B Tech (Biotechnology) Curriculum – 2022

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT ****	ENGINEERING MATHEMATICS - III	2	1	0	3	MAT ****	ENGINEERING MATHEMATICS - IV	2	1	0	3
	BIO ****	BIOCHEMISTRY	3	0	0	3	BIO ****	CHEMICAL AND BIOCHEMICAL ENGINEERING THERMODYNAMICS	2	1	0	3
	BIO ****	MICROBIOLOGY	3	0	0	3	BIO ****	DOWNSTREAM PROCESSES-I	2	1	0	3
	BIO ****	CELL AND MOLECULAR BIOLOGY	3	0	0	3	BIO ****	GENETIC ENGINEERING	3	0	0	3
	BIO ****	FLUID FLOW OPERATIONS	2	1	0	3	BIO ****	PRINCIPLES OF HEAT AND MASS TRANSFER	2	1	0	3
	BIO ****	BIOPROCESS CALCULATIONS	2	1	0	3	BIO ****	IMMUNOLOGY	3	0	0	3
	BIO ****	BIOCHEMISTRY LAB	0	0	3	1	BIO ****	UNIT OPERATIONS LAB	0	0	6	2
	BIO ****	MICROBIOLOGY LAB	0	0	6	2	BIO ****	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	0	0	6	2
			15	**3**	**9**	**21***			**14**	**4**	**12**	**22***
	Total Contact Hours (L + T + P)		**27**				**Total Contact Hours (L + T + P)**		**30**			

Year	FIFTH SEMESTER						SIXTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM ****	ENGG ECONOMICS AND FINANCIAL MANAGEMENT	3	0	0	3	HUM ****	ESSENTIALS OF MANAGEMENT	3	0	0	3
	BIO ****	BIOINFORMATICS	3	0	0	3	BIO ****	ANIMAL AND PLANT BIOTECHNOLOGY	3	0	0	3
	BIO ****	BIOPROCESS ENGINEERING	2	1	0	3	BIO ****	BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS	3	0	0	3
	BIO ****	BIOREACTION ENGINEERING	2	1	0	3	BIO ****	PE – 1 / Minor Specialization	3	0	0	3
	BIO ****	DOWNSTREAM PROCESSES-II	2	1	0	3	BIO ****	PE – 2 / Minor Specialization	3	0	0	3
		OE – Creativity, Problem Solving and Innovation (MLC) - mandatory	3	0	0	3	BIO ****	OE – 1	3	0	0	3
	BIO ****	BIOINFORMATICS LAB	0	0	3	1	BIO ****	BIOREACTION ENGINEERING AND CELL CULTURE LAB	0	0	6	2
	BIO ****	DOWNSTREAM PROCESSING AND BIOPROCESS ENGINEERING LAB	0	0	6	2	BIO ****	MODELING AND SIMULATION LAB	0	0	3	1
			15	**3**	**9**	**21**			**18**	**0**	**9**	**21**
	Total Contact Hours (L + T + P)		**27**				**Total Contact Hours (L + T + P)**		**27**			

Year	SEVENTH SEMESTER						EIGHTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	BIO ****	PE – 3 / Minor Specialization	3	0	0	3	BIO ****	Industrial Training (MLC)				1
	BIO ****	PE – 4 / Minor Specialization	3	0	0	3	BIO ****	Project Work				12
	BIO ****	PE – 5	3	0	0	3	BIO ****	Project Work (B Tech – honours)* (V - VIII sem)				20
	BIO ****	PE – 6	3	0	0	3	BIO ****	B Tech – honours Theory – 1* (V semester)				4
	BIO ****	PE - 7	3	0	0	3	BIO ****	B Tech – honours Theory – 2* (VI semester)				4
	BIO ****	OE – 2	3	0	0	3	BIO ****	B Tech – honours Theory – 3* (VII semester)				4
		Mini Project (Minor specialization)***				8						
			18	**0**		**18/26***						**13/33***
	Total Contact Hours (L + T + P)		**18**				**Total Contact Hours (L + T + P)**					

Third semester

MAT ** ENIGINEERING MATHEMATICS III [2 1 0 3]**

Periodic Functions, odd and even functions, Euler's formulae. Half range expansions, Harmonic analysis. Fourier integrals & transforms, Parseval's identity. Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Conformal mappings, bilinear transformations. Gradient, divergence and curl, their physical meaning and vector identities. Line, surface and volume integrals. Green's theorem, divergence and Stokes' theorem, applications. Formation, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of Variables. Derivation of one dimensional wave equation (vibrating string) and its solution by using the method of separation of Variables. D'Alembert's solution of wave equation. Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables. References:

References:

1. Eewin Kreyszig, Advanced Engineering Mathematics, (7e), 1993, John Wiley & Sons, Inc.

2. Murray R.Spiegel : Vector Analysis, (2e), 2009, Schaum Publishing Co.

3. Grewal. B. S : Higher Engg.Mathematics, (43e), 2014, Khanna Publishers.

4. Ramana B.V., Engineering Mathematics, (2e), 2007, Tata McGraw Hill Publishing Company limited.

BIO ** BIOCHEMISTRY [3 0 0 3]**

Introduction to Biochemistry, Scope, and objectives. **Carbohydrates:** Classification, general properties in reference to glucose, cyclic structure mutarotation, biological importance of monosaccharides, disaccharides and polysaccharides, interconversion of sugars, **Lipids:** classification of lipids, simple lipids, compound lipids, derived lipids, miscellaneous- with examples. Types of fatty acids. Biosynthesis and degradation of fatty acids, **Proteins:** classification, structure, and properties of amino acids, structure of proteins, secondary, tertiary, and quaternary structure, nature and function of enzymes, Km and Vmax. Interconversion of amino acids, **Nucleic acids**: Structure of Nucleic acids – DNA, RNA,

biosynthesis and degradation of purines and pyrimidines, inborn errors of metabolism and associated disorders.

References:

1. Albert L Lehninger. *Principles of Biochemistry*. 8th edition W.H. Freeman, 2021
1. Donald Voet. *Biochemistry.* John Wiley & Sons, 5th edition, 2018
2. Stryer. *Biochemistry*. 9th edition, W.H.Freeman & Co Ltd, 2019

BIO ** BIOPROCESS CALCULATIONS [2 1 0 3]**

Bioprocess Development: An Interdisciplinary Challenge , Biotechnology and Bioprocess Engineering, , Introduction to Engineering Calculations, Physical Variables, Dimensions and Units, Unit conversion, Presentation and Analysis of Data, plotting graphs using excel, Steady state material balances, Law of Conservation of Mass, Material Balances With Recycle, By-Pass and Purge Streams, Stoichiometry of microbial growth and product formation, Basic Energy Concepts, Intensive and Extensive Properties, General Energy-Balance Equations, Procedure For Energy-Balance Calculations Without Reaction, Energy-Balance Equation For Cell Culture.

