Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology
B.Tech. (Biotechnology)
Scheme of Syllabi (2018 Onwards)

3rd Semester (Second Year) – Curriculum

Contact Hours: 25

Course code	Course name	Hours per week			Marks Distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT-18301	Mathematics-III	3	1	-	40	60	100	4
BTBT-18302	Microbiology	4	-	-	40	60	100	4
BTBT-18303	Biochemistry	3	-	-	40	60	100	3
BTBT-18304	Bioanalytical Techniques	3	-	-	40	60	100	3
BTBS-18305	Biology	3	-	-	40	60	100	3
BTBT-18306	Biotech Lab – I (Microbiology Lab)	-	-	4	30	20	50	2
BTBT-18307	Biotech Lab-II (Biochemistry and Bioanalytical Techniques Lab)	-	-	4	30	20	50	2
Total		**16**	**1**	**8**	**260**	**340**	**600**	**21**

Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology

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Scheme of Syllabi (2018 Onwards)

4th Semester (Second Year) – Curriculum

Contact Hours: 26

Course code	Course name	Hours per week			Marks Distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT-18401*	Biostatistics	3	1	-	40	60	100	4
BTBT-18402	Immunology and Immunotechnology	4	-	-	40	60	100	4
BTBT-18403	Animal Cell Culture and Biotechnology	3	-	-	40	60	100	3
BTBT-18404	Transport Phenomena	3	1	-	40	60	100	4
BTHS-18901	Fundamentals of Management for Engineers	3	-	-	40	60	100	3
BTBT-18405	Biotech Lab-III (Immunology Lab)	-	-	4	30	20	50	2
BTBT-18406	Biotech Lab-IV (Animal Cell Culture and Biotechnology Lab)	-	-	4	30	20	50	
BTMC- I	Environmental Sciences	-	-	-				0
Total		**16**	**2**	**8**	**260**	**340**	**600**	**22**

***This Subject shall be taught by the faculty of Applied Sciences Department.**

Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology

B.Tech. (Biotechnology)

Scheme of Syllabi (2018 Onwards)

5th Semester (Third Year) – Curriculum

Contact Hours: 27

Course code	Course name	Hours per week			Marks Distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT-18501	Chemical Engineering Principles	3	1	-	40	60	100	4
BTBT-18502	Genetic Engineering	3	-	-	40	60	100	3
BTBT-18503	Cell and Molecular Biology	3	-	-	40	60	100	3
BTBT-18XXX	DE-I	3	-	-	40	60	100	3
BTXX-18XXX	OE-I	3	-	-	40	60	100	3
BTHS-18902	Entrepreneurship and Project Management	3	-	-	40	60	100	3
BTBT-18504	Biotech Lab-V (Genetic Engineering Lab)	-	-	4	30	20	50	2
BTBT-18505	Biotech Lab- VI (Cell and Molecular Biology Lab)	-	-	4	30	20	50	2
BTMC-II	Constitution of India/Essence of Indian Traditional Knowledge	-	-	-				0
Total		**18**	**1**	**8**	**300**	**400**	**700**	**23**

Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology

B.Tech. (Biotechnology)

Scheme of Syllabi (2018 Onwards)

6th Semester (Third Year) – Curriculum

Contact Hours: 25

Course code	Course name	Hours per week			Marks Distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT-18601	Fundamentals of Biochemical Engineering	3	1	-	40	60	100	4
BTBT-18602	Plant Biotechnology	4	-	-	40	60	100	4
BTBT-18603	Food and Fermentation Technology	3	-	-	40	60	100	3
BTHS-18903	Human Resource Management	3	-	-	40	60	100	3
BTXX-18XXX	OE-II	3	-	-	40	60	100	3
BTBT-18604	Biotech Lab-VII (Plant Biotechnology Lab)	-	-	4	30	20	50	2
BTBT-18605	Biotech Lab-VIII (Biochemical Engineering Lab)	-	-	4	30	20	50	2
Total		**16**	**1**	**8**	**260**	**340**	**600**	**21**

Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology

B.Tech. (Biotechnology)

Scheme of Syllabi (2018 Onwards)

