bacteria, Yeast, Fungi, Algae, Bacteriophage and Viruses.

UNIT III **8**

MICROBIAL NUTRITION AND ENVIRONMENT

Nutritional requirements, Growth of microorganisms in Natural and Artificial Environment, Aerobic and anaerobic growth, Different methods of enumeration of multiplying microorganisms, Growth curve, Axenic culture, Synchronus culture, Continuous culture, Methods of preservation of microbes, Effects of physical and chemical factors on microbial growth.

UNIT IV **10**

CLINICAL MICROBIOLOGY

Bacterial, Fungal, Viral and Parasitic Diseases, Clinically important microorganisms and their role in infections and immunity, Formation of toxic Substances by microorganisms.

UNIT V **10**

CONTROL OF MICROORGANISMS AND ITS ENVIRONMENTAL APPLICATIONS

Antimicrobial agents and disinfectants, Microbes in Air, Drinking water, Waste water and Extreme Environments, Recycling of biomaterials, Leaching of ores by Microorganisms, Microbial degradation of Recalcitrant Organic Pollutants, Biofouling, Production of biogas, Application of biofertilizers and biopesticides, Microbial indicators of pollution, Food preservation, Food spoilage, Food poisoning.

Total : 45 Hours

TEXT BOOKS

1. Pelzar, M.J., Chan, E.C.S and Krieg, N.R. Microbiology. *Tata McGraw Hill Edition.* New Delhi. India.
2. Ananthanarayan and Jayaram Paniker, 1999. Text Book of Microbiology. *Orient Longman Publishers.*

REFERENCES

1. Talaro, K., Talaro A. Cassida Pelza and Reid, 1993. Foundation in Microbiology. *W.C. Brown Publishers.*
2. Prescott, Harley and Klen, 2003. Microbiology. *McGraw Hill Publications.* 5th *Edition*.

I YEAR / II SEM	STEM CELL BIOLOGY	L	T	P	C
		3	0	0	3

AIM

To understand the fundamental concept of Stem Cell Technology.

OBJECTIVES

At the end of the course the student would have gained extensive knowledge on

- Types of Stem cell and its characterization.
- Cell lines and Tissue engineering.
- Isolation and Cloning of Stem cells.
- Types of Stem cell transplantation.
- Applications and Ethics.

UNIT I **8**

STEM CELL AND ITS TYPES

Stem cell – Definition, Embryonic stem cells, Adult stem cells, Origin and characterization of human stem cells and potential applications for stem cell research, Plasticity of human stem cell research, Cord blood stem cells, Stem cell marker.

UNIT II **11**

CELL CULTURE AND TISSUE ENGINEERING

Cell types and sources, Cell culture facilities and applications, Cell and tissue culture medias, Primary cultures and cell lines, Cell culture and scale up, Assays for cell viability and cytotoxicity, Maintenance of stock cells, Biology and characterization of cultured cell, Design and engineering of tissues, Stem cell engineering, Reconstruction of connective tissues, Reconstruction of epithelial or endothelial surfaces – Cells embedded in extracellular matrix material, Culture on a single surface and sandwich configuration, Bioreactor design on tissue engineering – Hollow fibre systems, Microcarrier based systems, Liver tissue engineering.

UNIT III **8**

ISOLATION AND CLONING OF STEM CELLS

Protocols for isolation and identification of stem cells, Culturing and subculturing human neurospheres, Differentiation of human – Neurospheres into neurons, Astocytes and Oligodentrocytes, Immunolabelling procedures, Stem cells and cloning.

UNIT IV **8**

HUMAN EMBRYONIC STEM CELLS

Human Embryonic Stem Cell Research : Possible sources for human embryonic stem cells, Growing embryonic stem cells in laboratory, Current advantages and limitations of human embryonic stem cells and human somatic stem cells, Developments regarding establishment of human stem cell banks and registries, Government of human embryonic stem cell research, Regulations in European member states and Non - European countries regarding human embryonic stem cell research, Human embryonic stem cell ethics and public policy.

UNIT V **10**

STEM CELL TRANSPLANTATION AND APPLICATION

Types of stem cell transplantation – Autologous, Allogeneic, Syngeneic; Nuclear transplantation, Therapeutic transplantation, Embryonic stem cell transfer and Targetted gene transfer, Neural stem cells for Brain / Spinal cord repair, Miracle stem cell heart repair, Stem cell and future of regenerative medicine, Haematopoietic stem cell therapy for autoimmune disease, Prenatal diagnosis of genetic abnormalities using foetal CD 34+ stem cells, Embryonic stem cell – Germ-line therapy, Human stem cell research in India

Total : 45 Hours

TEXT BOOKS

1. Bernhard Palsson, Jeffery A. Hubble, Robert P. Lonsey and Joseph D. Bronzino, 2005. Tissue Engineering, Principles and Applications in Engineering. C. R. C. Press.
2. John, R. and Master, W., 2004. A Practical Approach. Oxford University Press.

REFERENCES

1. Stewart Sell. Stem Cell Handbook. Humana Press.
2. Campbell, N. A. and Jane B. Reece, 2002. Biology.6th Edition. Pearson Education, Inc. San Francisco, California.
3. Freshney, R. and Ian. Alan, R. Culture of Animal Cells : A Manual of Basic Techniques. Liss Inc.
4. Gamborg, O. L. and Phillips, G. C., 1995. Plant Cell, Tissue, and Organ Culture : Fundamental Methods. Springer-Verlag, Berlin Heidelberg.

5. Modlinske, J. A., Reed, M. A., Wagner, T. E. and Karasiewicz, J., 1996. Embryonic Stem Cells : Developmental Capabilities and their Possible Use in Mammalian Embryo Cloning. Animal Reproduction Science 42 : 437 – 446.

I YEAR / II SEM	MICROBIOLOGY LAB	L	T	P	C
		0	0	3	2

AIM

To give an opportunity of verifying the theoretical concept by experimentally in a more explicit and concentrated manner.

OBJECTIVES

The students would have learnt the

- Basic concepts of Microbiology,
- Skills in the preparation, identification and quantification of microorganisms.

EXPERIMENTS

i. Sterilisation Techniques.

ii. Culture Media Preparations
   a. Broth type media
   b. Solid type media
   c. Semi solid type media

iii. Culturing of Micro organisms
   a. Pure Culture techniques
   - Streak plate
   - Pour plate

iv. Identification of Micro organisms
   a. Staining techniques
   - Simple
   - Gram
   - Spore
   - Acid fast
   - Hanging drop
   b. Biochemical testing

v. Environmental Sample Analysis
   - Isolation and enumeration of microbes from sewage or soil samples.
   - Assay of Microbial growth by Substrate Utilisation Test

vi. Food Microbiology
   - Milk

- Fermented food

vii. Clinical Microbiology

- Normal Mouth Flora
- Antibiotic Disc test Assay.

III SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Research Methodology	Biotechnology	3	0	0	3
2		Immunotechnology	Biotechnology	3	0	0	3
3		Elective II	Biotechnology	4	0	0	4
Practical							
4		Immunotechnology Lab	Biotechnology	0	0	4	2
			TOTAL	**10**	**0**	**4**	**12**

II YEAR / III SEM	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

AIM

The students are introduced to the intricacies of Research and the protocol for a scientific report.

OBJECTIVES

To enable the students to understand the principles

- Scientific writing.
- Data collection, analysis and proper interpretation of the data.
- Processing the collected data and to discuss before arriving at inferences and conclusions.
- Chromatographic techniques & Spectroscopy.

UNIT I **13**

THE SCIENTIFIC WRITING

Need for research, Meaning of research, Characteristics of good research, Major steps in research, Types of research : Pure research, Applied research, Action research Expost Facto research, Experimental research, Survey research, Evaluation of research, Types of research design – Exploratory, Diagnostic, Descriptive and Experimental research designs, Field and documentary sources of data – Primary and secondary data, Survey method, Questionnaire method, Observation method, Case study method, Pilot study and Pre – testing.

Research reports, Thesis – Structure, Style and discourse markers, Topics and topic sentence, Development and illustrations, Logic, Coherence and Cohesion , Journal articles – Format and writing style, Requirement of technical communications – Eliminating wordiness and Jargon – tautology, Redundancy, Imprecise words, Superfluous phrases, Steps to publishing a scientific article in a journal : Types of publications – Communications, Articles, Reviews, When to publish, Where to publish, Specific format required for submission, Organization of the material, Documenting : Abstracts – Indicative or descriptive abstract, Informative abstracts, Foot notes, End notes, Reference styles, Bibliography – Journal abbreviations, Abbreviations used in scientific writing.

UNIT II **10**

TECHNIQUES FOR DATA ANALYSIS

Statistical considerations : Population and samples, Sampling distributions, Collection and presentation of data, Parametric and Non – Parametric data, Descriptive and inferential analysis, Frequency distribution : Tabulation, Graphing frequency distribution – Discrete versus continuous scales, Bar graphs, Frequency polygons.

UNIT III **13**

USING DATA TO MAKE DECISIONS

Measures of central tendency – The Mean, Median and Mode, Measures of variability : Range, Mean deviation, Standard deviation, Variance, Coefficient of variance, Probability distributions – Normal, Binomial and Poisson distribution, Correlation methods – Scatter diagrams, Karl Pearson's correlation coefficient, Spearman's rank order correlation coefficient, Linear and multiple regression. Non – Parametric tests : Chi square, Mann Whitney test, Kolmogorov – Smirnov two sample test, Duncan's Multiple test, Test statistical significance : The logic of hypothesis, Testing the null hypothesis ($H_{0)}$ Level of significance, Degrees of freedom, Students t test, Parametric tests : One way - Analysis of Variance (ANOVA), Two way - Analysis of Variance, Computer software application using Students Statistical Package for Social Science (SPSS) Package for basic and Advanced statistical analysis.

UNIT IV **11**

CHROMATOGRAPHIC TECHNIQUES

Chromatographic techniques : Paper chromatography – Principle, Instrumentation, Application. Column chromatography – Principle, Instrumentation, Application. Thin Layer Layer Cromatography – Principle, Instrumentation, Application. Gas Cromatography – Principle, Instrumentation , Application.

UNIT V **13**

SPECTROSCOPY

Colrimetry – Principle, Instrumentation , Application. UV - visible spectroscopy – Principle, Instrumentation, Application. Flame Photometry – Principle, Instrumentation, Application. Atomic Absorption Spectroscopy – Principle, Instrumentation, Application. Infra - red Spectroscopy – Principle, Instrumentation, Application. NMR – Principle, Instrumentation, Application.

Total : 45 Hours

TEXT BOOKS

1. Dominoswki, R. L., 1981. Research Methods. *Prentice - Hall*.
2. Best, J. W., 1981. Research in Education. *Prentice - Hall* of India, New Delhi.
3. Ebel, H. F., Bliefert, C. and Russey, W. E., 1988. The Art of Scientific Writing. *V. C. H. Publications*, Weinheim.