References:

1. Pauline Doran. 1995. Bioprocess Engineering Principles. Academic Press.

2. David M. Himmelblau 1989 Basic Principles and Calculations in Chemical Engineering. Prentice Hall of India (P) Ltd.

BIO ** CELL AND MOLECULAR BIOLOGY [3 0 0 3]**

Introduction to cells: Cell organelles, Membrane structure, Visualizing cells by fluorescence microscopy. Cytoskeleton: Structure of cytoskeletal filaments, Assembly of tubulin and actin subunits to create polar filaments. Regulation of cytoskeletal filaments. Molecular motors. Cell behavior in relation to cytoskeleton. DNA Replication: DNA Replication in Prokaryotes and Eukaryotes, Telomeric Replication in Eukaryotes, Replication of Viral DNA. Transcription: Transcription in Prokaryotes; Transcription in Eukaryotes, Post-transcriptional Modifications. Translation: The Genetic Code, Translation in Prokaryotes and Eukaryotes, Post-translational Modifications. Control of gene expression: DNA-binding motifs of gene regulatory proteins. Introduction to eukaryotic gene control. Molecular genetic mechanisms that create specialized cell types. Post-transcriptional controls. Mechanisms of cell communication: Principles of cell

communication. Signaling through G-protein coupled receptors. Signaling through enzyme coupled cell surface receptors. Cell cycle and its regulation: Brief introduction to cell cycle. Cell cycle control system. Apoptosis. Cancer. Specialized tissues, stem cells and tissue renewal:Epidermis and its renewal by stem cells, Blood vessels, lymphatics and endothelial cells, Renewal by multipotent stem cells. Blood cell formation, Genesis, modulation, and regeneration of skeletal muscle.

References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Eds). Molecular Biology of the cell. (5e), Garland Science, 2008

2. Harvey Lodish, Arnold Ber, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. Molecular cell biology. (8e), Scientific American Books, W. H. Freeman, New York, 2016

BIO ** FLUID FLOW OPERATIONS [2 1 0 3]**

Review of fluid statics, fluid dynamics, Types of flow; Newtonian and non-Newtonian fluids; Shear stress; Viscosity; Classification of fluids. Basic equations of fluid flow – continuity equation, Bernoulli's equation, Flowrate and velocity measurements- Orifice, Venturimeter and Pitot tube. Reynolds number and friction factor, Hagen Poiseuille equation. Flow through a bed of solids – Ergun, Kozeny Carmen and Blake Plumer equation. Agitation and mixing of liquids.

References:

1. McCabe & Smith. 2017. Unit Operations of Chemical Engineering. 7th Edition. McGraw Hill
2. Yunus A Cengel, John M Cimbala. 2018. Fluid Mechanics-Fundamentals and applications, 4th Edition. McGraw Hill.
3. Christie John Geankoplis. 2015. Transport Processes and Separation Process Principles (Includes Unit Operations) 4th Edition. Pearson.
4. Badger and Banchero. 1995. Introduction to Chemical engineering. McGraw Hill

BIO **** **MICROBIOLOGY** **[3 0 0 3]**

Introduction to Microbiology, Scope and objectives. **Microbial diversity and taxonomy:** Prokaryotes and Eukaryotes, Types of Microorganisms, Bacteria, Viruses, Fungi, Protozoans & Helminthes, **Microbiological Techniques:** Study of microscopes, Sterilization Techniques, **Structure, Functions and Replication of Microorganisms:** Bacteria, Viruses, Fungi, Algae, Protozoans, **Medical Microbiology:** Common diseases caused by microbes, **Microbial insecticides, enzymes:** Bacillus thuringinesis, Sphaericus, Popilliae, Baculoviruses, **Food industry:** Microbial spoilage of food and its control; food preservatives

References:

1. Albert L Lehninger. *Principles of Biochemistry*. 5th edition W.H. Freeman, 2008
2. Donald Voet. *Biochemistry.* John Wiley & Sons, 5th edition, 2018
3. Stryer. *Biochemistry*. 9th edition, W.H.Freeman & Co Ltd, 2019

BIO **: BIOCHEMISTRY LAB [0 0 3 1]**

This laboratory deals with both qualitative and quantitative analysis of biomolecules such as carbohdrates, proteins, lipids and nucleic acids. The estimation of carbohydrates is done qualitatively by Osazone test and the reducing sugars are analysed using Dinitrosalicylic acid (DNS) method. Besides, the estimation of glucose is done by both DNS method as well as by enzymatic (GOD/POD) method. Simple polysaccharides such as starch is estimated by Iodine method. The specific activity of amylase is also done. Proteins are estimated by Lowry's and Bradford's methods. Amino acids are estimated by Sorenson's titrimetric method. Estimation of cholesterol by Zak's method, and spectrophotometric detection of DNA/RNA are also introduced.

References:

1. David T Plummer Introduction to Practical Biochemistry. Mc Graw Hill Publication 2017

2. Keith Wilson and Walker Principles and Techniques of Practical Biochemistry. Cambridge University Press 2000.

BIO **: MICROBIOLOGY LAB [0 0 6 2]**

Experiments are based on the preparation of broth and agar media for the growth of bacterial species. Pure culture techniques (streak, pour and spread) are taught to isolate and sub-culture a specimen obtained from natural sources. Experiments are also designed to learn how to stain

and view different types of microbes using a compound microscope. A basic set of biochemical tests are also performed to identify and differentiate between certain microbial classes. A biochemical test is also conducted to check the extent of contamination of a milk sample.

References:

1. David Friefelder. Molecular Biology. Jones and Bartlett Publishers Inc. 1987

2. Benjamin Lewin. Genes VII. Oxford University Press. 2003

Fourth semester

MAT ** ENIGINEERING MATHEMATICS IV [2 1 0 3]**

Formation of Linear Programming problem, Graphical method, Simplex method, Penalty cost and two-phase methods. Finite sample spaces, conditional probability and independence, Bayes' theorem. One dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential. Finite difference expressions for first and second order derivatives (ordinary and partial). Solution of BVP's in ODE. Classification of second order linear partial differential equations. Numerical solutions of two-dimensional Laplace and Poisson equations by standard five-point formula. Solution of one-dimensional heat and wave equations by explicit methods. Crank-Nicolson method. Finite element method, Introduction, simple applications. Difference equations representing physical systems, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem.