7th Semester (Fourth Year) – Curriculum

Contact Hours: 24

Course code	Course name	Hours per week			Marks Distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT-18701	Enzymology and Enzyme Technology	3	1	-	40	60	100	4
BTBT-18702	Bioinformatics	3	-	-	40	60	100	3
BTBT-18703	Biomedical Instrumentation	3	-	-	40	60	100	3
BTBT-18XXX	DE II	3	-	-	40	60	100	3
BTXX-18XXX	OE III	3	-	-	40	60	100	3
BTBT-18704	Biotech Lab-IX (Enzymology and Enzyme Technology Lab)	-	-	4	30	20	50	2
BTBT-18705	Biotech Lab-X (Bioinformatics Lab)	-	-	4	30	20	50	2
BTBT-18706	Summer Internship (6-8 weeks)*	-	-	-	40	60	100	3
Total		**15**	**1**	**8**	**300**	**400**	**700**	**23**

***This internship is during the summer break after 6th Semester (3rd Year).**

Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology
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Scheme of Syllabi (2018 Onwards)

8th Semester (Fourth Year) - Curriculum

Course Code	Course Name	Marks Distribution		Total Marks	Credits
		Internal	External		
BTBT-18801	Industrial training	200	200	400	12

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Department of Biotechnology
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Scheme of Syllabi (2018 Onwards)

List of Departmental Elective (DE)

Course Code	Course Name
BTBT-18951	IPR management in Biotechnology
BTBT-18952	Stem Cell Technology
BTBT-18953	Advances in drug design and pharmacogenomics
BTBT-18954	Biological waste treatment
BTBT-18955	Introduction to Cancer Biology
BTBT-18956	Protein Engineering
BTBT-18957	Molecular Farming
BTBT-18958	Environmental Biotechnology
BTBT-18959	Pharmaceutical Biotechnology
BTBT-18960	Agricultural Biotechnology

Beant College of Engineering and Technology, Gurdaspur, Punjab

Department of Biotechnology
B.Tech. (Biotechnology)
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List of Open Elective (OE)

Course Code	Course Name
BTBT-18970	Industrial Waste management
BTBT-18971	Bioinformatics
BTBT-18972	Food Safety
BTBT-18973	IPR
BTBT-18974	Biomedical Instrumentation
BTBT-18975	Human Disease and Control
BTBT-18976	Bio fertilizer Technology
BTBT-18977	Bio Nanotechnology
BTBT-18978	Biofuels
BTBT-18979	Computational Biology

Total Credits=122

From 3rd Semester to 8th Semester

Total Internal Marks: 1580

Total External Marks: 2020

Total Marks: 3600

BTBT-18301 Mathematics – III

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 1 0**

Objectives:
The objective of this course is to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Laplace transformations:
Laplace transforms of various standard functions, properties of Laplace transform.

(10)

Partial Differential Equations:
Formation of Partial Differential Equations, linear Partial Differential Equations, Homogeneous Partial Differential Equations with constant coefficients.

(10)

Functions of complex variables:
Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function

(10)

Linear Systems and Eigen- Values:
Gauss–elimination method, gauss- Jordan method, Gauss- Seidel iteration method, Rayleigh's Power method for Eigen values and Eigenvectors.

(10)

Suggested Books:

1 Kreyszig, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi
2 Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi
3 Ian N. Sneedon, Elements of Partial Differential Equations, McGraw- Hill, Singapore, 1957
4 Peter. V. O'Nil, Advanced Engineering Mathematics, Wadsworth Publishing Company

BTBT-18302 Microbiology

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 0 0**

Objective: The course imparts the knowledge of different types of microorganisms that are invisible to our naked eyes. Discovery, origin and evaluation of different forms of bacteria, fungi, protozoa and viruses constitute the basics of biotechnology. It will also give an insight of the industrial applications of microbial organisms.