REFERENCES

1. Cain, B. E., 1988. The Basis of Technical Communicating. *A. C. S. Publications*, Washington, DC.
2. Kanare, H. M., 1985. Writing the Laboratory Notebook. *American Chemical Society*, Washington, DC.
3. Alexis Antony Joseph, 1986. Methodology for Research (Guide for Writing Dissertation, Thesis and Scientific Papers). *Theological Publications in India*, Bangalore
4. Anderson, J., Durston, B. H. and Poole, M., 1970. Thesis and Assignment Writing. *Wiley Eastern Ltd.*, New Delhi.
5. Kothari, C. R., 2008. Research Methodology. *New Age International Publishers*, New Delhi.
6. Khan and Khanum.,1994. Fundamentals of Biostatistics. *Ukaaz Publications*.
7. Arora, P. N. and Malhotra, P. K., 2013, Biostatistics. Himalaya Publishing House.
8. Norman and Bailey, T. S.,1995. Statistical Methods in Biology. *Cambridge University Press*, UK.
9. Jerrod, H. Zar, 1999. Biostatistical Analysis. *Prentice - Hall International Inc. Press*, London.

II YEAR / III SEM	IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

AIM

To study in detail about the immune system and the immunotechniques.

OBJECTIVES

- To have a basic knowledge about the immune system.
- To study about the cell mediated immunity.
- To study about the immunity against specific diseases.
- To understand the role of markers and the safety guidelines for rDNA.
- To read in detail about the different types of vaccines and therapeutics.

UNIT I **9**

INTRODUCTION TO IMMUNE SYSTEM

Phylogeny of immune system, Innate and acquired immunity, Hematopoiesis and differentiation, Organization and structure of lymphoid organs, Cells of immune system – B - Lymphocytes, T - Lymphocytes, Macrophages, Dendritic cells, Natural killer, Lymphocyte activated killer cells, Eosinophils, Neutrophils, Mast cells, Clonal nature of immune response, Antibody structure and function – Structural features and biological properties of IgG, IgM, IgA, IgD and IgE.

UNIT II **8**

ASSESSMENT OF CELL MEDIATED IMMUNITY

Identification of lymphocytes and their subsets in blood, T - cell and B - cell activation, Macrophage activation, Macrophage microbicidal assays, Cytokines : Monokines, Lymphokines and Interleukines, In vitro experimentation – Application of the above technology to understand the pathogenesis of infectious diseases.

UNIT III **9**

DISEASES AND IMMUNE SYSTEM

Immunity to Virus, Bacteria, Parasites, Genetic control of immune response, MHC associated predisposition to disease, Infectious diseases – Leprosy, Tuberculosis, Malaria, Filariasis, Amoebiasis, Rabies, Typhoid, Hepatitis, AIDS.

UNIT IV **10**

IMMUNOTECHNIQUES

Antigen - antibody interaction, Agglutination and precipitation, Complement fixation test, Immunodiffusion, Radio Immuno Assay (RIA), Enzyme Linked Immunosorbent Assay (ELISA), Western blotting, Immunoelectrophoresis, SDS – PAGE, Purification and synthesis of antigen, Fluorescence immunoassay – Immuno Fluorescence (IF), Substrate Labelled Fluorescent Immunoassay (SLFIA), DELFIA, Fluorescence Activated Cell Sorter (FACS), Immunomics.

UNIT V **9**

VACCINES AND IMMUNOTHERAPEUTICS

Basic principles of vaccine development, Protein based vaccines, DNA vaccines, Plant based vaccines, Recombinant antigens as vaccines, Reverse vaccinology, Engineered antibodies – Catalytic antibodies, Idiotypic antibodies, Combinatorial libraries for antibody isolation.

Total : 45 Hours

TEXT BOOKS

1. Lydyard, P. M., Whelan, A. and Fanger, M. W., 2003. Instant Notes in Immunology. Viva Books Private Limited, 2nd Edition.
2. Talwar, G. P., and Gupta, S. K., 1992. A Handbook of Practical and Clinical Immunology. CBS Publications, Volume I and II.
3. Weir, D. M., 1990. Practical Immunology. Blackwell Scientific Publications, Oxford.
4. Dulsy Fatima. Immunology. Saras Publications.

REFERENCES

1. Talwar, G. P. and Gupta, S. K., 1992. A Handbook of Practical and Clinical Immunology. CBS Publications, Volume 12.
2. Roitt and Roitt. Immunology.
3. Richard, A., Goldsby, Thomas J. Kindt and Barbara A. Osborne, Kuby. Immunology. W. H. Freeman and Company, New York, 4th Edition.

4. Goding, J. W., 1983. Monoclonal Antibodies : Principles and Practice. Academic Press.

5. Benjamin, E. and Leskowitz, S., 1991. Immunology – A Short Course. Wiley Liss., New York.

6. Austin, J. M. and Wood, K. J., 1993. Principle of Cellular and Molecular Immunology. Oxford University Press, Oxford.

II YEAR / III SEM	IMMUNOTECHNOLOGY LAB	L	T	P	C
		0	0	4	2

AIM

To develop skills of students in Immunology by performing simple experiments in the laboratory.

OBJECTIVES

At the end of the course the student would have gained knowledge to

• Perform test for blood grouping, ELISA and identification of T-cell, Immunofluorescence etc.

EXPERIMENTS

1. Handling of animals, immunization and raising antisera.
2. Identification of cells in a blood smear.
3. Identification of blood groups.
4. Immunodiffusion and immunoelectrophoresis.
5. Testing for Typhoid antigens by Widal test.
6. Enzyme Linked Immunosorbent Assay (ELISA).
7. Isolation and culture of peripheral blood mononuclear cells.
8. Isolation of monocytes from blood.
9. Immunofluorescence.
10. Identification of T-cell rossetting using sheep RBC.

REFERENCES

1. Rajasekara Pandian M , 2007 Immunology & Immunotechnology 1st Edition, Publisher: Panima Publishing Corporation, New Delhi, India.

IV SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Genetic Engineering	Biotechnology	3	0	0	3
2		Advanced Bioprocess Engineering	Biotechnology	4	0	0	4
3		Elective III	Biotechnology	3	0	0	3
Practical							
4		Genetic Engineering Lab	Biotechnology	0	0	4	2
5		Advanced Bioprocess Lab	Biotechnology	0	0	4	2
			TOTAL	**10**	**0**	**7**	**14**

II YEAR / IV SEM	GENETIC ENGINEERING	L	T	P	C
		3	0	0	3

AIM

To study in detail about the basic concepts underlying the technique of recombinant technology.

OBJECTIVES

- To have a basic knowledge about the cloning vectors.
- To study about the concepts involved in cloning.
- To know the techniques in Genetic Engineering.
- To understand the role of markers and the safety guidelines for rDNA.
- To read in detail about the various applications of transgenesis.

UNIT I **10**

CLONING VECTORS

Concepts of recombinant DNA technology – Cutting (Restriction enzymes) and joining of DNA, Plasmid biology, Plasmids as vectors – pBR 322, Derivatives of pBR 322, pUC vectors, Lambda vectors, In vitro packaging, M13 vectors, Cosmids, Phasmids, Retroviral vectors, Baculovirus vectors, Cloning vectors in Gram positive bacteria (p1J101), Cloning vectors in Gram negative bacterium (Col E1, R1, pT181, pSC 101), Cloning vectors in Streptomyces (SLP and SCP), Expression vectors – Prokaryotic expression vectors (E. coli, Streptomyces) and Eukaryotic expression vectors.

UNIT II **8**

CLONING STRATEGIES AND RECOMBINANT DNA TECHNOLOGY

Preparation of competent cells, Transformation, Gene transfer methods in plants and animals, Construction and screening of genomic DNA and cDNA library, Analysis of gene expression, Chromosome walking, Chromosome jumping, Transcript mapping, Gene targetting, Transposon tagging.

UNIT III **9**

TECHNIQUES IN GENETIC ENGINEERING

DNA Labeling – Radioactive and non - radioactive methods, DNA amplification using PCR and it's applications, Random Amplified Polymorphic DNA (RAPD), RT - PCR, Ligase chain reaction, Heteroduplexing, DNA sequencing – Maxam and Gilbert method and Sanger and Coulson enzymatic chain termination method, Nucleic acid hybridization – Southern, Western and Northern, Gene targeting vectors : Gene replacement, Gene knockout, Gene addition – Reporter gene technology, Enhancer trap technology, Phage display technology, Baculovirus Display (BUDS), Yeast one hybrid and two hybrid vectors, iRNA technology : Therpeutic potential of RNAi in metabolic diseases, Gene synthesis.

UNIT IV **9**

GENETIC ENGINEERING AND SAFETY GUIDELINES

Mutagenesis – Deletion mutagenesis, Oligonucleotide derived mutagenesis, Site directed mutagenesis and their applications, Molecular Markers – Variable Number Tandem Repeats (VNTR's), Minisatellite sequences, Short Tandem Repeats (STR), Microsatellite sequences, Restriction mapping, DNA fingerprinting – Restriction Fragment Length Polymorphism (RFLP) analysis, Gene therapy, Molecular diagnostic methods for genetic diseases, In situ methods to locate transgenes and transcripts, Safety guidelines for recombinant DNA technology and guidelines for the disposal of bio-waste.

UNIT V **9**

APPLICATIONS OF TRANSGENIC PLANTS AND ANIMALS

Gene products : Insulin, Human Gonadotrophic Hormone (HGH), BST, Factor VIII, Interferons, Production of antibodies by genetic engineering, Targetting gene therapeutics ribozymes, Triple helix therapeutics, Oligonucleotide aptemers, Intrabodies, Genetically engineered vaccines, Biofortification (Nutraceuticals), Plantibodies and Pharmaceutical pharming, Plastics from plants, Flavr Savr tomato, Blue roses, Golden rice, Transgenic animals – Mastitis resistant cattle, Tick resistant sheep, Fast growing sheep, Fast growing fish, Antimalarial mosquitoes, Antifreeze proteins, Fat Salomon, Mutation detection fish, Spider silk from goat milk, Low phosphorus Enron pig, Vaccination for animal health, Engineering food for animals.

Total : 45 Hours

TEXT BOOKS

1. Old, R. W. and Primrose, S. B., 1993. Principles of Gene Manipulation. An Introduction to Genetic Engineering. Blackwell Scientific Publication.

2. Freifelder, D., 1987. Molecular Biology. Jones and Bartlett Publishers Inc.
3. Brown, T.A.,2012 Gene Cloning. 6th Edition, Wiley-Blackwell Publication.
4. Purohit, S. S., 2002. Biotechnology: Fundamentals and Applications. Agrobios (Ind), Jodhpur.
5. Satyanarayana, U., 2008. Biotechnology. Books and Allied Pvt. Ltd.

REFERENCES

1. Sambrook and Elliot. Molecular Cloning. Vol. III.
2. Lewin, B. I. Genes VIII. John Wiley and Sons, New York.
3. Watson, J. Recombinant DNA Technology.
4. Winnacker. From Genes to Clones.
5. Ansubel, F. M., Brent, R., Kingston, R. E. and Moore, D. D., 1988. Current Protocols in Molecular Biology. Green Publishing Associates, New York.
6. Benjamin Lewin, 2000. Genes VI and Genes VII. Oxford University Press, Cambridge, UK, 7th Edition.
7. RobertHorton, H., Lawrence A. Moran, Raymond S. Ochs, David Rawn, J. and Gray Scrimgeour, K., 2002. Principles of Biochemistry. Prentice - Hall, 3rd Edition.
8. Jose Cibelli, Robert P. Lnza, Keith H. S. Campbell and Michael D. West, 2002. Principles of Cloning. Academic Press.

II YEAR / IV SEM	ADVANCED BIOPROCESS ENGINEERING	L	T	P	C
		4	0	0	4

AIM

To study in detail about the advanced concepts of Bioprocess Engineering.