References:

1. Eewin Kreyszig, Advanced Engineering Mathematics, (7e), 1993, John Wiley & Sons, Inc.

2. Meyer P.L., Introduction to probability and Statistical applications, (2e), 1970, American Publishing Co.

3. Hamdy A Taha - Operation research, (7e), 2002, Pearson Education, Inc.

4 Grewal B.S - Higher Engineering Mathematics, (43e), 2014, Khanna Publishers.

5. Sastry S.S - Introductory methods for Numerical Analysis, (5e), 2012, PHI Learning Private Limited.

BIO ** Chemical and Biochemical Engineering Thermodynamics [2 1 0 3]**

Introduction – Scope and definition, First law of Thermodynamics, Joule and Joule-Thomson Coefficient. Definition of enthalpy, different thermodynamic processes, Second law of thermodynamics – Statements of second law, Carnot's engine, entropy, entropy change of ideal gas. Thermodynamic properties of fluid – Property relations for homogenous phases, Solution thermodynamics – Fundamental property relation, Chemical potential and Phase Equilibria, Partial molal properties. Ideal gas mixtures, Fugacity, Activity, residual and excess properties. Single component two phase system, two component phase equilibrium. Chemical reaction equilibrium – Reaction Co-ordinate, Standard Gibb's Energy change and Equilibrium constant. Colligative Properties of solutions: freezing point depression, boiling point elevation, Vapor pressure lowering, osmotic pressure. Thermodynamics of Biochemical reactions – Free energy calculations

References:

1. J. M. Smith, H.C. Van Ness and M.M. Abbott. Introduction to Chemical Engineering Thermodynamics, McGraw Hill International (7e) 2010

2. Silbey, Alberty, Bawendi.Physical Chemistry, Wiley India (4e), 2004

3. Donald T. Haynie. Biological Thermodynamics,Cambridge University Press, 2001

BIO ** DOWNSTREAM PROCESSES [2 1 0 3]**

Fundamentals of downstream processing, High-value & Low-value bioproducts, Cell Disruption & Types, Flocculation, Sedimentation, Centrifugation & Types, Filtration, Membrane-based separation, Ultrafiltration, Reverse Osmosis, Precipitation with Salts, Organic solvents, Fundamentals of Extraction, Types, Reverse Micellar, Super-critical fluid Extraction.

References:

1. B. Sivasankar. Bioseperations: Principles and Techniques. PHI Learning Pvt. Ltd., 2006

2. Raja Ghosh, Principles of Bioseparations Engineering. World Scientific Publishing Company., 2006.

3. Belter P.A., Cussler E. and Wei Shan Hu. Bioseparation – Downstream processing for Biotechnology. Wiley Interscience Pub, 1988

BIO ** GENETIC ENGINEERING [3 0 0 3]**

Classical Genetics: Classical experiments of Hershey and Chase, Avery McLeod and McCarty, Bacterial Conjugation, Generalized and Specialized Transduction, Transformation. Structure and Organization of Nucleic Acids: Structure of various forms of DNA. Organization of DNA in Prokaryotic and Eukaryotic Chromosome, Denaturation and Renaturation. DNA Repair, Mutagenesis and Mutations: Biochemical mechanisms of DNA Repair, Types of Mutations, Biochemical basis of mutants, Modes of Mutagenesis, Reversion. Basics of Recombinant DNA Technology: Introduction to cloning, Method of creating recombinant DNA molecules, Cloning Vectors, Expression Vectors. Enzymes in Genetic Engineering: Restriction-Modification (RM) Systems – Restriction Endonucleases and Exonucleases, Dam and Dcm Methylases, Ligases, Terminal Transferase, Polynucleotide Kinase, Phosphorylases, Phosphatases, RNase, DNase. Nucleic Acid Hybridization and DNA Libraries: Hybridization reaction, Production and Labelling of Gene Probes, Southern and Northern Blotting, in situ hybridization, Construction of Genomic and cDNA libraries, Screening approaches. Molecular Analysis and Amplification Methods: Restriction Mapping, Design of Adaptors & Linkers, Polymerases chain reaction (PCR), Restriction Fragment Length Polymorphisms (RFLP), Random Amplified Polymorphic DNA (RAPD), RACE, Methods of Nucleic Acid Sequencing. Applications of Recombinant DNA Technology: Single Nucleotide Polymorphisms (SNPs), Variable Number Tandem Repeats (VNTRs) and their application, Methods of DNA Transfection to plants and animals; Therapeutic proteins from Transgenic plants and animals (Pharming), Transgenic animals as Models of human disease, Gene Therapy; Recombinant bacterial vaccines, and viruses, DNA Vaccines, Plants as edible vaccines, in vivo Expression Technology (IVET); Plant Breeding. Genome Editing.

References:

1. David Friefelder. Molecular Biology. Jones and Bartlett Publishers Inc., 1987

2. Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. Lewin's Genes XII. Jones and Bartlett Publishers Inc., 2017

3. James D. Watson, Michael Gilman, Jan A. Witkowski, Mark Zoller. Recombinant DNA. W. H. Freeman, 1992

4. J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of the Gene. Benjamin-Cummings, 1987

5. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. Principles of Gene Manipulation. Wiley-Blackwell Publishers, 2002

6. Desmond S.T. Nicholl. Introduction to Genetic Engineering. Cambridge University Press, 2012

7. T. A. Brown. Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell, 2010

BIO** PRINCIPLES OF HEAT AND MASS TRANSFER [2 1 0 3]**

Various modes of heat transfer, Conduction –Fourier's law, Convection – Natural and forced convection Co-current and countercurrent types of flow, LMTD, overall coefficient determination of film coefficients, Heat transfer with phase change, boiling and condensation, Radiation; Diffusion, Mass transfer and its significance, Fick's law of diffusion and Concept of mass transfer coefficients; two film theory; dimensionless numbers, Theory of gas absorption, Henry's law, calculation of stages for absorption column

References:

1. Heat Transfer, J P Holman, McGraw Hill, 10th Edition, 2017
2. Mass Transfer Operations, Robert E Treybal, McGraw-Hill, 1981
3. Unit Operations of Chemical Engineering by McCabe & Smith, McGraw Hill Inc, 7th Edition , 2017

BIO** IMMUNOLOGY [3 0 0 3]**

Introduction to Immunotechnology, Scope and objectives, **The Immune System Innate:** Introduction to Innate Lymphatic circulation, Inflammation, Complement System, **The Immune System Adaptive:** Adaptive Antigen presenting cells, Langerhans cells- their origin, B-cell Immunity- classes and subclasses, Genetic control of antibody types, **Immune diseases and detection methods** Autoimmunity, Infections, FACS, western blotting, Immunofluorescence, RIA, ELISA, Chemiluminescence.

References:

1. Charles A. Janeway, Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology: The Immune System in Health & Disease. Sixth Edition, 2005

2. Roitt I. Essential Immunology. Blackwell Scientific Publications, 1991

3. Richard Goldsby, Thomas J. Kindt, Barbara A. Osborne. Kuby Immunology. 2006

BIO**** MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB [0 0 6 2]

Experiments are based on the extraction and electrophoresis of nucleic acids (plasmid and genomic) from bacterial and plant sources. Restriction digestion and ligation of DNA is also performed to understand the concepts of targeted gene modification. Bacterial cells are made competent and transformed with a gene of interest to calculate the transformation efficiency. An experiment is also based on the polymerase chain reaction for large-scale of amplification of target sequence in a given DNA sample.