Unit–I Prokaryotic Cell Organization: General account of cell size, arrangement, shape, capsule, slime, pili, spores, structure and function of gram negative & gram-positive cell wall and membrane, periplasmic space. Brief account of viruses, mycoplasma and fungi. (5)

Unit–II Bacteriological Techniques: Isolation of industrially important microbial strains, strain improvement, maintenance and preservation of industrial microbes. (5)

Unit–III Bacterial Nutrition: Physical growth requirements viz. temperature, pH, oxygen concentration, water activity, light, pressure. Chemical growth requirements viz. nutrients, nutrient uptake in bacteria: Passive and facilitated diffusion, active transport. (4)

Unit–IV Bacterial Growth Kinetics: Growth curve, growth rate and generation time. Growth kinetics, mathematical nature and expression of growth, measurement of growth by quantitating cell mass, cell number and a cell constituent, concept of geometric & arithmetic nature of growth, asynchronous and synchronous cultures, diauxic growth. (6)

Unit–V Bacterial Reproduction: Asexual reproduction, DNA replication in bacterial cell, general principles of bacterial recombination - transformation, transduction and conjugation. (6)

Unit–VI Medical Microbiology: Characteristics of major pathogens (Mycobacterium tuberculosis, Plasmodium sp., etc) their modes of transmission, mechanisms of infection and growth. Production and application of health care products(antibiotics, vitamins, amino acids, alkaloids, steroids) (4)

Unit–VII Agricultural & Environmental Microbial Biotechnology: Large-scale production of microbial inoculants for agriculture, mycorrhiza, treatment of urban (sewage) and industrial effluents. Bioplastics, Bioinstecticides, Biofertilizers, Biofuels (bioethanol, biogas, biohydrogen andbiodiesel),Biosensors. (6)

Course outcomes:

1. To be able to understand the roles and characteristics of microorganisms.
2. To understand the basic concept of replication in microorganisms.
3. To be able to understand economic significance of microorganisms and assess their impact on environment.
4. To be able to evaluate explicitly, the metabolic pathways, role of microbes in public health as well as physical and chemical control of microorganisms.

Suggested Reading and Books:

1. Microbiology 10th Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill
2. Microbiology: An Introduction (9th Ed.) by Tortora GJ, Funke BR, and Case CL, Pearson Education, 2008.
3. Prescott, Harley and Klein's Microbiology (7th Ed.) by Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education, 2008.
4. Principles of Fermentation Technology (3rd Ed.) by Stanbury PF, Whitaker A and Hall SJ, Elsevier Science Ltd, 2006.
5. Environmental Microbiology (3rd Ed.) by R. Mitchel, Wiley-Blackwell, 2009.
6. Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd Ed) by Glazer & Nikaido, W.H. Freeman and Co., New York, 1995.
7. Molecular Biotechnology (3rd Ed.) by Glick BR and Pasternak JJ, ASM Press, Washington D.C., 2003

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BTBT-18303 Biochemistry

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 0 0**

Objective: The course aims on understanding of the relationships between structure and function in the major classes of biopolymers. It augurs understanding on central metabolic process and the role of enzymes in modulating pathways. The theoretical background of biochemical systems helps to interpret the results of laboratory experiments.

Unit–I Biomolecules: Chemistry and Properties of Amino Acids, Proteins, Carbohydrates, Lipids, Purines, Pyrimidines and Vitamins. Chemical Bonds: Covalent Bonds, Ionic Bonds, Co-Ordinate Bonds, Hydrogen Bonds, Vander Waal Forces, Hydrophobic Interactions, Diode Interactions. (5)

Unit–II Proteins: Primary, Secondary, Tertiary and Quaternary Structure, Proteins Analysis, Methods for Isolation and Purification of Proteins. (6)

Unit–III Fat Metabolism: Oxidation of fatty acids, synthesis of fatty acids (fatty acid synthesis complex system), and ketone bodies. Carbohydrates Metabolism: Glycolysis, glycogenolysis, glycogenesis and their regulations, citric acid cycle. (7)

Unit–IV Amino acid Metabolism: Oxidative degradation and synthesis of amino acids, estimation of amino acids. Nucleic Acid Metabolism: Biosynthesis of purines and pyrimidines, their regulation and catabolism (6)

Unit–V Mitochondria: Structure of mitochondria, organization of respiratory chain, oxidative phosphorylation and its inhibitors (5)

Unit–VI Plant & Microbial Biochemistry: Photosynthesis, differences in respiratory mechanisms and anaerobes. (4)

Unit–VII Nitrogen- Fixation: Role of Various Enzymes in Nitrogen Cycle. (3)

Course outcomes

1. Understand complex biochemical pathways within living cells
2. Understand the physiological functioning of the cells
3. Understand catabolic and anabolic metabolism
4. Determine the kinetic parameters of enzymatic reactions

Suggested Reading and Books:

1. A.L. Lehninger: Principles of Biochemistry, 7th edition, Worth Publishers, New York (2017)
2. L. Stryer: Biochemistry, W.H. Freeman and Company, 8th edition New York (2015)
3. B.D. Hames et al: Instant Notes in Biochemistry, BIOS Sci. Pub. Ltd. U.K. (2001)
4. G. Zubay: Biochemistry, W.C. Brown Publishers, Oxford, England (2002).