OBJECTIVES

- To have a basic knowledge about the Sterilization and Inoculum development
- To study about the concepts involved in design of Bioreactors.
- To know the techniques in Process control of fermentation process
- To read in detail about the various fermentation products
- To know about the bioprocess considerations in plant and animal cultures.

UNIT I **13**

STERILIZATION AND INOCULUM DEVELOPMENT

Fermentation process – General requirements of fermentation processes – Bioreactor definition, Media requirements for fermentation processes – Examples of simple and complex media, Sterilization – Thermal death kinetics of micro organisms – Batch and continuous heat sterilization of liquid media – Filter sterilization of liquid media and air, Inocula development – Introduction – Criteria for the transfer of inoculum – Development of inocula for : Yeast processes, Bacterial processes, mycelial processes.

UNIT II **13**

DESIGN AND ANALYSIS OF BIOREACTORS

Design and operation of Bioreactors- bioreactor design of agitator/agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes, Batch and continuous stirred tank reactor, Design and analysis of Packed bed and membrane bioreactors – Design and operation of Novel bioreactors – Airlift loop reactor, Fluidized bed and Trickle bed bioreactors, Immobilized enzyme bioreactors.

UNIT III **13**

PROCESS CONTROL AND APPLICATIONS

Biologically important set points and their importance, Measurement of physical and chemical parameters in bioreactors – Monitoring and control of dissolved oxygen, pH, impeller speed and temperature in stirred tank fermenter, Types of controls, Monitoring, Control-loops, Feed back and feed forward, Self adapting controllers, Expert system approach.

UNIT IV **11**

CULTIVATION AND PRODUCT DEVELOPMENT

Culture phases, Monod kinetics, Michaelis - Menten kinetics – Modifications, Cell and product recovery and purification techniques – Micro and macro scale production – Fermentation of Ethanol, Antibiotics, Biofertilizer, Biosurfactants, Industrial enzymes, Interleukins, Interferon, Lymphokines.

UNIT V **10**

BIOPROCESS CONSIDERATIONS IN ANIMAL AND PLANT CELL CULTURE

Animal cell cultures – Methods used for the cultivation of animal cells, Bioreactor consideration and products. Plant cell cultures – Comparison to microbes, Bioreactor considerations – Economics of tissue culture.

Total : 45 Hours

TEXT BOOKS

1. James E. Bailey and David F. Ollis, 1986. Biochemical Engineering Fundamentals. 2nd Edition., *Tata McGraw Hill International Edition*, New York.
2. Stanbury, P.F., Whitaker, A. and Hall, S. J., 1997. Principles of Fermentation. Technology. 2nd Edition., *Aditya Books (P) Ltd.*, New Delhi.
3. Shuler, M. L. and Kargi, F., 2001. Bioprocess Engineering: Basic concepts. 2nd Edition., *Prentice – Hal.*
4. O.P. Ward, 1989. Fermentation Biotechnology: Principles, Processes, and Products .*Open University Press,* Milton Keynes, UK,
5. Atkinson, B. & Mavituna. F., 1993. Biochemical Engineering and Biotechnology. 2nd Edition., Handbook, *McGraw Hill.*

REFERENCES

1. SH. Aiba, A. E. Humphrey and Nancy F. Millis 1973, Biochemical Engineering *Academic Press, 2nd* Edition

2. Webb F.C, 1964. Biochemical Engineering. 1st Edition. Van Nostrand, London, *H&G Antiquarian Books.*

II YEAR / IV SEM	GENETIC ENGINEERING LAB	L	T	P	C
		0	0	4	2

AIM

The course aim is to offer hands on training in the area of Cell culture and cell identification. This will serve as a prerequisite for Post graduate and specialized studies and Research.

OBJECTIVES

At the end of the course from various sources, the students would have learnt the methodology

- To isolate cells and to identify them by specialized Microscopy. This will be extremely beneficial to take up project work in Cellular biology.
- To familiarize with core Nucleic acid techniques such as extraction and nucleic acid separations.
- To amplify DNA using Polymerase Chain Reaction.
- To detect and characterize Nucleic acids, through the application of gene probes and blotting techniques.
- To acquire skills in Gene cloning and screening of recombinants.
- To analyze proteins through SDS-PAGE and Western blotting.

EXPERIMENTS

1. Leishman staining
2. Giemsa staining
3. Osmosis and tonicity

4. Tryphan blue assay
5. Staining for different stages of mitosis in Allium cepa (Onion)
6. Staining for different stages of meiosis using (Grasshopper)
7. Blue and White selection for recombinants
8. Isolation of Genomic DNA from Plant / Animal / Bacterial Cells
9. Isolation of Total RNA
10. Isolation of Plasmid DNA
11. Quantification of DNA and RNA
12. Gel Electrophoresis of DNA – Agarose Gel, Polyacrylamide gel.
13. Southern Blotting.
14. Polymerase Chain Reaction.
15. Elution of Plasmid DNA from Agarose gel.
16. Restriction digestion of Bacterial Genomic and Plasmid DNA.
17. Ligation of DNA.
18. Preparation of Competent Cells.
19. Transformation in E. Coli.
20. Screening and selection of Recombinants and Confirmation of Insert DNA in Plasmid.
21. SDS-PAGE.
22. Western Blotting.

REFERENCES

1. Kalaichelvan, P.T., 2006. Microbiology and Biotechnology. A Laboratory Manual. Lab Man Series, MJP Publishers.

2. Ralph Rapley and John M. Walker, 1998. Molecular Biomethods Handbook. Humana Press

II YEAR / IV SEM	ADVANCED BIOPROCESS LAB	L	T	P	C
		0	0	4	2

AIM

To develop the skills of the students by providing hands on training in various concepts of Bioprocess Engineering.

OBJECTIVES

At the end of this laboratory course, the students would have learnt about the

- Sterilization and Inoculum development
- Design of Bioreactors.
- Process control of fermentation process
- Production of various fermentation products

List of Experiments

1. Demonstration of a Fermentor and its components.
2. Determination of KL a by sodium sulphite oxidation method
3. Centrifugation
4. Batch Sedimentation
5. Liquid-Liquid extraction
6. Batch Distillation
7. Ammonium Sulphate precipitation
8. Estimation of MM parameters
9. Effect of substrate concentration on growth of E.coli
10. Immobilization of Enzyme-_ amylase
11. Effect of temperature on enzyme activity
12. Effect of pH on Enzyme activity
13. Production of wine

14. Estimation of Biomass

REFERENCE

1. Kumar and Hartland. Ind. Eng. Chem. Res. 34, 3925 (1995).
2. Henry Z. Kister, 1992, Distillation Design**,** McGraw-Hill publications
3. Zuiderweg. F. J, 2009, Laboratory Manual of Batch Distillation, Interscience Publishers.
4. Karin Kovárová-Kovar and Thomas Egli,1998, Growth Kinetics of Suspended Microbial Cells: From Single-Substrate-Controlled Growth to Mixed-Substrate Kinetics, Microbiol Mol Biol Rev.
5. G. Szasz. 1974, The Effect of Temperature on Enzyme Activity and on the affinity of enzymes to their Substrates, Z Klin Chem Klin Biochem.

V SEMESTER

S. No.	Course Code	Subject Name	Dept. Offering the course	L	T	P	C
Theory							
1		Bioindustries and Entrepreneurship	Biotechnology	3	0	0	3
2		Elective IV	Biotechnology	3	0	0	3
Practical							
3		Project Work- Phase I & Viva Voce	Biotechnology	0	0	12	6
			TOTAL	**06**	**0**	**12**	**12**

III YEAR / V SEM	BIOINDUSTRIES AND ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

AIM

To understand the basics of entrepreneurship and concepts involved in Bioindustries.

OBJECTIVES

To discuss in detail about the

- Basic Management principles
- Understanding Management strategy
- Bio safety and Bioethics
- Entrepreneurship in Biotechnology
- Biotech demand and investment

UNIT I **9**

BASIC MANAGEMENT PRINCIPLES

Principles of management – Management functions – Planning – Organizing – Organization structures – Span of control – Delegation – Directing – Leadership and motivation – Controlling – Decision making – Single stage decision making under risk – Multistage decision making, Operation management – Production systems and functions – Product design and selection, Concept of total quality management and ISO 9000 system of standards – Concept of supply chain management.

UNIT II **9**

MANAGEMENT STRATEGY

Scientific organizations under Government of India – PASTER program aimed at technological self - reliance – Management strategy – Operational strategy – Strategic Vs tactical planning – Globalization – Open-economy – Strategic alliances – Enterprise resource planning – Generic strategy alternatives – Stability expansion – Modernization /

Diversification / Merger, Takeover and liquidation strategies – Strategy evaluation and correction – Strategy implementation.

UNIT III **9**

BIOSAFETY AND BIOETHICS

Biosafety regulation and guidelines, National and International guidelines – rDNA guidelines, Experimental protocol approvals, Levels of containment, The Cartagena protocol on the Biosafety and Biosafety management, Bioethics : Definition and concepts, Theology, National and International legislation / Law, Bioethical issues – Personhood, Reproduction, Abortion, Population explosion and control, Assisted reproduction, Egg donation, Prenatal screening and sex selection, Cloning, Ethical issues on life and death, Voluntary euthanasia and physician assisted suicide, Organ donation and transplantation, Genetically engineered organisms and Genetically modified foods, Human genome project, Gene therapy, Stem cell research.

UNIT IV **9**

ENTREPRENEURSHIP IN BIOTECHNOLOGY

Why Biotech?, Biotechnology innovations benefits society, Pharma and Biotech Industry, Entrepreneurship in Biotechnology, What is Bioentrepreneurship?, Profiling the bioentrepreneur, Intellectual capital in Biotech firms, Global healthcare markets in Biotechnology.

UNIT V **9**

BIOTECH DEMAND AND INVESTMENT

Introduction to Biotech investing : Value investing, Growth investing, The industry life cycle, Biotechnology investment trading rules, Bioindustry – Global and Indian Scenario, Policy Environment of Biotech industries in India. Government funding for Biotechnology, Venture capital financing of Biotechnology, Perceptional analysis of biotech companies (A case study).

Total : 45 Hours

TEXT BOOKS

1. Beler, F. K., Crespi, R. S. and Straus, T. Biotechnology and Patent Protection. *Oxford and IBH Publishing Co.,* New Delhi.
2. Singh, K. Intellectual Property Rights on Biotechnology. *BCIL*, New Delhi.
3. Smith, J. E., 2004. Biotechnology. 3rd Edition. *Cambridge University Press*.
4. Mark Tang, C., 2007. The Essential Biotech Investment Guide. *World Scientific*.
5. Damina, H. and John, K., 2006. Innovations and Entrepreneurship in Biotechnology. *Edward Elgar Publications.*

REFERENCES

1. Edmund G. Seebauer and Robert L. Barry, 2001. Fundamentals of Ethics for Scientists and Engineers. *Oxford University Press,* Oxford.
2. Holger Patzelt and Thomas Brenner, 2007. Hand Book of Bioentrepreneurship. *Springer.*
3. Satyanarayana Chary and Mishra, R. K, 2008. Venture Capital Financing for Biotechnology. *Concept Publishing Company*.
4. Alain Vert's, Nasib Qureshi, Hideaki Yukawa and Hans Blascheck, 2007. Biomass to Biofuels: Strategies for Global Industries. *Wiley & Sons*.
6. Bioentrepreneurship: Building a Biotechnology Company from the Ground Up.1998. *Nature Biotechnology,* Volume 16.