References:

1. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. Principles of Gene Manipulation, Wiley-Blackwell Publishers, 2002

2. Benjamin Lewin. Genes VII. Oxford University Press, 2003

BIO **** UNIT OPERATIONS LAB [0 0 6 2]

Unit operations laboratory curriculum comprises of experiments based on fluid flow and heat transfer. Fluid flow experiments are based on flow measurement, flow dynamics in pipes and fittings and particle dynamics under fluid flow. Heat transfer experiments aim to estimate heat transfer coefficients and thermal conductivity of metals and insulators.

References:

1. Pauline M. Doran. Bioprocess Engineering Principles, Academic Press, 2013

2. Unit Operations of Chemical Engineering by McCabe & Smith, McGraw Hill Inc, 7th Edition, 2017

FIFTH SEMESTER

BIO**** **BIOINFORMATICS** **[3 0 0 3]**

Bioinformatics overview; Computational biology and bioinformatics; The digital code of life; Introduction to biological sequence databases; The evolutionary basis of sequence alignment; Detecting ORFs; protein Vs nucletotide sequence alignment; Global and Local alignments; Substitution Matrices; Gaps and Gap penalties; Dynamic programming algorithm; Statistical and Biological significance; Introduction to computational biology; Multiple Sequence Alignment; sequence assembly: Overlap-Layout-Consensus approach; Repetitive elements, assembly issues; PCR Primer Design; Gene finding; Graph theory; chemical graphs and amino acid comparisons; Hierarchial levels of macromolecules; Special structures of nucleic acids, pseudoknots, G-quartet; Motifs and domains; symmetry of proteins; HP-lattice model; Secondary structure; Molecular visualization; Protein structure-function relationships; Protein modeling; Structure validation; Evolution; Morphology based cladogram; Building Phylogenetic Trees; Phylogenetic Networks; Bioinformatics: future aspects

References:

1. David W Mount. 2004. BIOINFORMATICS: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press

2. Andreas D Baxevanis, Gary D. Bader, David S. Wishart. 4th Edn, 2020. BIOINFORMATICS. Wiley Interscience.

BIO **** **BIOPROCESS ENGINEERING** **[2 1 0 3]**

Introduction to Enzymes and Enzyme catalyzed reactions: Nature and function of enzymes, Michaelis-Menten Equation – derivations, types of enzyme inhibition, kinetics. Media Design and Sterilization: Fermentation processes, Medium requirements for fermentation processes - examples of simple and complex media, Batch and continuous heat sterilization. Transport Phenomena in Bioreactors: Immobilization methods, Immobilized enzyme/cell kinetics: effectiveness factor derivations; Oxygen transfer in submerged fermentation processes: OTR, OUR calculations, kLa estimations. Kinetics of Microbial Growth and Product Formation: Microbial cell kinetics, Monod model; Growth associated and non-growth associated product formation kinetics.

Reference:

1. Michael L Shuler and Fikret Kargi. 2008. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd.

2. Pauline M. Doran. 2012. Bioprocess Engineering Principles. 2nd Edition. Academic Press.

3. PF Stanbury, S. Hall, A. Whitaker. 2017. Principles of Fermentation Technology. 3rd Edition, Elsevier Science Publishers.

4. Levenspiel, O. 2006. Chemical Reaction Engineering. 3rd Edition. John Wiley.

BIO ** BIOREACTION ENGINEERING [2 1 0 3]**

Reaction Kinetics: Rate equation, elementary, non-elementary reactions and kinetic modeling, Analysis of experimental batch reactor data- integral and differential analysis, **Ideal Reactors:** Design for homogeneous reaction system-batch, stirred tank and plug flow reactors, Multiple reactor system-size comparison, recycle reactor, **Bioreactor Design and Analysis:** Batch reactor performance with Monod cell growth kinetics, Chemostat performance analysis with Monod kinetics, Fed-batch reactor

References:

1. Octave Levenspiel. *Chemical Reaction Engineering*. John Wiley & Sons,3rd edition,2003
2. Harvey W.Blanch and Douglas S. Clark. *Biochemical Engineering* CRC Press, 1997
3. Michael L Shuler and Fikret Kargi. *Bioprocess Engineering: Basic Concepts*. Prentice-Hall of India Pvt Ltd.2008

BIO** SEPARATION PROCESSES [2 1 0 3]**

Vapor Liquid Equilibrium (VLE), Flash and steam distillation, Theories of adsorption – Adsorption isotherms and calculations, and models, adsorption in fixed beds, Pressure Swing Adsorption (PSA); Chromatography – principles of chromatographic separation and Plate theory, HPLC and GC, Various types of Chromatographic practices, Retention time, Capacity, band broadening, Size exclusion, Ion Exchange and Affinity chromatography; Crystallization, Supersaturation, Yield Calculation, Meir's and Oswald's Theorems; Drying-theory, Equilibrium and batch drying curve, calculations.

References:

1. Bioseperations: Principles and Techniques by B.Sivasankar, PHI Learning Pvt. Ltd., 2006
2. Ghosh Raja, Principles of Bioseparation Engineering, World Scientific Publishing Company, 2006
3. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993.
4. R G Harrison, P .Todd, R.Rudge, D.P.Petrides, Bioseparation Science and Engineering, Oxford University Press, 2003
5. Unit Operations of Chemical Engineering by McCabe & Smith, McGraw Hill Inc, 7th Edition , 2017
6. Mass transfer, R.E. Treybal, McGraw Hill (Indian Edition), 2017

BIO***: BIOINFORMATICS LAB [0 0 3 1]

This laboratory introduces a pragmatic approach on sequence retrieval, alignment, and analysis such as similarity search including pairwise and multiple alignment, basics of PERL programming, primer design, molecular phylogeny with various algorithms such as NJ, UPGMA, FM & ME, secondary structure prediction, structure visualization and analysis, structure alignments to explore homology as well as distant relationship, protein homology-based modeling, and structure validations.

References:

1. David W Mount. 2004. BIOINFORMATICS: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press
2. Andreas D Baxevanis, Gary D. Bader, David S. Wishart. 4th Edn, 2020. BIOINFORMATICS. Wiley Interscience.

BIO ****: DOWNSTREAM PROCESSING AND BIOPROCESS ENGINEERING LAB [0 0 6 2]

Experiments are based on aqueous two phase based separation, extraction of intracellular proteins, precipitation of proteins, ultrafiltration, separation of solids from slurry using leaf filter and sedimentation.

References:

1. Cussler, E. L., et al. Bioseparations : downstream processing for biotechnology. United Kingdom, Wiley, 1988.

2. Asenjo, Juan A.. Separation Processes in Biotechnology. United States, CRC Press, 2020.

SIXTH SEMESTER

BIO** ANIMAL AND PLANT BIOTECHNOLOGY [3 0 0 3]**

Plant genome and its organization, In vitro culture techniques for plant cells, callus and cell suspension cultures, industrial plant biotechnology, plant cell bioreactors, plant molecular biology, vectors and gene transfer for plant cells, recent trends in plant biotechnology – production of foreign proteins, plant stem cells, cellular agriculture, and plant biotechnology in space applications. Design of animal cell culture laboratory, types of equipment and application, Media components, Contamination, types and prevention, Adhesion and suspension culture, Methods of primary culture, Subculture, Cryopreservation, 3D culture Cell quantification techniques.