BTBT-18304 Bioanalytical Techniques

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 0 0**

Objective: Research in the field of biotechnology and its applications in development of technologies involve various kinds of unique techniques. Though these techniques are purely based on the principles of physics and chemistry yet they are specialized for biological applications. The course is aimed to impart conceptual as well as descriptive knowledge about such techniques to the bachelor students pursuing education in the field of biotechnology.

Unit–I Centrifugation: Basic principles of sedimentation, centrifugal field and relative centrifugal force, types of centrifuges, ultracentrifugation, safety aspects of centrifuges, types of rotors, differential centrifugation, density gradient centrifugation, preparative and analytical centrifugation. (4)

Unit–II Microscopy: Introduction to basic principles of microscopy, light microscopy, basic components of light microscope, compound microscope, contrast in light microscopy, advances in microscopy including confocal microscopy, fluorescent microscopy, stereomicroscope, introduction to basic principles of electron microscopy, preparation of samples, TEM, SEM and AFM. (6)

Unit–III Electrophoresis: General principle of electrophoresis, support media (agarose and polyacrylamide gels), electrophoresis of proteins by SDS-PAGE, native PAGE, gradient gels, isoelectric focusing, two dimensional PAGE, Western blot analysis, visualization of proteins in gels, electrophoresis of nucleic acids using agarose gel, sequencing gel, denaturing agarose gel, capillary electrophoresis. (5)

Unit–IV Chromatography: Principles of chromatography, distribution coefficient, retention time, capacity factor, plate height and resolution, peak broadening and van Deemter plot, TLC and column chromatography, matrix materials, LPLC, HPLC, normal phase and reversed phase chromatography, ion exchange chromatography, gel exclusion chromatography, affinity chromatography, GC. (6)

Unit–V Spectroscopy-I: Properties of electromagnetic radiations and their interaction with matter, UV and visible light spectroscopy, Beer-Lambert law, spectrofluorimetry, CD spectroscopy, Mass spectrometry, components of mass spectrometer, methods of ionization and mass analysis including MALDI-TOF. (6)

Unit–VI Spectroscopy-II: IR spectroscopy, Raman spectroscopy, ESR and NMR spectroscopy, X-ray crystallography. (5)

Unit–VII Radioisotope Techniques: Atomic stability and radiation, types of decay, rate of radioactive decay and half-life, units of radioactivity, specific activity, detection methods based

on ionization (GeigerMuller monitor), excitation (solid and liquid scintillation counting), Cerenkov counting, autoradiography, safety aspects of handling radioactive material and radiations, units of exposure such as gray and sievert, precautions associated with radioactivity handling. (4)

Course Outcomes:

1. To be able to use selected analytical techniques.
2. Familiarity with working principals, tools and techniques of different instruments.
3. To understand the strengths, limitations and creative use of techniques for problem-solving.
4. Able to design experiments and understand the instrumentation

Suggested Books:

1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K. And Walker J., Cambridge University Press (2010) 7th ed.
2. Biochemical Method-A Concise guide for students and researchers, Pingoud A., Urbanke C., Hoggett J. and Jeltsch A. Wiley-VCH Publishers (2002)
3. Bioseparations: Science and Engineering, Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. Oxford University Press (2006).
4. Microscopy and Microtechniques. Marimuthu, R., MJP Publishers (2011).
5. Instrumental Methods of Analysis, Willard H.W., Merritt L.L., Dean J.A. & Settle F.A. 7th ed. (2011) East West Publishers.

BTBS-18305 Biology

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 1 0**

Objective: Students will be introduced to the basics of biology such as cell structure and functions, inheritance & evolution, basic concepts of genetics, and an introduction to microbiology. So that they can use technology for the betterment of life on this planet.