ELECTIVE 1	BIOINSTRUMENTATION	L	T	P	C
		4	0	0	4

AIM

To familiarize the students with various instruments that are applied in the field of Biotechnology.

OBJECTIVES

To study in detail about the

- Introduction of Spectroscopy
- Optical instruments.
- Molecular spectroscopy.
- Thermal and X - ray methods.

UNIT I **9**

INTRODUCTION

Electromagnetic Radiation and equation of wave, Different types of Molecular Energies, Quantization of Energy and its calculation , Definition and Importance of Spectroscopy, Region of different spectra, Absorption and emission spectra, Instruments – Signal to noise ratio, Spectral Width , Signal Intensity, UV-Visible – Theory of Electronic Spectra (Atomic and Band Spectra, L-B Law, Application and Exception), Chromophore, Auxochrome, Woodward's rule, Solvent Effect (Bathochromic shift, etc.,)

UNIT II **9**

COMPONENTS OF OPTICAL INSTRUMENTS

Classification and Calibration of Instrumental Methods. General designs of optical instruments, Sources of Radiation, Wavelength Selectors, Sample Containers, Radiation

Transducers, Signal Processors and Readouts, Fiber Optics, Types of Optical Instruments, Principles of Fourier Transform Optical Measurements.

UNIT III **9**

MOLECULAR SPECTROSCOPY

Introduction to Spectroscopy, Types of Spectrophotometers – UV-Visible, IR, Raman Spectroscopy, NMR Spectroscopy, Atomic Absorption Spectroscopy, X-Ray Photoelectron Spectroscopy, Ultraviolet Photoelectron Spectroscopy, Electron Impact Spectroscopy, Auger Electron Spectroscopy, Flame Photometry, Nephelometry and Turbidimetry.

UNIT IV **9**

THERMAL METHODS

Thermogravimetric Analysis – Types of Thermogravimetry, Instrumentation, Thermogravimetric Curves, Applications, Differential Thermal Analysis – Instrumentation, General Principles and Applications, Differential Scanning Calorimetry (DSC) – Power Compensated DSC, Heat Flux DSC, Modulated DSC, DSC experiment and calibration, DSC data Analysis.

UNIT V **9**

X-RAY METHODS

General Theory – Origin of X-Ray, Interaction of X-Ray with matter, Scattering and Diffraction, Fluorescence, Instrumentation, X-Ray Absorption methods, X-Ray Diffraction methods, X-Ray Fluorescence methods.

Total : 45 Hours

TEXT BOOKS

1. Gurdeep R. Chatwal and Sham K. Anand, 2006. Instrumental Methods of Analysis. *Himalaya Publishing House.*
2. Skoog, D., 2000. Instrumental Methods of Analysis, Brooks/Cole Publishing Company.
3. Willard and Merrit, H., 1999. Instrumental Methods of Analysis. *C. B. S. Publishers*.

REFERENCES

1. Campbell, I. D. and Dwek, R. A., 1986. Biological Spectroscopy, *Benjamin Cummins and Company*.
2. Atkins, P. W., 1990. Physical Chemistry. 4th Edition, *Oxford University Press.*
3. Ewing, G. W., 1989. Instrumental Methods of Chemical Analysis. *McGraw Hill Book Company*.
4. Braun, H., 1987. Introduction to Chemical Analysis. *McGraw Hill Book Company*.

ELECTIVE 1	PROTEIN ENGINEERING	L	T	P	C
		4	0	0	4

AIM

This course imparts advance knowledge on proteins through a detailed study of protein structure, characteristic property and significance in biological systems.

OBJECTIVES

- To focus on the primary, secondary, tertiary and quaternary structure and their determination.
- Structure and functions of protein of particular importance.
- Protein design principles and database analysis.

UNIT I **9**

PROTEIN ARCHITECTURE

Primary structure : Peptide mapping, Peptide sequencing – Automated Edman method and mass spectroscopy. MALDI – TOF, High - throughput protein sequencing setup, Secondary structure : Alpha, Beta, Loop structures and methods to determine.

Super-secondary structure : Alpha-turn-alpha, Beta-turn-beta (hairpin), Beta-sheets, Alpha-beta-alpha, Topology diagrams, Up and down and TIM barrel structures nucleotide binding folds, Prediction of substrate binding sites.

UNIT II **9**

PROTEIN FOLDING AND STRUCTURE DETERMINATION

Tertiary structure : Domains, Folding, Denaturation and renaturation. Quaternary structure : Modular nature, Formation of complexes, Protein folding pathways, Stability of folded conformation of proteins, Methods to determine tertiary and quaternary structure – X - ray diffraction, NMR and IR applications.

UNIT III **9**

PROTEIN LIGAND BINDING EQUILIBRIA

Equilibrium dissociation constant, Kinetic approach to equilibrium, Binding measurements at equilibrium, Derivation of Langmuir isotherm, Multiple binding sites, Graphic analysis of equilibrium ligand binding data, Equilibrium binding with ligand depletion (Tight binding interactions), Competition among ligands for common binding site.

UNIT IV **9**

MEMBRANE PROTEINS AND RECEPTORS

Membrane proteins and receptors, Bacteriorhodopsin, Photosynthetic centers, Fibrous proteins, Collagen, Spider silk, Actin and myosin – Serine proteases, Ribonuclease and lysozyme, Epidermal growth factor, Insulin and PDGF receptors and their interaction with effectors, Protein phosphorylation, Immunoglobulins, Nucleotide and binding proteins.

UNIT V **9**

ENGINEERING AND DESIGN OF PROTEIN STRUCTURES

Protein engineering to increase protein stability, Disulfide bridges, Positive effects of glycine and proline, Stabilizing the dipoles of α helices – Combinatorial methods, Phage display, Optimization of proteinase inhibitors by affinity and specificity, Structural scaffolds, Random peptide libraries (EPO receptor), DNA shuffling, β-structure convertion to α structure.

Total : 45 Hours

TEXT BOOKS

1. Doanald Voet and Judith G. Voet, 2001. Biochemistry. *John Wiley and Sons*, 3rd Edition.
2. Branden, C. and Tooze, J., 1999. Introduction to Protein structure. *Garland Publishing*, NY, *USA*, 2nd Edition
3. Thomas E. Creighton, 1993. Proteins. Structure and Molecular Properties. *W. H. Freeman*, 2nd Edition.

REFERENCES

1. Moody P. C. E. and Wilkinson A. J., 1990. Protein Engineering. *I. R. L Press*, Oxford, UK.
2. Thomas M. Devlin., 2010, Text Book of Biochemistry with Clinical Correlations. *John Wiley and Sons, Inc,*. 7th Edition.
3. Copeland, R. A., 2000. Enzymes – A Practical Introduction to Structure, Mechanism and Data analysis. *V. C. H Publication*, 2nd Edition.
4. Branden, C. and Tooze, J., 1999. Introduction to Protein Structure. *Garland Publishing*, 2nd Edition

5. Alberghina, L., 2000. Protein Engineering in Industrial Biotechnology. *Harwood Academic Publishers*.

ELECTIVE I	ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS	L	T	P	C
		4	0	0	4

AIM

To understand the fundamental concepts in enzymology and to study the kinetics and applications of enzymes in an explicit manner.

OBJECTIVES

To impart knowledge on

- Enzyme nomenclature and purification
- Mechanism of enzyme action and kinetics
- Enzyme immobilization and mass transfer effects
- Design of enzyme reactors
- Application of enzymes in various fields
- enzymatic biotransformation of drugs

UNIT I **9**

INTRODUCTION

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes , Enzymes of biological importance - Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5 -nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes.

UNIT II **9**

KINETICS OF ENZYME ACTION

Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity Studies, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions.

UNIT III **9**

IMMOBILIZED ENZYMES

Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization

UNIT IV ENZYMES IN FUNCTIONAL GROUP TRANSFORMATION 9

Functional group interconversion using enzymes (hydrolysis reaction, oxidation/reduction reactions, C-C bond formations), Retrosynthetic biocatalysis, Chemoenzymatic synthesis of natural products. Industrial process using enzymes for production of drugs, fine chemicals and chiral intermediates.

UNIT V ENZYMATIC TRANSFORMATION **9**

Reaction engineering for enzyme-catalyzed biotransformations.Catalytic antibodies.Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes). The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids), Host Guest Complexation chemistry, enzyme design using steroid templates, enzymes for production of drugs, fine chemicals and chiral intermediates.

TOTAL : 45 Hours

TEXT BOOKS:

1. Blanch, H.W., Clark, D.S. “Biochemical Engineering.” Marcel Dekker, 1997.
2. Lee, James M. “Biochemical Engineering.” PHI, 1982.
3. Bailey J.E. & Ollis, D.F. “Biochemical Engineering Fundamentals.” 2nd Edition. McGraw Hill, 1986.

REFERENCES:

1. Faber, Kurt “Biotransformations in Organic Chemistry : A Textbook.” 5th Edition. Springer, 2008.
2. Palmer, Trevor. “Enzymes : Biochemistry, Biotechnology, Clinical Chemistry.” 2nd Edition, East West Press, 2008.

ELECTIVE I	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	C
		4	0	0	4

AIM

To make the students understand about the various concepts involved in the development of drugs and its manufacture in Biopharmaceuticals.

OBJECTIVES

To impart knowledge on

- Sources of Biopharmaceuticals
- Drug action, metabolism and development process
- Preparation, Preservation and Quality testing of drugs.
- Growth Factors and hormones as Biopharmaceuticals
- Vaccines, adjuvants as Biopharmaceuticals

UNIT I **9**

PHARMACEUTICALS OF BIOLOGICAL ORIGIN

Current status and future prospects of biopharmaceuticals – Pharmaceuticals of animal origin, plant origin and microbial origin – Sources of biopharmaceuticals.

UNIT II **9**

DRUG DEVELOPMENT PROCESS

Drug – Definition, Mechanism of drug action, Principles of drug metabolism, Drug discovery – Gene chips, Proteomics, Structural Genomics, Pharmacogenetics – Plant as a source of drugs, microbial drugs – Pre-clinical trial – Pharmacokinetics and pharmacodynamics –

Toxicity studies – Clinical trial, clinical trial design, trial size and study population – Randomized control studies.

UNIT III **9**

PRINCIPLES OF DRUG MANUFACTURE

Compressed tablets, Dry and wet granulation, Slugging or direct compression, Tablet presses, Coating of tablets, Capsule preparation, Oral liquids – Vegetable drugs – Topical applications, Preservation of Drugs, Analytical methods and other tests used in drug manufacture, Packing techniques, Quality management, Good Manufacturing Practice (GMP).

UNIT IV **9**

GROWTH FACTORS AND HORMONES

Haemopoietic growth factors – Granulocyte and macrophage colony stimulating factor – Insulin like growth factors – Epidermal growth factor – Platelet growth factor – Neurotrophic factors – Hormones of therapeutic interest – Insulin, glucagon – Human growth hormones – Gonadotrophins, Disease transmission – Whole blood, platelets and red blood cells – Blood substitutes – Haemostasis – Antithrombin – Thrombolytic agents.