Reference:

1. Dixon R.A. and Gonzales. *Plant Cell Culture: A Practical Approach,* IRL Press. 1995
2. Lindsey K. and Jones M.G.K. *Plant Biotechnology in Agriculture,* Prentice Hall, 1990
3. Singh K. *Intellectual property rights on biotechnology,* BCIL, New Delhi, 2001
4. M.Butler -Animal Cell Culture and Technology' Second Edition (2004) BIOS Scientific Publisher, New York.
5. R Ian Freshney Culture of animal cells: A manual of Basic techniques and Specialized applications, Wiley Blackwell Press, 2010

BIO ** BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS [3 0 0 3]**

Total no of contact hours: 36

Biotechnology and Bioethics, Hazardous materials, Handling and disposal, Good laboratory practice, regulatory guidelines for biotechnology research, ethical concerns and issues in biological research, Intellectual Property Rights, various types, protecting IPR, Patent, types, Patent system in India and United States of America, Filing of patent application, Patenting in biotechnology and biopharma, Patenting life forms, Copyright, Trademark, Trade secrets, Geographical Indications, Protection of traditional knowledge

Reference:

1. Ashok K. M., & Mohd I. A., (2008). Intellectual property rights, 1st ed., Serials Publications New Delhi.
2. Campbell A. V., (2013). Biothics: The Basics, Routledge (Taylor and Francis group). London and New York
3. Padma Nambisan (2017). An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology. Academic Press, London
4. Richard Stim A., (2014). Patent, Copyright and Trademark: An Intellectual property desk reference. 13th ed. Sheridan, USA
5. Vallero D. A., (2007). Biomedical ethics for Engineers. Academic Press, London

BIO ****: BIOREACTION ENGINEERING AND CELL CULTURE LAB [0 0 6 2]

Bioreaction Engineering laboratory experiments are based on the growth kinetics of bacterial species in a shake flask and fed-batch cultures with various carbon sources. Also experiments are designed to evaluate the performance of various bioreactors such as stirred tank reactor (STR) and fluidized bed reactor (FBR) and packed bed reactor (PBR) with immobilized enzymes.

References:

1. Octave Levenspiel. Chemical Reaction Engineering. John Wiley & Sons, (3e), 2003

2. Harvey W. Blanch and Douglas S. Clark. Biochemical Engineering, CRC Press, 1997

3. John Villadsen. Bioreaction Engineering Principles. (3e), springer publishers 2011

BIO ****: MODELING AND SIMULATION LAB [0 0 3 1]

In Bioprocess control lab experiments are designed to study about the controllers (P, PI, PD & PID), advanced control system, control valves, first order system & second order system (inherent/multi capacity processes) with different inputs which usually appears in the process industries.

References:

1. Gonzales, R. A., and Dixon, R. A.. Plant Cell Culture: A Practical Approach. United States, Oxford University Press, 2004.

2. Lindsey, K.. Plant Biotechnology in Agriculture. N.p., Richard Dennis Publications, 1991.

3. Shuler, Michael L., and Kargi, Fikret. Bioprocess Engineering: Basic Concepts. India, Pearson., 2015.

SEVENTH SEMESTER

There are five program electives and one open elective with total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

BIO ****: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

BIO ****: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institution. The duration of the project work shall be a minimum of 16 weeks, which may be extended to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. A student must make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATIONS

I. ENVIRONMENTAL BIOTECHNOLOGY

BIO **** **BIOREMEDIATION** **[3 0 0 3]**

Introduction: Advantages & disadvantages of bioremediation; Microbial ecology and metabolism: Factors influencing Growth and Biodegradation, Modelling Growth & Biodegradation, Redox reactions, Metabolism of Organic & Inorganics, Phototrophic Metabolism, Cometabolism; Mechanisms of Biodegradation: Biodegradation of Hydrocarbons, Halogenated Aliphatics & Aromatics; Bioremediation processes: In situ Remediation of Aquifers & Soils, Solid Phase Bioremediation – Land Treatment & Composting, Slurry-Phase & Vapor phase Bioremediation – Biofilters & Biotrickling filters; Biotreatment of Metals: Microbial Transformation of Metals; Bioleaching; Phytoremediation: Phytoremediation of organics, metals & inorganics, Phytoextraction, Rhizofiltration, Phytostabilization

References:

1. Martin Alexander, “Biodegradation and Bioremediation”, Academic press. 1999
2. John. T. Cookson, Jr., “Bioremediation engineering; design and application” McGraw Hill, Inc. 1995
3. Eweis, Ergas, Chang and Schroeder. “Bioremediation Principles” McGraw-Hill Series in Water Resources and Environmental Engineering, 1998

BIO**** **BIOLOGICAL TREATMENT OF WASTEWATER** **[3 0 0 3]**

Need for wastewater treatment; Characterization of wastewater- Biological- BOD, COD, TOC, MPN, and Bacterial count; BOD kinetic parameter fitting by Least square, Fujimoto, Daily difference, Thomas and Moments-Methods; Physical characterization such as solids, Turbidity, and Chemical characterizations. Bacterial metabolism in treatment, Decomposition of organic compounds in Ecosystem, Biology, Mass energy balance for Aerobic respiration, and Anaerobic respiration, General considerations for Aerobic Vs. Anaerobic treatment, Kinetic aspects, Hydrolysis of cellulose-biological aspects, Anaerobic degradation of lignocellulose and cellulose, proteins, fats; Various types of anaerobic treatment reactors-UASB and its

variations, calculation of biogas by Buswell equation, Nitrification and denitrification processes, and Anammox process, Biological Phosphorus removal processes.