Unit–I Introduction to living world: Diversity of life, major prokaryotes- monera, eubacteria and eukaryotic kingdoms- Protista, Fungi, Plantae, and Animalia. (8)

Unit–II Biochemistry: Metabolism (Catabolism: oxidation reactions and Anabolism: reduction reactions), ATP, Bioenergetics: cellular respiration and photosynthesis. (10)

Unit–III Genetics: Basic principles of Mendel, molecular genetics, structure and function of genes and chromosomes, Central dogma, Replication, Transcription and Translation, introduction to recombinant DNA technology and its applications including genetically modified foods and organisms. (10)

Unit–IV Cell Biology: Macromolecules: carbohydrates, lipids, water, aminoacids, proteins, nucleic acids, cell membrane, organelles: mitochondria, ribosomes, golgi appratus, endoplasmic reticulum, cytoskeleton, cell-signaling, cell division: mitosis, meosis, differentiation, motility. (10)

Unit–V Microbiology: Host-microbe interactions, physiology, ecology, diversity, and virology, microbial diseases and preventions, Antibiotics production with major examples, types of vaccines and important examples. (10)

Course Outcomes:

1. Get insight into basic biology as a science
2. Outlining the diversity and evolution
3. Organization and fundamental principles of living systems
4. Principle behind recombinant technology

Suggested Books:

1. Biology Fundamental Principles by Balaji S Thorat and Sumit M Raut
2. Lehlinger's Principles of Biochemistry
3. Microbiology by Prescott

BTBT-18306 Biotech Lab –I (Microbiology Lab)

Internal Marks: 30
External Marks: 20 **L T P**
Total Marks: 50 **0 0 4**

1. Microscopic Examination of Microorganisms: - Staining methods:
    - Simple staining of bacteria
    - Gram staining of bacteria
2. Measurement of cell concentration of bacteria by counting chamber/Haemocytometer.
3. Preparation and Sterilization of Culture Media:
    - Preparation of basic liquid media (broth) for the routine cultivation of bacteria
    - Preparation of basic solid media, agar slants and agar deeps for the routine cultivation of bacteria
    - Preparation of selective and differential media.
4. Isolation and Maintenance of Microorganisms:
    - Pour plate method
    - Spread plate method
    - Streak plate method
    - Sub culturing techniques
    - Preservation of the microbial culture (preparation of glycerol stock)
5. Isolation of cellulose/protease/lipase producing bacteria and fungi from soil
6. Purification and partial characterization of the desired microbes.

BTBT-18307 Biotech Lab –II (Biochemistry and Bioanalytical Techniques Lab)

Internal Marks: 30
External Marks: 20 **L T P**
Total Marks: 50 **0 0 4**

Buffers

- Preparation of standard buffers (buffering capacity & buffering range) & determination of pH.
- Qualitative and Quantitative test for carbohydrates (anthrone method).
- Estimation of amino acid by ninhydrin method.
- Determination of saponification value and Iodine number of fats.
- To test salivary amylase activity.

Spectrophotometer

- To determine the concentration of DNA by UV – spectrophotometer.
- Estimation of proteins by Lowery & Bradford method.

Chromatography

- To analyse amino acids by 2D-Thin layer chromatography.
- To extract and separate biomolecules from plant tissue by column chromatography.

Electrophoresis

- Comparison of Coomassie brilliant blue and silver staining methods for visualizing protein bands in SDS-PAGE
- Comparison of ethidium bromide and silver staining methods for visualization of small DNA fragments analyzed by native PAGE

BTBT-18401 Biostatistics

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 1 0**

Objective/s and Expected Outcome: The course provides students a firm foundation in statistical methods

Introduction: types of biological data (data on ratio scale, interval scale, ordinal scale, nominal scale, continuous and discrete data), frequency distribution and graphical representations (bar graph, histogram and frequency polygon), cumulative frequency distribution. (5)

Measures of central tendency and dispersion: Arithmetic mean, geometric mean, harmonic mean, median, quartiles, mode, range, variance, standard deviation. (10)

Correlation and Regression: Correlation, Karl Prearson and Spearman's Coefficient, Properties of correlation coefficient. Linear regression, Properties of regression coefficients and regression equations. (8)

Moments: Moments, Skewness and Kurtosis (7)

Probability: Permutations and Combinations, basic probability, Probability of an event, addition and multiplication of probabilities. Probability distributions: Binomial, Poisson and Normal Probability distributions (8)