UNIT V **9**

ANTIBODIES, VACCINES, ADJUVANTS AND ANTI-SENSE TECHNOLOGY

Enzymes of therapeutic value Polyclonal antibody – Monoclonal antibodies – Tumour immunology – Vaccine technology, Adjuvant technology – Anti-sense oligonucleotides, uses, advantages and disadvantages of 'oligos', vitravene, an approved anitsense agent – Antigene sequences and ribozymes.

Total : 45 Hours

TEXT BOOKS

1. Gareth Thomas, 2000. Medicinal Chemistry. An introduction. *John Wiley*
2. Katzung, B.G., 1995. Basic and Clinical Pharmacology. *Prentice Hall of International Publication.*

REFERENCES

1. Dutton R. and Scharer J., "Advanced Technologies in Biopharmaceutical processing", Blackwell Publishing, 2007.
2. Gary W., "Biopharmaceuticals: Biochemistry and Biotechnology", Second Edition, John Wiley, 2003.
3. Leon Lachman, 1986. Theory and Practice of Industrial Pharmacy. 3rd Edition., *Lea and Febger*. Remington, 1991. Pharmaceutical Science. *Mark Publishing and Co*.
4. http://ocw.kyoto-u.ac.jp/en/pharmaceutical/course01/lecturenote.htm

ELECTIVE II	NANO SCIENCE AND ITS APPLICATIONS	L	T	P	C
		4	0	0	4

AIM

To introduce the concepts of Nanotechnology and to understand its applications in biotechnology.

OBJECTIVES

To study about

- The basic concepts of Nanotechnology.
- Fabrication and characterisation of nanomaterials.
- Nanoparticles in Biosystems.
- Role of microbes in nanotechnology.
- Applications of Nanobiotechnology.

UNIT I **9**

INTRODUCTION TO CONCEPTS OF NANOTECHNOLOGY

Principle of size, Types of approaches-nano architecture, Molecular manipulations – Bond width Sp hybridization, allotropy, mean path, tensile strength. Overivew of micro and nano systems, synthesis properties and characterization of nano materials. Four generation of nano science, Fabrication, Application of nano particles (long and short term).

UNIT II **9**

FABRICATION AND CHARACTERISATION

Fabrication, ottom-up Vs. Top-down, Epitaxial growth, Self assembly, Characterisation – X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Scanning Electron

Microscopy (SEM), Scanning Tunnelling Microscopy (STM), Atomic Force Microscopy (AFM). Properties and Measurement of Nanomaterials.

UNIT III **9**

NANOMOLECULES IN BIOSYSTEMS

DNA, RNA, Proteins and Lipids – Nanoscale elements for delivery of materials into cells, Peptide coupled nanoparticles, DNA based artificial nanostructures, DNA - based metallic nanowires and networks, DNA - Gold nanoparticle conjugates, Nanoparticles as non - viral transfection agents, Proteins as components in nanodevices, Nanotechnology in cell - cell motility : Nanomotors and cellular navigation, Chemotaxis, Transmembrane signalling and related proteins.

UNIT IV **9**

MICRO ORGANISMS AND NANOBIOTECHNOLOGY

Nanobiotechnology and micro organisms, Polyhydroxyalkanoates (PHA), Cyanophycin inclusions, Magnetosomes, Alginates, Bacteriophages, Bacterial spores, Bacterial protein complexes, s - layer proteins, Bacteriorhodopsin, Nanoscale magnetic iron minerals in bacteria, Nanoparticle - Biomaterial hybrid system.

UNIT V **9**

APPLICATIONS OF NANOBIOTECHNOLOGY AND NANOANALYTICS

Nanomedicine, Nanobiosensor – Electrochemical DNA sensors, Nanobiochips, Nanocrystals in Biological Detection, Fabrication of novel biomaterials through molecular self-assembly, Small scale systems for *in vivo* drug delivery, Nanotechnology for diagnosis and treatment, Common techniques available for the measurement of nanoparticles – Biochemical computers, Biomechanical computers, Organic and Bioelectronic computers.

Total : 45 Hours

TEXT BOOKS

1. Ajayan, P. A. and Schadler, L.2003, Nanocomposite Science and Technology. *V. C. H. Publication.*
2. Nlemeyer, C. M. and Mirkin, C. A. 2004, Nanobiotechnology – Concepts, Applications and Perspectives. *V. C. H. Publication.*
4. Geoff Ozin and Arsenault, A., 2005. Nanochemistry : A Chemical Approach to Nanomaterials. *Royal Society of Chemistry* 1st Edition.
5. Charles P. Poole and Junior Frank J. Owens, 2003. Introduction to Nanotechnology. *John Wiley and Sons.*
6. Jain, K. K., 2006. Nanobiotechnology Molecular Diagnostics : Current Techniques and Applications. Horizon Bioscience, *Taylor and Francis*.
7. Bernard, H. and Relim, A. Microbial Bionanotechnology.

REFERENCES

1. Rosenthal, S. J. and Wright, D. W. Nanobiotechnology Protocols in methods in Molecular Biology Series. *Humana Press*.
2. Michael Crichton. Undestanding Nanotechnology. *Scientific American Publisher*.
3. Ralph S. Greco, Fritz B. Prinz and Lane Smithm, R., 2005. Nanoscale Technology in Biological Systems. *C. R. C Press*.
4. Nalwa, H. S. Cancer Nanotechnology. *American Scientific Publishers*.
5. Salata, O. V., 2004. Applications of Nanoparticles in Biology and Medicine. *J. Nanobiotechnol.,* **2 :** 3.
6. Niemeyer C. M. and Mirkin, C. A., 2004. Nanobiotechnology: Concepts, Applications and Perspectives. *Wiley – VCH Verlag GmbH and Co. KGaA.*
7. Freitas, Jr. R. A., 2004. Nanomedicine. Landes Biosciences, 1st Edition, Volume II A.
8. http://www.chem.latech.edu/~ramu/msnt505/lec_notes/Ji/MSNT505_Ji_notes.html.

ELECTIVE II	METABOLIC ENGINEERING	L	T	P	C
		4	0	0	4

AIM

The paper is meant for an in depth study of the nuances of Metabolic engineering.

OBJECTIVES

A comprehensive programme for the students to

- Learn the engineering aspects of metabolism.
- Understand the underlying concepts of Cellular reactions.
- Study the applications of metabolic flux analysis.
- Get to know details of metabolic control.
- Know about the analysis ofmetabolic networks.

UNIT I

REVIEW OF CELLULAR METABOLISM 9

An overview of cellular metabolism, Transport processes, Fuelling reactions : Glycolysis, Fermentative pathways, Biosynthetic reactions, Polymerization, Cellular energetics.

UNIT II

MATERIAL BALANCES AND DATA CONSISTENCY 9

Comprehensive models of cellular reactions, Stoichiometry of cellular reactions, Reaction rates, Dynamic mass balances, Yield co-efficients and linear rate equations, Analysis of over determined systems – Identification of gross measurement errors.

UNIT III

METABOLIC FLUX ANALYSIS 9

Theory, Over-determined systems, Under-determined systems – Linear programming, Sensitivity analysis, Methods for the experimental determination of metabolic fluxes by isotope labelling, Applications of metabolic flux analysis.

UNIT IV

METABOLIC CONTROL ANALYSIS 9

Fundamentals of metabolic control analysis, Control co-efficients and the summation theorems, Determination of flux control co-efficients, MCA of linear pathways, Branched pathways, Theory of large deviations.

UNIT V

ANALYSIS OF METABOLIC NETWORKS 9

Control of flux distribution at a single branch point, Grouping of reactions, Case studies, Extension of control analysis to intermetabolite, Optimization of flux amplifications, Consistency tests and experimental validation.

Total : 45 Hours

TEXTBOOKS

1. Stephanopoulas, G., *et al*., 1996. Introduction to Metabolic Engineering – Principles and Methodologies. *Elsevier Science.*
2. Lee, S. Y. and Papoutsakis, E. T., 1998. Metabolic Engineering. *Marcel Dekker*.
3. Nielsen, J. and Villadsen, J., 2007. Bioreaction Engineering Principles. 2. ed., Kluywer Plenum, New York.

REFERENCES

1. Voit, E. O., 2000. Computational Analysis of Biochemical Systems : A Practical Guide for Biochemists and Molecular Biologist. *Cambridge University Press*.
2. Scheter, T., 2001. Metabolic Engineering. (Advances in Biochemical Engineering, Biotechnology). *Springer*. Vol. 73.
3. Rhodes, P. M. and Stanbury, P. F., 1997. Applied Microbial Physiology Practical Approach. *IRL Press.*
4. Caldwell, D. R., 1995. Microbial Physiology and Metabolism. *Wm.C.Brown.*
5. Rehm, H. J. and Reed, G., 1997. Biotechnology : Products of Primary Metabolism (Vol. 6), Biotechnology : Products of Secondary Metabolism (Vol. 7)., VCH / Wiley.

ELECTIVE II	BIOREACTOR ENGINEERING	L	T	P	C
		4	0	0	4

AIM

This course introduces basic principles involved in Bioreactor engineering and makes the students learn the fundamentals needed for a Bioreactor design.

OBJECTIVE

This course aims to elaborate on concepts like

- Transport process in Bioreactor.
- Monitoring of Bioprocesses.
- Design and analysis of Biological reactors.
- Fermentation technology.
- Scale up of reactors.

UNIT I **9**

TRANSPORT PROCESS IN BIOREACTOR

Gas-liquid mass transfer in cellular systems, Determination of oxygen transfer rates, Mass transfer for freely rising or falling bodies, Forced convection mass transfer, Overall K_La estimation and power requirements for sparged and agitated vessels, Mass transfer across free surfaces, Other factors affecting K_La, Non-Newtonian fluids, Heat transfer correlations, Thermal death kinetics of microorganisms, Batch and continuous heat, Sterilization of liquid media, Filter sterilisation of liquid media, Air, Design of sterilisation equipment batch and continuous.

UNIT II **9**

MONITORING OF BIOPROCESSES

On-line data analysis for measurement of important physico-chemical and biochemical parameters, Methods of on-line and off-line biomass estimation, Microbial calorimetry, Flow injection analysis for measurement of substrates, Product and other metabolites, State and parameter estimation techniques for biochemical processes.

UNIT III **9**

DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS

Ideal bioreactors – Batch, Fed batch, Continuous, Cell recycle, Plug flow reactor, Two stage reactors, Enzyme catalyzed reactions, Reactor dynamics and stability, Reactors with non-ideal mixing, Other types of reactors – Fluidized bed reactors, Packed bed reactors, Bubble column reactors, Trickle bed reactors.

UNIT IV **9**

FERMENTATION TECHNOLOGY

Case studies on production of Lactic acid, Glutamic acid, Pencillin, Microbial lipase and Protease, Recombinant insulin. Case studies should deal with strain improvement, Medium designs, Process optimization etc.

UNIT V **9**

SCALE-UP OF REACTORS

Scale-up by geometry similitude, Oxygen transfer, Power correlations, Mixing time.

Total : 45 Hours

TEXT BOOKS

1. Bailey, J. E. and Ollis, D. F., 1986. Biochemical Engineering Fundamentals, *McGraw Hill*. 2nd Edn.
2. Shuler, M. L. and Kargi, F., 2002. Bioprocess Engineering : Basic Concepts. *Prentice-Hall*, 2nd Edn.
3. Doran Pauline M., 1995. Bioprocess Engineering Principles. *Academic Press*.