References:

1. Metcalf and Eddy.Wastewater Engineering - Treatment, Disposal and Reuse. Tata McGraw Hill Publishing Co. Ltd, 1991

2. Rao C.S.Environmental Pollution Control Engg. New Age International (P) Ltd. Publishers, 1991

3. Jordening H.J. and Winter J. Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag GmbH & Co., 2005

BIO** BIOFUELS ENGINEERING [3 0 0 3]**

Various feedstock for different kinds of Biofuels; Biochemical pathways; Life Cycle Analysis (LCA) of various biofuels, Various process technologies for bioethanol production; Microorganism selection; Comparison of various bioethanol processes; Biodiesel from Seeds and Waste cooking oils, Acid base, enzyme catalyzed transesterification process; Biodiesel from Microalgae and various contemporary technologies and their comparisons; Hydrogen production by enzymes and various microorganisms, Inhibition effects of Hydrogen production; Biogas production from various sources and process technologies

References:

1. Caye M. Drapcho, Nghiem Phu Nhuan and Terry H. Walker, “Biofuels Engineering Process Technology”, Mc Graw Hill Publishers, New York, 2008
2. Jonathan R.Meilenz (Ed.), “Biofuels – Methods and Protocols (Methods in Molecular Biology Series)”, Humana Press, New York, 2009
3. Lisbeth Olsson (Ed.). “Biofuels (Advances in Biochemical Engineering/Biotechnology Series)”, Springer-Verlag Publishers, Berlin, 2007

BIO ** SOLID WASTE MANAGEMENT [3 0 0 3]**

Introduction to solid waste management: Waste generation in technological society, integrated solid waste management, operation of solid state waste management systems. Legislative Trends and Impacts. Sources, Types and Composition of solid wastes: Determination of the

composition of municipal solid wastes in the field, Physical, chemical and biological properties of MSW; transformations of solid waste; Properties and classification of Hazardous wastes; transformations of Hazardous waste constituents found in MSW. Engineering Principles: Solid waste generation and collection Rates, Collection of solid waste, Separation and Processing and Transformation of solid waste, Transfer and Transport, Disposal of solid wastes and residual matter: The landfill method, classification and types; Layout and preliminary design of landfills. Biological and chemical conversion technologies: Biological principles, aerobic composting, low and high solids anaerobic digestion, development of anaerobic digestion processes and technologies for treatment of the organic fraction of MSW. Solid waste management and planning issues: Meeting federal and state mandated diversion goals: source reduction and recycling, Implementation of solid waste management options; planning, siting and permitting of waste management facilities.

References

1. Theisen, Hilary, et al. *Integrated Solid Waste Management: Engineering Principles and Management Issues.* India, McGraw-Hill Education (India) Private Limited, 2014.
2. William D Robinson, *The solid waste handbook: A practical guide*, John Willy & sons, 1986.

II. PHARMACUETICAL BIOTECHNOLOGY

BIO ****

BIOMATERIALS AND DRUG DELIVERY ENGINEERING PRINCIPLES [3 0 0 3]

Properties of materials & classes of materials used in Medicine, Host reaction to biomaterials and their evaluation, testing biomaterials, degradation of materials in the biological environment, application of materials in medicine & dentistry, implants & devices, basics of artificial organs.

Introduction to drug administration and drug effectiveness, Diffusion and drug dispersion, diffusion in biological systems, drug permeation through biological barriers, drug transport by fluid motion, pharmacokinetics of drug distribution. Drug delivery systems: drug modification, controlled drug delivery systems. Some case studies in drug delivery.

References:

1. Drug Delivery, W. Mark Saltzman , Oxford University Press, 2001

2. Pharmaceutical Biotechnology, Gary Walsh, Wiley Publication

3. Buddy Ratner, Allan Hoffman, Frederick Schoen, Jack Lemon.Biomaterial Science: An introduction to materials in medicine, Academic press, Elsevier publication, (3e), 2012

4. Joon Park, LakesR.S. Biomaterials: An Introduction,Springer publication, (3e), 2007

5. Pharmaceutical Biotechnology, K. Sambhamurthy and Ashutosh Kar, Newage International Pvt Ltd Publisher.2016

BIO ** BIOPHARMACEUTICAL ENGINEERING [3 0 0 3]**

Introduction – Development of drugs and pharmaceutical industry organic therapeutic agents. Drug Metabolism and Pharmaco-Kinetics – physico chemical principles, radioactivity, action of drug on human bodies. Important Unit Processes and Their Applications.Manufacturing Principles of different type of tablets. Analytical methods and test for various drugs and pharmaceuticals, packaging techniques – quality control. Health Biotechnology - health care products, edible vaccines, nutrition value of foods. Health bioinformatics - microbes and human health, biotechnology kits to monitor day to day human health.

References:

1. Heinrich Klefenz. Industrial pharmaceutical biotechnology, Wiley- VCH, 2002

2. Susanna Wu-Pong, YongyutRojanasakul, and Joseph Robinson. Biopharmaceutical drug and design and development. Humana Press, 2010

BIO** BIOLOGICAL THERAPEUTICS [3 0 0 3]**

History of vaccine and immunotherapy development, Antibody based therapeutics, Chimeric antigen receptor engineering and clinical studies, Introduction of molecular biology and history, oligonucleotide therapy (siRNA, miRNA, shRNA, antisense RNA), Development of gene transfer tools – viral and non-viral vectors, Gene therapy for genetic diseases, infectious diseases, Gene therapy clinical trials, Basic concept of cancer treatment and immune response, Cancer vaccines and preclinical studies, Immune checkpoint regulation and cancer treatment, Gene therapy for cancer, Introduction to Stem Cells, Stem cell-based therapies, Ethical considerations.

References:

1. Friedman T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor, NY: Cold Spring Harbor Lab. Press.
2. Knipe DM, Howley PM, eds. 2001. Fields Virology. Philadelphia, PA: Lippincott Williams & Wilkins.
3. Hackett NR, Crystal RG. 2000. Adenovirus vectors for gene therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker
4. Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E.D. and Thomson, J.A. eds., 2005. Essentials of stem cell biology. Elsevier.
5. Owen, J.A., Punt, J. and Stranford, S.A., 2013. Kuby immunology p. 574. New York, NY, USA:: WH Freeman.

BIO** MOLECULAR MODELING AND DRUG DESIGN [3 0 0 3]**

General concepts of Pharmacology – Bioavailability, Pharmacokinetic and pharmacodynamics. Drug Design – Computational Drug Discovery, Binding interactions, Lipinski's rule of five (RO5), SMILES, Molecular Descriptors – chemical, topological and geometrical descriptors. Molecular Modeling –1D, 2D and 3D analyses. Computer Simulation Methods – Molecular Dynamics methods, Binding affinity calculations & conformational analysis, QSAR. Design New Molecules – *De novo* ligand design, Similarity search - Virtual screening, Molecular docking – SNPs and Pharmacogenomics, Toxicology, Clinical trials, Regulatory affairs & Patenting.

References:

1. Leach A.R. *Molecular Modelling Principles and Applications.* Longman, 2001
2. Haile J.M. *Molecular Dynamics Simulation Elementary Methods.* J. Wiley and Sons, 1997
3. Patrick, Graham L.. *An Introduction to Medicinal Chemistry*. United Kingdom, OUP Oxford, 2013.

OTHER ELECTIVES

BIO ** BIOPROCESS EQUIPMENT DESIGN [3 0 0 3]**

Design of pressure vessels: Codes and standards, Design factors, Classification of pressure vessels; design considerations; design of vessels under internal and external pressure. Design of fermenters: Mixing in Fermenters, Power Requirements for Newtonian, Non-Newtonian broths and Gassed Fluids. Design criteria for batch fermenter, and chemostat. Scale-up of fermenters. Heat Exchanger Design: Type of heat exchangers, energy balances in heat exchanger, Heat transfer in fermenters, and process design of shell and tube heat exchangers.