REFERENCES

1. Moser and Anton, 1988. Bioprocess Technology : Kinetics and Reactors, *Springer Verlag*.
2. Lee and James, M. Biochemical Engineering, *PHI, USA*.
3. Atkinson, 1999. Handbook of Bioreactors.
4. Blanch, H. W. and Clark, D. S. Biochemical Engineering, *Marcel Decker*.
5. Stanbury, P. F., Stephen J. Hall and Whitaker, A.. Principles of Fermentation Technology, *Science & Technology Books*.

ELECTIVE II	MARINE AND AQUACULTURE BIOTECHNOLOGY	L	T	P	C
		4		0	0 4

AIM

To study about in detail the marine organisms and the application of biotechnology on the marine environment.

OBJECTIVES

To learn and study about the details of

- Marine organisms in the ocean.
- Biotechnology of aquatic animals.
- Biomedical importance of marine organisms.
- Biomaterials produced by the marine organisms.
- The impact of biotechnology for improving the marine environment.

UNIT I **9**

INTRODUCTION TO MARINE MICROBES IN THE OCEAN

Marine Microbial Diversity – Criterion Habitats – Presences of other organisms : Symbiotic, Free Living , Biofilm, Proximity to the ocean surface or sediments – Euphotic, Mesopelagic, Bathopelagic, Benthos (Sediments) – Concentration of Nutrients and required growth substrates : Oligotrophic, Abundance and distribution of Bacterial and Viral Pathogens - Metabolic Capabilities of Marine Microbes : Adapting to Extreme Environments – Algal Blooms – Marine Bacteria. Major Fisheries in India, Fisheries Mangaement and Fisheries related Marketing Strategies.

UNIT II **9**

BIOTECHNOLOGY OF AQUATIC ANIMALS

Shell Fish and Crustacean Culture : Aqua Culture – Shrimps, Corals, Pearl Oyster, Sea weeds, Edible Mussels, Crabs, Fish Breeding and Mass Production, Induced Breeding, Artificial insemination, Transgenic Breeding, Fish Farming and Culture, Developments of Healthy Fish Diets, Disease Prevention in Fish and GM Fish and Shell Fish. Aquaculture of Marine Invertebrates such as Bryozoans, Sponges and Tunicates. Isolation , Cultivation and Fermentation of Microorganisms from their Invertebrate hosts.

Disease Associated with Cultured Shrimps and Fishes : Disease Management – Vaccines, Antibiotics, Immunostimulants, Immunomodulants, Diagnostic Kits, Probiotics.

UNIT III **9**

BIOMEDICAL IMPORTANCE OF MARINE ORGANISMS

Marine Pharmocology : Pharmaceutical and Bioactive Natural Products – Microalgae as a source of Bioactive Molecules – New Antibiotics, Antiviral and Anticancer Drugs, Anti Fungal drugs, Medicines and Marine Organisms – Potentialities in the treatment of Infectious Diseases, Osteoporosis and Alzheimer's Disease.

Cynaobacterial Biotechnology – Secondary Metabolites and Biosynthetic Gene clusters of Marine Cyanobacteria – Applications in Biotechnology – Secondary Metabolites from Marine derived Fungi.

UNIT IV **9**

BIOMATERIALS AND BIOPROCESSING

Polymers and Biomaterials : Agarose, Agar, Alginates, Carrageaas, chitin, Chitosan, Carotene, Heparin, Marine Flavourants – Environemtnatlly Friendly Antifouling Compuounds.

Biopotential Uses of HalophilicOrganisms, Role of Halophilic Bacteria and Artemia in salt purification.

Tetrodotoxins, Conotoxins, extremozymes from Microbes, Nucleases form Marine Microbes, Exoenzymes from Benthic Flora.

UNIT V **9**

ENVIRONMENTAL AND BIOTECHNOLOGY

Oil spillage and Oil degradation in coastal waters, Genetically Engineered Marine Organisms, algal blooms and phosphate removal, biodegradation of pesticides and heavy metals discharged coastal waters, management of solid wastes disposed into coastal waters, water quality management in Hatcheries and grow out ponds - Biofilters in recycling of water, use of microcosm.

Total : 45 Hours

TEXT BOOKS

1. Attaway, D. H. and Zaborsky, O. R., 1993. Marine Biotechnology : Pharmaceuticals and Bioactive Natural Products. Plenum, New York, Volume 1.
2. Weber, P., 1993. Abandoned Seas : Reversing the Decline. *World Watch.*
3. Powers, D. A., 1995. New Frontiers in Marine Biotechnology : Opportunities for the Twenty First Century. In : Marine Biotechnology in the Asian Pacific Region. C. G. Lundin and R. A. Zilinskas. (Eds.). *The World Bank and SIDA,* Stockholm.

REFERENCES

1. Rhodina, A. G., 1996. Aquatic Biotechnology.
2. S.Felix., 2010 .Marine and Aquaculture Biotechnology, Agrobios.

ELECTIVE III	PLANT AND ANIMAL TISSUE CULTURE	L	T	P	C
		3	0	0	3

AIM

This course makes the students knowledgeable in the organization of a plant cell culture laboratory and prepare themselves to exploit the vast plant biodiversity for economically important products.

OBJECTIVES

To expose and make the students understand the concepts of

- Basic concepts in plant Cell propagation and sterile techniques
- Micro propagation
- Cell culture
- Haploid and embryo culture
- Transgenic plants

UNIT I **9**

Laboratory organization, Sterile techniques, Nutrition medium, Explant culture, Callus culture, Cell and organ differentiation, Cell culture, Suspension cultures - Batch and continuous cultures, Growth measurements, Photobioreactors.

UNIT II **9**

Organogenesis, Somatic embryogenesis Micro propagation, Protoplast - isolation culture, regeneration, somatic hybridization, cybrid technology, Embryo culture and embryo rescue, artificial seeds overcoming crossing barriers, Somaclonal variation, *in vitro* selection of mutants, Production of haploids – Anther and Pollen culture, Triploid Production: *In vitro* Pollination and Fertilization, Germplasm storage and cryopreservation.

UNIT III **9**

Origin and characterization of different cell types - differentiation - organ culture - Subculture - cell clines - Selection of medium - chemically defined and serum free media - Role of serum in cell culture - Strategies of medium optimization - commercially available medium for mammalian cell culture - different methods - long term cultivation of human adult tissue, Insect cell culture.

UNIT IV **9**

Cell quantification - practical consideration - growth kinetics - medium and nutrients - Types of culture system monolayer culture - Roller bottle - modification - fermenter system - Suspension culture - adaptation - static suspension culture - Scaling up factors - stirred fermenters - Air lift fermenters - Encapsulated cells, Preservation and characterization of cell lines, cytotoxicity and viability assays.

UNIT V **9**

TISSUE ENGINEERING

Developmental biology, Tissue engineering : Basic principles and consideration – Cell type and source, metabolic requirements of cells, reconstruction of connective tissues, reconstruction of epithelial or endothelial surfaces – Cell embedded in extracellular matrix material, Culture on a single surface and sandwich configuration, Scaffolds and tissue engineering – Basic properties, Bioreactor design on tissue engineering – Hollow fibre systems, Microcarrier based systems, Tissue engineering of the liver.

Total : 45 Hours

TEXT BOOKS

1. Walton, P. D., 1988. Principles and Practices. Plant cell culture. *Prentice Hall*.
2. Bhowjwani, S. S., 1990. Plant Tissue Culture : Applications and Limitations.
3. Gupta, P. K. 1998. Elements of Biotechnology. Rastogi Publications.
4. Chawla, H. S., 2002. Introduction to plant Biotechnology. *Oxford and IBH Publishing Co. Pvt. Ltd*., New Delhi.

REFERENCES

1. John R. W. Master, 2004. Animal Cell Culture – A Practical approach. Oxford University Press.
2. Bernhard Palsson, Jeffery A. Hubble, Robert P. Lonsey and Joseph D. Bronzino, 2005. Tissue Engineering, Principles and Applications in Engineering. CRC Press.

ELECTIVE III	FOOD SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

AIM

To get knowledge in the field of Food process technology and its application.

OBJECTIVES

To understand the role of

- Biomolecules in food.
- Food additives in food processing.
- Microorganism in food fermentation.
- Microorganism in food spoilage.
- Microorganism in food preservation.

UNIT I **9**

FOOD CHEMISTRY

Constituents of food – Carbohydrates, Lipids, Proteins, Water, Vitamins and Minerals, Texture, Flavour and Organoleptic properties of food, Dietary sources, Role and functional properties in food, Biotechnology in relation to the food industry.

UNIT II

FOOD MICROBIOLOGY **9**

Sources and activity of microorganisms associated with food, Bacteria, Yeast and Molds – Sources, Types and Species of importance in food processing and preservation, Fermented foods – Dairy products, Meat, Fishery, Non-beverage plant products, Beverages and related products, Single cell protein, Food fermentation, Food chemicals, Food borne diseases – Infections and intoxications, Food spoilage – Causes. .

UNIT III

FOOD PROCESSING AND FOOD ADDITIVES 9

Raw material characteristics, Cleaning, Sorting and grading of foods, Physical conversion operations – Mixing, Emulsification, Extraction, Filtration, Centrifugation, Membrane separation, Crystallization, Heat processing, Classification, Intentional and non-intentional additives, Functional role in food processing – Meat, Fisheries, Vegetables, Food colourants – Natural and artificial, Food flavours, Enzymes as food processing aids.

UNIT IV

FOOD PRESERVATION AND FOOD BORNE DISEASES 9

Principles involved in the use of high temperatures – Sterilization, Pasteurization, Blanching, Thermal death curves of microorganisms, Canning, Frozen storage – Freezing characteristics of foods, Microbial activity at low temperature, Factors affecting quality of frozen foods, Irradiation preservation of foods, Classification, Food infections – Bacterial and other types, Food intoxications and poisonings.

UNIT V 9

APPLICATIONS OF FOOD BIOTECHNOLOGY

Fermented food – Batter and baked goods, Diary products – Milk processing, Cheese, butter, Yoghurt, Ice-cream, Vegetable and fruit products, Edible oils and fats, Meat, Poultry and fish products, Confectionery and beverages.

Total : 45 Hours

TEXT BOOKS

1. Coultate, T.P., 1992. Food – The Chemistry of Its components. 2nd Edition., Royal Society, London.
2. Sivasankar, B., 2002. Food Processing and Preservation, *Prentice Hall of India Pvt. Ltd*., New Delhi.

REFERENCES

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edition., *McGraw Hill Book Co.*, New York.
2. Jay, J.M., 1987. Modern Food Microbiology, *CBS Publications*, New Delhi.
3. Lindsay, 1988. Applied Science Biotechnology. Challenges for the flavour and Food Industry. *Willis Elsevier.*
4. Roger, A., Gordon, B. and John, T., 1989. Food Biotechnology.
5. George, J.B., 1987. Basic Food Microbiology. *CBS Publishers and Distributors.*
6. James, M.J., 1987. Modern Food Microbiology. *CBS Publishers and Distributors.*
7. Fennema, O. R., 1976. Principles of Food Science : Part I, Food Chemistry. *Marcel Dekker*, New York.

8. Brenner, J. G., Butters, J. R., Cowell, N. D. and Lilly, A. E. V., 1979. Food Engineering Operations. *Applied Sciences Pub. Ltd.*, London. 2nd Edition.
9. Pyke, M., 1981. Food Science and Technology. *John Murray*, London. 4th Edition.

ELECTIVE III	MEDICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

AIM

The course offers the fundamental concepts in disease transmission, basic principles of molecular methods used in diagnosis, treatment and preventive measures.

OBJECTIVES

Students who successfully completed this course will be able to

- Identify the mode of infection and transmissions of disease causing organisms.
- Relate the microorganisms and their specific disease in detail.
- Explain the genetic nature of human diseases.
- Comprehend the recent molecular analysis and how these methods are used in current diagnostics of infectious diseases.
- Understand the treatment and preventive measures in the medical field.

UNIT I **9**

MODE OF INFECTION AND TRANSMISSION

History of infection, Mode of transmission, Pre-disposing factors of microbial pathogenecity, Normal microbial flora of the human body, Types of infectious diseases, Host - Parasite relationships, Clinical specimens – Collection, Transport and Processing of samples, Interpretation of results.

UNIT II **9**

MICROBIAL, FUNGAL AND VIRAL INFECTIONS AND DISEASES

Bacteria : Representative diseases to be studied in detail are – Tetanus, Diphtheria, Cholera, Typhoid, Tuberculosis, Leprosy, Plague, and Syphilis, Infections caused by Anaerobic bacteria, Spirochetes, Chlamydia and Rickettsiae.

Viruses : Diseases to be studied in detail are – Viral hepatitis, Influenza, Rabies, Polio and AIDS and Viral cancers.

Fungi : Diseases to be taken up in the following categories : Superficial, Subcutaneous, Systemic and Opportunistic mycoses.

Protozoa : Diseases to be discussed are – Amoebiasis, Toxoplasmosis, Trichomoniasis and leishmaniasis.

UNIT III

INHERITED HUMAN DISEASES **9**

Inherited human diseases – Single gene diseases, Complex traits, Cancer genetics, Immunogenetics, Pre-natal diagnosis – Chorionic villus sampling, Amniocentesis pre-implantation diagnosis, Identification and isolation of disease genes – Positional cloning, Functional cloning, Genetic counselling, Concept of gene therapy

UNIT IV **9**

MORDERN DIAGNOSTIC METHODS

Modern approaches for diagnosis of infectious diseases, Automated DNA sequencing, Microarrays, Isolation and purification of nucleic acids, Nucleic acid labelling, Hybridization, Basic concepts of gene probes, Dot hybridization and PCR assays, Different levels of Biosafety containments for rDNA experiments.

UNIT V **9**

TREATMENT AND PREVENTIVE MEASURES

Viral vaccines : Conventional – Killed / Attenuated, DNA, Peptide, Recombinant proteins, Bacterial and viral vectors, Biological warfare agents, Mode of action of antibiotics and antiviral : Molecular Mechanism of Drug Resistance (MDR), Anti-viral chemotherapy, Anti-fungal chemotherapy.

Total Hours : 45

TEXT BOOKS

1. Lele Buckingham and Maribeth L. Flaws, 2007. Molecular Diagnostics : Fundamentals, Methods & Clinical Applications.
2. David E. Bruns, Edward R. Ashwood and Carl A. Burtis, 2007. Fundamentals of Molecular Diagnostics.
3. Griffiths, A. J. F., Miller, J. H. and Suzuki, D. T., 2000. An Introduction to Genetic Analysis.

REFERENCES

1. Turner, P. C., McLennan, A. G., Bates, A. D. and White, M. R. H., 2003. Instant Notes in Molecular Biology. *Viva Books Private Limited*.
2. Brown, T. A. Gentics – A Molecular Approach.
3. Lodish, Berk, Zipursky, Matsudaira, Baltimore Darnell, 2000. Molecular Cell Biology. *W.H. Freeman and Company*. 4th Edition.
4. James Watson *et al.,* 1987. Molecular Biology of Gene. *The Benjamin / Cummings Publication Co. Inc.*, California.
5. Benjamin, L., 2008. Genes IX. *Jones and Bartlett*.
6. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, 2002. Biochemistry. *W.H. Freeman and Company.* 5th Edition.

ELECTIVE III	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

AIM

This paper provides details of important topics in Environmental biotechnology and will be useful for those who are looking for a challenging career in Environmental biotechnology.

OBJECTIVES

The students are introduced to the topics like

Environment and pollution

- Concept of biodegradation and bioremediation
- Treatment of waste water
- Solid and hazardous waste management
- Environmental management and ethics

UNIT I **9**

ENVIRONMENT AND POLLUTION

Air, Water and Land, Ecosystem, Ecological adaptations, Interactions among soil micro organisms, Biogeochemical cycles, Concepts of biodiversity, Endangered species, *In situ* and *Ex situ* conservation, Gene banks, Types of environmental pollution, Biosensors to detect environmental pollution.

UNIT II **9**

BIODEGRADATION AND BIOREMEDIATION

Biodegradability testing, Biodegradation – Xenobiotic compounds, Pesticides and surfactants, Bioremediation – Efficacy and side effect testing, Approaches – *In situ*

bioremediation (Land forming, Bioventing, Biosparging, Bioaccumulation, Bioaugmentation), *Ex situ* bioremediation – Composting, Vermicomposting, Biophile process, Phytoremediation, Bioremediation of ecosystem – Soil and aquifiers, Marine oil pollutants and Air pollutants.

UNIT III **9**

WASTE WATER TREATMENT

Waste water characterization, Sewage and industrial waste, Water treatment – Primary, Secondary and Tertiary treatment, Treatment of Dairy, Paper and pulp, Dye, Leather and Pharmaceutical waste water.

UNIT IV **9**

SOLID AND HAZARDOUS WASTE MANAGEMENT

Waste minimization technique, Solid Waste Management (MSW), Methods of collection and disposal, Hazardous waste management – Classification, Methods of treatment and disposal.

UNIT V **9**

ENVIRONMENTAL MANAGEMENT

Sustainable development, Environmental issues at Global and National level, Laws governing environment, Environment Impact Assessment (EIA), Environmental ethics

Total : 45 Hours

TEXT BOOKS

1. Foster, C. F. and John Ware, D. A., 1987. Environmental Biotechnology. *Ellis Honwood Ltd*.
2. Jogdand, S. N., 2003. Environmental Biotechnology. *Himalaya Publishing House*, Mumbai, 2nd Edition, Website : WWW. Himpub.com.
3. Glynn Henry, J. and Gary W. Heinke, 2005. Environmental Science and Engineering. *Prentice - Hall* of India Pvt. Ltd.
4. Rao, C. S., 2006. Environmental Pollution Control Engineering. *New Age International (P) Ltd. Publishers*.
5. Satyanarayana, U., 2008. Biotechnology. *Books and Allied Pvt. Ltd*.
6. Dubey, R. C., 2006. Textbook of Biotechnology. *S. Chand and Company Ltd.*, New Delhi.
7. Sharma, B. K., 2005. Environmental Chemistry. *Goel Publishing House*.
8. Ronald M. Atlas and Richard Bartha, 2005. Microbial Ecology : Fundamentals and Applications. *Pearson Education* (Singapore) Pte. Ltd., Indian Branch, 4th Edition.

REFERENCES

1. Karnley, D., Chakrabarty, K. and Omen, G. S., 1989. Biotechnology and Biodegradation, Advances in Applied Biotechnology. *Gulf Publications Co.*, London.
2. Kumar, H. D., 2005. Modern Concepts of Biotechnology. *Vikas Publishing House Pvt. Ltd*.
3. Pradipta Kumar Mohapatra, 2007. Textbook of Environmental Biotechnology. I. *K. International Publishing House Pvt. Ltd*.
4. Indu Shekhar Thakur, 2006. Environmental Biotechnology Basic Concepts and Applications. *I. K. International Publishing House Pvt. Ltd*.
5. Dhameja, S. K., 1999. Environmental Engineering and Management. *S. K. Kataria and Sons*, New Delhi.
6. Masters, J. G., 1997. Introduction of Environmental Engineering and Science. *Prentice - Hall*, New Delhi.
7. Stainr, R.Y., Ingraham, J. L., Wheelis, M. L. and Painter, R. R., 1989. General Microbiology. *Mac Millan Publications.*

ELECTIVE IV	APPLIED BIOINFORMATICS	L	T	P	C
		3	0	0	3

AIM

This course aims to develop the skills of the students in Bioinformatics in different aspects like Genome analysis, sequence alignment, construction of Phylogeny tree and applications.

OBJECTIVES

To introduce the students to

- The basics of Bioinformatics.
- Understanding of popular genome analysis and methods.
- A comprehensive understanding of sequence alignment and the related statistics.
- Understand the basic concepts of Evolutionary tree and phylogeny.
- The applications of Bioinformatics in various fields.

UNIT I **9**

INTRODUCTION

Introduction, Scope of Bioinformatics - Basic UNIX commands and protocols, E-mail, ftp, telnet, Internet, http.

Introduction to databases – Database search – Sequence database search – Biological databases and their uses.

UNIT II

GENOME ANALYSIS **9**

Isolation of genomic and organelle DNA from prokaryotes and eukaryotes, Mapping and sequencing genes, Electrophoretic karyotyping, Construction and screening of genomic DNA libraries, Functional genomics : Sequence based, Microarray based approaches, *In silico* vector construction.

UNIT III **9**

SEQUENCE ALIGNMENT AND DYNAMIC PROGRAMMING

Basic concepts of sequence similarity, Identity and homology, Definitions of homologues, Orthologues, Paralogues, Sequence patterns and profiles : Basic concept and definition of sequence patterns, Motifs and profiles, Various types of pattern representations viz., Consensus, Regular expression (Prosite-type) and profiles, Profile-based database searches using PSI-BLAST, Analysis and interpretation of profile-based searches.

UNIT IV **9**

EVOLUTIONARY TREE AND PHYLOGENY

Trees, Parsimony, Phylogeny, Phylogenetic alignment – Connection between multiple alignment and Tree construction, Tools for phylogenetic analysis – CLUSTALW, PHYLIP, MEGA.

UNIT V **9**

APPLICATION OF BIOINFORMATICS

Emerging new ideas on treating biological systems, Applications of Bioinformatics in various fields – Medicine, Agriculture and Industries.

Total : 45 Hours

TEXT BOOKS

1. Rastogi, S. C., Namita Mendiratta and Parag Rastogi. Bioinformatics – Concepts, Skills, Application.
2. Westhead, D. R., Parish, J. H. and Twyman, R. M., 2000. Instant Notes in Bioinformatics.
   BIOS Scientific Publishers.
3. Teresa, K., Attwood and David J. Parry-Smith. Introduction to Bioinformatics. *Pearson Education Ltd.*

REFERENCES

1. Bergeran, B., 2002. Bioinformatics Computing. *PHI*.
2. Richard Durbin, Sean Eddy, Anders Krogh and Graeme Mitchison, 1998. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids. *Cambridge University Press*.

3. Bishop, M. J. and Rawlings, C. J., 1997. DNA and Protein Sequence Analysis. A Practical Approach. *IRL Press,* Oxford.
4. Gibas, C. and Jambeck, P., 1999. Developing Bioinformatics Skills. *O'Reilly*.
5. Dan Gusfield, 1997. Algorithms on Strings Tree and Sequence. *Cambridge University Press*.
6. Baldi, P. and Brunak, S., 1998. Bioinformatics : A Machine Learning Approach. *MIT Press*.

ELECTIVE IV	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

AIM

To develop advance level skills in the areas of Genomics and Proteomics.