References:

1. Richardson, and Sinott R.K. Chemical Engineering Vol. 6, J.F. Pergamon Press, 2005
2. Joshi M.V. Process Equipment Design, McMillan India, 2005
3. PF Stanbury, S. Hall, A. Whitaker. 2017. Principles of Fermentation Technology. 3rd Edition, Elsevier Science Publishers.
4. Bjorn K. Lydersen, Nancy A D'elia and Kim L. Nelson. Bioprocess Engineering-Systems, Equipment and Facilities, A Wiley Interscience Publication, 1994
5. Unfired Pressure Vessel Code BIS 2825
6. Code for Shell & Tube heat exchangers BIS 4503
7. Chemical Engineer's Handbook by Perry

BIO ** BIOSTATISTICS AND DESIGN OF EXPERIMENTS [3 0 0 3]**

Introduction to statistics: Descriptive and inferential statistics. Measures of central tendency Measures of spread. Probability distributions, Hypothesis testing. Linear & quadratic models, regression coefficients, estimation using least squares method. Introduction to statistical design: Introduction to factorial designs, 2k factorial design, main effects, interaction effects Screening designs: Fractional factorial designs, Plackett-Burmann screening designs. Model reduction, model assumption checking, residual plots. Optimization designs: Response surface methodology – concepts & methods, central composite designs and Box-Behnken design.

References:

1. Montgomery Douglas C. Design and analysis of experiments, John Wiley, 2013

2. Lawson John &Erjavec John. Modern Statistics for Engineering and Quality Improvement, Thomson, 2001

3. Panda T., Theodore T. and Kumar R.A. Statistical Optimization of Biological Systems. CRC Press, 2015

4. Rosner B. Fundamentals of Biostatistics, (5e), Duxbury Thomson Learning, 2000

BIO**** **COMPUTATIONAL BIOLOGY** **[3 0 0 3]**

Algorithms and complexity, Algorithm Design Techniques, Data Storage, Relational Databases, Biological Data Types, Biological Data Mining, Machine learning Methods, Biological data mining tools, Hidden Markov Models, Artificial Neural Networks, Clustering, Nucleotide and Protein Sequence Analysis, Dynamic Programming Algorithm, Multiple Sequence Alignment Algorithms, Phylogenetic Algorithms, Gene Expression Analysis, Heuristic Algorithms, Identification of Functional Sites in Sequences, Pattern Matching, Gene and Domain Prediction, Restriction Mapping, Genome Rearrangement, Genome Assembly, Protein secondary structure prediction methods and algorithms, RNA structure, RNA secondary structure prediction, Structure File Formats, Structure Similarity Search, Basis of Structural Alignment, Set & Graph theory, Graph Algorithms, Chemical Graphs, Protein Graphs and Networks.

References:

1. Neil Jones & Pavel Pevzner, “Introduction to Bioinformatics Algorithms”, MIT Press, 2004.
2. Heitor Silvério Lopes & Leonardo Magalhães Cruz, “Computational Biology and Applied Bioinformatics”, InTech, 2011.
3. Dongqing Wei, Qin Xu, Tangzhen Zhao, Hao Dai, Bryan Bergeron, “Advance in Structural Bioinformatics”, Springer, 2014.
4. David W Mount, “BIOINFORMATICS: Sequence and Genome Analysis”, Cold Spring Harbor, 2001.

BIO ** FOOD PROCESS ENGINEERING AND TECHNOLOGY** [3 0 0 3]

Introduction to Food Processing: Biotechnology in relation to the food industry; nutritive value of food; types of microorganisms associated with food - their sources, types and behavior. **Food Spoilage & Preservation:** Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry and Seafood. **Food Preservation:** Food Preservation Using Irradiation, Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying. **Biotechnology in Food Industry:** Characteristics of Food Industry. Food manufacturing & processing, common additives, bioorganic additives, spoilage, prevention of spoilage, storage and preservation through biotechnological means. **Food Industry:** Basal metabolic rate, influences on nutritional status, dietary strategies for individuals, diet for specific groups, Market Place, ecologically sustainable production, risks and benefits of biotechnology to food industry. **Unit Operations in Food Processing:** Unit operations applied to the food processing industry – Fluid flow applications, Heat transfer applications, Centrifugation, Filtration, Extraction, Membrane separations, Evaporation, Distillation, Absorption, Size reduction, Mixing, Drying, and Crystallization.

References:

1. Roger, A., Gordon, B. and John, T. 1989. *Food Biotechnology.* Cambridge University Press
2. Golden, David A., et al. *Modern food microbiology*. India, Springer, 2005.
3. W Lindsay. 1988. *Biotechnology – Challenges for the flavor and food industry*. Elsevier Applied Science.
4. Earle, R. L.. *Unit Operations in Food Processing*. United Kingdom, Elsevier Science, 2013.

BIO** GENOMICS & PROTEOMICS [3 0 0 3]**

Genomics and proteomics are newer fields in modern biology which help us to understand the living organisms as a whole. These two fields were developed based on the concepts that existed before but now they have been applied to high throughput techniques. Genomics is mainly concerned with the organization of genes and genomes, the mapping of genomes, genome sequencing, and the annotation of genomes. Proteomics deals with proteins expressed in a cell at different times, post-translational modifications, protein–protein interactions, etc. This course covers the important techniques that are used in genomics and proteomics.

Investigation of these latest techniques and their applications in various fields will help undergraduate students enhance their current perception on biology.

References:

1. Benjamin Lewis. 2003. Genes VIII. Oxford University Press.
2. Smith D. W. 1994. Biocomputing Informatics and the Genome Projects. Academic Press.
3. Jonathan Pevsner. 2015. Bioinformatics and Functional Genomics. Wiley Blackwell
4. Daniel Liebler. 2002. Introduction to Proteomics. Humana Press

BIO** HEALTH DIAGNOSTICS [3 0 0 3]**

Introduction to Health diagnostics, Importance, and applications, Infectious diseases, Parasitic diseases, Viral diseases, Genetic disorders, Neurological diseases, Immune disorders, Genes & Disease, Antimicrobial resistance, New technologies in Diagnostics, DNA based diagnostics methods, Biochemical diagnostics methods, Cell-based diagnostics methods, Antibody markers, CD Markers, FACS, HLA typing, Bioassays, Immunodiagnostics methods, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Case studies related to bacterial, viral and parasitic infections, Diagnosis of infectious diseases, respiratory diseases, Viral disease, bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases, Phage display, immunoassays, and FACs.

References:

1. Patrinos, G. P., Ansorge, W. J. and Danielson, P.B. (2016) Molecular Diagnostics, Academy Press
2. Burtis, C. A., & Bruns, D. E. (2014). Tietz Fundamentals of clinical chemistry and molecular diagnostics. Elsevier Health Sciences.
3. Tille, P. (2015). Bailey & Scott's diagnostic microbiology. Elsevier Health Sciences.
4. McPherson, R. A., & Pincus, M. R. (2021). Henry's clinical diagnosis and management by laboratory methods E-book. Elsevier Health Sciences.
5. Turgeon, M. L. (2018). Linne & Ringsrud's Clinical Laboratory Science E-Book: Concepts, Procedures, and Clinical Applications. Elsevier Health Sciences.