OBJECTIVES

To emphasize the concepts of

- Genome organisation.
- Mapping techniques.
- Micro array techniques.
- 2DE and Mass spectrometry.
- Application of Proteomics.

UNIT I **9**

OVERVIEW OF GENOMES OF BACTERIA, ARCHAE AND EUKARYOTA

Genome of prokaryote – E. coli – Genome of eukaryote – S. cerevisiae Genome of H. sapiens – Protein coding sequence, repeat sequence – SNP basic concepts on identification of disease genes – OMIM database, reference genome sequence, integrated genomic maps – Gene expression profiling – Use of SNPs for identification of genetic traits – SNPs databases (DBSNP).

UNIT II **9**

PHYSICAL MAPPING TECHNIQUES

Top down and bottom up approach , Physical Maps - Restriction Map,Linking arid jumping of cloned genome sequencing placing small fragments on map,SI assembly, Gap closure,Pooling strategies, Cytogenetic mapping techniques, , Compartive Map,Integrated Map, HGP, DNA microarray , Understanding of microarray data , Correlation of gene expression data to biological processes and computational analysis tools , Metabolic pathways – Databases such as KEGG, EMP.

UNIT III **9**

FUNCTIONAL GENOMICS

Gene finding ,Annotation ,ORF and functional prediction , Substractive DNA library screening ,Differential display and representational difference analysis – SAGE, TOGA application of sequence based and structure based approaches to assign gene functions – e.g., sequence comparison, structure analysis (esp. active site, binding sites) and comparison, pattern identification, use of various derived databases in function assignment.

UNIT IV **9**

PROTEOMICS TECHNIQUES

Protein level estimation, Edman protein micro sequencing, Protein cleavage, 2D gel electrophoresis, Metabolic labelling, Detection of proteins on SOS gels, Pattern analysis, Mass spectrometry principles of MALDI-TOF, Tandem MS-MS peptide mass fingerprinting.

UNIT V **9**

PROTEIN PROFILING

Post translational modification – Glycoprotein analysis, Phosphoprotein analysis – Protein arrays – Basic principles of bioinformatics-based tools for analysis of proteomic data , Databases such as DIP, PPI server and tools for analysis of Protein-Protein interaction.

Total : 45 Hours

TEXT BOOKS

1. Pennington S.R. and Dunn M. J., 2002. Proteomics : From Protein Sequence to Function. *Viva Books*.
2. Pennington and Dunn, 2001. Proteomics. *BIOS Scientific Publishers*.
3. Liebler, D.C., 2002. Introduction to Proteomics : Tools for the New Biology. *Humana Press*.
4. Rastogi, S.C., Mendiratta, N. and Rastogi, P. Bioinformatics Methods and Applications.
5. Cantor and Smith, 1999. Genomics. *John Wiley and Sons*.
6. Andreas D. Baxevanis and Francis Oueliette, B.F. Bioinformatics A Practical Guide to the Analysis of Genes and Proteins. *John Wiley and Sons Inc.*
7. Ignacimuthu, S., 2005. Basic Bioinformatics. *Narosa Publishing House*.

8. Westhead, D.R., Parish, J.H. and Twyman, R.M., 2003. Instant Notes Bioinformatics. 1st Edition., *Viva Books Private Limited*.

REFERENCES

1. Primrose S.B., Twyman R.H and Old R.W., 2006. Principles of Gene Manipulation and Genomics. *Blackwell Science*, 7th Edition.
2. Primrose and Twyman, 2003. Principles of Genome Analysis and Genomics. *Blackwell Publishing Co*.
3. Liebler, 2002. Introduction to Proteomics. *Humana Prem*.
4. Hunt and Livesey, 2000. Functional Genomics. *Oxford University Press*.
5. Suhai, 1999. Genomics and Proteomics. Functional and Computational Aspects. *Pienum Publications*.
6. David W. Mount, 2001. Bioinformatics, Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
7. http://www.courses.fas.harvard.edu/~bphys101/lecturenotes/

ELECTIVE IV	MOLECULAR DIAGNOSTICS AND THERAPEUTICS	L	T	P	C
		3	0	0	3

AIM

The course offers the fundamental concepts and basic principles of Molecular infections and diagnosis, instrumentation and detection of genetic disorders

OBJECTIVES

Completing the course, the students should be able to

- Explain and interpret the nature of infection.
- Identify the importance of early detection of pathogens.
- Describe the genetic nature of Human diseases.
- Apply his knowledge in current diagnostics of infectious diseases.
- Understand the instrumentation and biosafety aspects involved in molecular diagnosis.

UNIT I **9**

INTRODUCTION

History of infection, Mode of transmissions, Pre-disposing factors of microbial pathogenicity, Normal microbial flora of the human body, Types of infectious diseases, Host - Parasite relationships, Clinical specimens – Collection, Transport and Processing of samples, Interpretation of results.

UNIT II **9**

MICROBIAL, FUNGAL & VIRAL INFECTIONS

Pathogenicity and diagnosis of major bacterial infections : *Streptococcus*, *Coliforms*, *Salmonella*, *Shigella*, *Vibrio* and *Mycobacterium*, Pathogenicity and diagnosis of major fungal infections : Dermetophytosis, Candidiosis and Aspergillosis, Pathogenicity and diagnosis of major Protozoan infections : Amoebiosis, Malaria, Trypanosomiosis, Leishmaniasis, DNA and RNA Viruses : Pox viruses, Rhabdo viruses, Hepatitis viruses, Adeno viruses and Retro viruses.

UNIT III **9**

MEDICAL GENETICS

Organization of Human genome, Human Genome Project, Identifying human disease genes, Oncogenes, Tumour suppressor genes, Genetic disorders, Neonatal and Pre-natal disease diagnostics, Gender identification, Analysis of mitochondrial DNA for maternal inheritance, Gene therapy and other molecular based therapeutic approaches, Genetic counselling.

UNIT IV **9**

METHODS IN MOLECULAR DIAGNOSTICS

Isolation and purification of nucleic acids, Nucleic acid labelling, Hybridization, PCR and types, PCR based molecular typing, Molecular diagnosis of pathogens based on 18S and 16S rRNA sequences, PCR in Forensic science.

UNIT V **9**

INSTRUMENTATION FOR MOLECULAR DIAGNOSTICS

Good Laboratory Practices, Automated DNA sequencing, Microarrays, Different levels of biosafety containments for rDNA experiments, Biosafety aspects of tissue / Cell transplantation.

Total: 45 Hours

TEXT BOOKS

1. Lele Buckingham and Maribeth L. Flaws, 2007. Molecular Diagnostics: Fundamentals, Methods & Clinical Applications.
2. David E. Bruns, Edward R. Ashwood and Carl A. Burtis, 2007. Fundamentals of Molecular Diagnostics.
3. Griffiths, A. J. F., Miller, J. H. and Suzuki, D. T., 2000. An Introduction to Genetic Analysis.
4. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, 2002. Biochemistry. *W.H. Freeman and Company*. 5th Edition.

REFERENCES

1. Turner, P. C., McLennan, A. G., Bates, A. D. and White, M. R. H., 2003. Instant Notes in Molecular Biology. *Viva Books Private Limited*.
2. Brown, T. A. Genetics – A Molecular Approach.
3. Lodish, Berk, Zipursky, Matsudaira, Baltimore Darnell, 2000. Molecular Cell Biology. *W.H. Freeman and Company*. 4th Edition.
4. James Watson *et al.*, 1987. Molecular Biology of Gene. *The Benjamin / Cummings Publication Co. Inc.*, California.
5. Benjamin L., 2008. Genes IX. *Jones and Bartlett*.

ELECTIVE IV	BIOLOGY OF CANCER CELLS AND THERAPY	L	T	P	C
		3	0	0	3

AIM

To study in detail about the various concepts of cancer including its carcinogenesis, diagnosis and therapy.

OBJECTIVES

- To know about the fundamental details of Cancer
- To study about the mechanism of carcinogenesis
- To understand about metastasis of cancer
- To study in detail about the cell biology of cancer
- To know about the diagnosis and therapeutics of cancer

UNIT I **9**

FUNDAMENTALS

Cancer : Definition, causes, properties, classification, Cell cycle-phases, cyclins and CDKs, check points, Regulation and modulation of cell cycle in cancer, Apoptosis – Extrinsic and intrinsic pathways, apoptosome and caspases – Relevance of apoptotic and anti-apoptotic factors in cancer, Role of Immune system in cancer – role of individual immune cell types against cancer, role of cytokines in immune cell programming against cancer.

UNIT II **9**

MECHANISM OF CARCINOGENESIS

Mechanism of carcinogenesis – Initiation, promotion and progression – Risk factors – Oncogenes, types, c-Myc, Ras, Bcl-2 family – Tumor suppressor genes – p53 / TP53, INK4A / ARF, Anti – oncogenes, Rb protein pathways – Chemicals, radiation, environmental factors and viruses (HPV, EBV etc).

UNIT III **9**

INVASION AND METASTASIS OF CANCER

Clinical significance of invasion, Three step theory of invasion, Proteinases and tumour cell invasionMetastasis, steps involved – Angiogenesis – Vascular growth and differentiation factors, EPH/EPHRIN signaling, NOTCH signaling, role of inhibitors – Tumour immunity - Tumour antigens and immunosurveillance.

UNIT IV **9**

SUSCEPTIBILITY TO CANCER

Genes conferring susceptibility to cancer, genetic instability – Types, sensing and repairing DNA damage, telomere attrition, aneuploidy – Telomeres and senescence – Cell-Matrix adhesion, cell-cell interaction, cell-cell signaling, malignancy – Role of cadherin, integrin, metalloproteinases and cell invasion.

UNIT V **9**

CANCER DIAGNOSIS AND THERAPY

Cancer screening, Prediction of aggressiveness of cancer, Disease staging, Tumour markers, Molecular tools for diagnosis of cancer - FISH, DNA microarrays, SNPs, CGH, proteomics tools – 2D - gels, LC - MS, MALDI – TOF, Histology, cytogenetics and imaging techniques, Apoptosis – TUNEL assay, Detection using biochemical assays. Treatment: Chemotherapy – Classification of cytotoxic drugs, alkylating agents and platinum drugs – Topoisomerase inhibitors – Radiotherapy – Gene therapy – Immuno therapy – Antigen specific and Adaptive therapy – Stem cell therapy.

Total : 45 Hours

TEXT BOOKS

1. Maly, B. W. J., 1987. Virology A Practical Approach. *IRLI Press*, Oxford.
2. Dunmock, N. J. and Primrose, S. B., 1988. Introduction to Modern Virology. *Blackwell Scientific Publications*, Oxford.
3. Thomas J. Kindt, Barbara A. Osborne and Richard Goldsby. 2007. Kuby Immunology, 6th edition. W.H. Freeman,

REFERENCES

1. An Introduction Top Cellular and Molecular Biology of Cancer, *Oxford Medical Publications*, 1991.

2. Primrose, S. B. and Twyman, R. M., 2006. Principles of Gene Manipulation and Genomics. *Blackwell Publishing*.
3. Ruddon, R. W., 2007. Cancer Biology. *Oxford University Press*, 2nd Edition.
4. Weinberg, R. A., 2007. The Biology of Cancer. *Taylor & Francis*, Garland Science.
5. Pelengaris, S. and Khan, M., 2006. The Molecular Biology of Cancer. *Blackwell Publishing*.
6. http://employees.oneonta.edu/bachman/cancer/index.html.