BIO **** **METABOLIC ENGINEERING** **[3 0 0 3]**

Introduction – Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feedback regulation. Synthesis of Primary Metabolites –Alteration of feedback regulation, limiting accumulation of end products, metabolites.Biosynthesis of Secondary Metabolites – Precursor effects, prophophase, idiophase relationship, enzyme induction & producers of secondary metabolites.Bioconversions – Advantages, specificity, yields, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances.Regulation of Enzyme Production – Strain selection,

improving fermentation, recognizing growth cycle peak, catabolite repression, mutants resistant to repression.

References:

1. Gregory Stephanopoulos, Aristos Aristidou, Jens Nielsen. *Metabolic engineering.* Academic Press Inc.1998

2. Stanbury, Peter F, et al. *Principles of Fermentation Technology*. Germany, Elsevier Science, 2016.

BIO** BIOPROCESS MODELLING AND SIMULATION IN BIOTECHNOLOGY**

[3 0 0 3]

Definition of modeling and simulations detailed applications and limitations; Classification of models and how to build model; Principles of formulation of models; Fundamentals Laws; Energy equations; Exercises in formulation of lumped and distributed parameter models; Several examples involving algebraic equations, ordinary differential equations, and integral equations; Formulation of batch distillation problem with ideal solution law; Draining time for different types of tanks – Formulation and solution; Batch, Semi-batch and continuous bioreactor formulation of models; Structured and unstructured models; Segregated and non-segregated models; Numerical problems; Numerical techniques for the solution of bioprocess models – Gauss-Jacobi and special methods, Method of bisection, Regular-false, Wegstein method, Newton – Raphson method, 4th order Range-Kutta method; Examples in Bioprocesses system.

References:

1. Himmelblau, David Mautner. Process Analysis and Simulation. United States, University of Texas at Austin, 1975.

2. Ramirez, W. Fred. Computational Methods for Process Simulation. United Kingdom, Elsevier Science, 1997.

3. Mathews, John H., and Fink, Kurtis K.. *Numerical Methods Using Matlab*. United Kingdom, Pearson Education, Limited, 2010.

4. Bequette, B. Wayne. *Process Control: Modeling, Design, and Simulation.* India, Prentice Hall PTR, 2003.

BIO ** Protein Engineering [3 0 0 3]**

Basic structural principles of protein, protein folding and flexibility, protein structure and function, protein prediction, engineering, design, molecular methods, protein analysis and characterization, computational methods, and applications.

References:

1. Branden C, Tooze R. 1993. *Introduction of Protein structure*. Garland.
2. Stefan L, Uwe TB. 2012. *Protein Engineering Handbook 2nd edition*. Wiley-VCH
3. Huimin Z, Sang YL, Jens N, Gregory S. 2021, *Protein Engineering: Tools and Applications.* Wiley-VHC

BIO** BIOPROCESS CONTROL [3 0 0 3]**

Measurement and signal transmission of process parameters – Flow, Pressure, Temperature, Level, pH, DO, density and viscosity; Mathematical modeling of chemical and bioprocesses; Introduction to Laplace Transforms, Development of Transfer functions. Dynamic behavior of first and second order processes; Introduction to feedback controllers, feedforward and ratio controller, final control elements and controller tuning; Block diagram representation, Stability of closed loop control systems -Routh stability criterion, Root locus diagrams.

References:

1. Seborg D. E., Edgar T.F. and Mellichamp D.A. Process Dynamics and control, John Willey & Sons, 2004

2. Stephanopoulos G. Chemical Process Control: An Introduction to Theory and Practice.Prentice Hall International, 1983

3. Riggs J.B. and Nazmul Karim M.Chemical and bioprocess control. Ferret Publisher, 2008

OPEN ELECTIVES

BIO** INTRODUCTION TO BIOINFORMATICS [3 0 0 3]**

Introduction to Bioinformatics, Central dogma of biology, Digital code of life, Biological database searching and analysis. Data sources connected through internet access, biomedical literature search. Information retrieval and interpretation, with practical considerations. Sequence analysis methods, phylogenetic analysis, Protein secondary structure prediction, 3D structures visualization, and modeling (with some practical considerations). Genome annotation and Genome compression methods.

References:

1. Lesk, Arthur M.. Introduction to Bioinformatics. United Kingdom, Oxford University Press, 2019.
2. Ouellette, B. F. Francis, and Baxevanis, Andreas D.. *Bioinformatics: a practical guide to the analysis of genes and proteins,* 3rd ed. India, Wiley India Pvt. Limited, 2009.
3. Brown, Stuart M.. Bioinformatics: A Biologist's Guide to Biocomputing and the Internet. United States, Eaton, 2000.

BIO** BIOINSPIRED DESIGN FOR ENGINEERS [3 0 0 3]**

Basic biological principles, design and working relationship in biological systems, Bioinspiration engineering, methodology and approach for Bioinspiration and biomimetics. Adhesion in biological systems, natural super-hydrophobic and hydrophilic substances, understanding chemical and physical processes in biological systems and its application in bioinspired engineering. Morphing and actuation in plants; lubrication and movement in biological systems, multimodal locomotion, propulsion features of biological systems, design of flying objects in biology and its application in aeronautical designs. Navigation,

communication, automation, shock absorption and mechanics of biological systems and its application in designs of engineering, mathematical modelling in plants and animals, Future trends in bioinspiration engineering.

References

1. Ashok K Goel, Daniel A McAdams and Robert B. Stone 2014. Biologically Inspired Design Computational Methods and Tools, Springer-Verlag London.

2. HashemiFarzaneh, Helena, Lindemann, Udo 2019. A practical guide to bioinspired design. Springer.

3. Christopher Jenkins, 2011. Bio-Inspired Engineering Momentum press, New York

4. Brebbia CS, 2010. Design and Nature V. Comparing design in nature with science and engineering. WIT Press, UK

BIO** BODY, MIND AND MEDICINE [3 0 0 3]**

Explanation of human body and its evaluation to the present form. How different cultures interpreted human body: energy centers, energy chakras. Explanation of mind and different aspects of it. Subconscious, conscious mind and their effect during the different stages of human growth. How it has reached the present form. Interaction of mind and body and its effect on human development and growth. The different interpretation of human body by allopathy medicine, Ayurveda medicine and Chinese medicine.

References:

1. Amit Goswami, The quantum doctor, Jaico Publishing House, 2011

2. Bruce H. Lipton, The Biology of Belief: Unleashing the Power of Consciousness, Matter and Miracles, ReadHowYouWant.com, 2010

3. Firstenberg A, The invisible Rainbow: The history of electricity and life, Chelsea Green Publishing, 2020