Sampling and Statistical hypothesis testing: Population, sample, sampling, sample size, parameters and statistics, statistical hypothesis testing. Errors, one-tailed and two-tailed tests, t-test, F-test, chi-square test, two sample hyposthesis (testing difference between two means). (10)

BOOKS RECOMMENDED:

1. Zar, JH, Biostatistical Analysis, Pearson-Prentice Hall (2007).

2. Rao K Visweswara, Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition & Anthropology, Jaypee Brothers Publishers (2007)

3. Pagano, M. and Gauvreau, K., Principles of Biostatistics, Thomson Learning (2005)

4. Mahajan BK, Methods in Biostatistics, Jaypee Brothers Publishers (2002)

BTBT-18402 Immunology and Immunotechnology

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **4 0 0**

Objective: The objective of this course is to provide students with a comprehensive overview of the immune system and its function as well as to introduce students to clinical situations in which the immune system plays an essential role. At the end of this course, students should be able to synthesize key concepts in immunology, understand the way in which different components of the immune system interact in a coordinated manner to fight infection and discuss the way the immune system reacts to various kinds of infectious agents.

Unit–I Introduction: Introduction to Immunology, Aims and Scope; Organization of the immune system, Structure and Functions of important immune cells & Immune organs, GALT, innate and acquired immunity, active and passive immunity. (8)

Unit–II Antigens and Antibodies: Characteristics of an antigen, haptens, epitopes, adjuvants. Structure, types, properties and functions of antibodies, VDJ rearrangements. (7)

Unit–III Immune Effector Mechanisms: Organization of MHC locus (mice & human); Structure and functions of MHC I and II molecules, Cytokines; Complement system; Leukocyte migration and inflammation. (7)

Unit–IV Generation of Immune response: T-cell receptor, B-cell receptor, Antigen processing and presentation. Primary and Secondary Immune response; Generation of Humoral Immune Response; Generation of cell mediated Immune response; Killing mechanisms by CTL and NK cells. (8)

Unit–V Immunotechnology: Antigen-antibody reactions, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Immunofluorescence, Vaccines (conventional and recombinant: subunit vaccines, conjugate vaccines, Synthetic vaccines). (6)

Unit–VI Immune system in health and disease: autoimmunity, hypersensitivity (7)

Unit–VII Applied Immunology: Tumor immunity, tissue and organ transplant, Immuno-toxins. (5)

Course Outcomes:

1. Understand innate and adaptive immune responses.
2. Understand the role of primary and secondary lymphoid organs.
3. Understand antigen and antibody interactions.
4. Understand the role of immune system in organ transplantation, autoimmune disorders and Cancer.

Suggested Books:

1. Immunology (6 th Ed.) by Thomas J. Kindt, Richard A. Goldsby, Barbara Anne Osborne, W.H. Freeman and Company,New York (2007)
2. Roitt's Essential Immunology (11 th Ed.) by Delves P, Martin S, Burton D, Roitt IM. Wiley- Blackwell Scientific Publication, Oxford (2006)
3. Immunology (6 th Ed) by Richard C, Geiffrey S. Wiley- Blackwell Scientific Publication, Oxford (2009)
4. Cellular and Molecular Immunology (6 th Ed.) by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders Publication, Philadelphia, (2007)

BTBT-18403 Animal Cell Culture and Biotechnology

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 0 0**

Objective: To develop an understanding about tissue culture as a science and advantages and disadvantages of tissue culture. To provide an exposure for the needs of different conditions required for successful experimentation with tissue culture along with its implications.

Unit–I Introduction to Animal Tissue culture: Background, Advantages, Limitations, Application, culture Environment, Cell Adhesion, Cell Proliferation, Differentiation. (3)

Unit–II Design, Layout and Equipment: Planning, Construction Layout, Essential Equipments, Aseptic Technique, Sterile Handling, Safety, Risk Assessment, biohazards (4)

Unit–III Media: Physicochemical Properties, Balanced salt Solutions, Complete Media, Serum, SerumFree Media, Disadvantages of Serum, Advantages of Serum-Free media (5)

Unit–IV Basic techniques of Mammalian Cell Culture: Isolation of the Tissue, Primary culture Subculture and Propagation. Cell line finite and continuouous cell line, Cell line designation and Routine maintenance (6)

Unit–V Scale up of Cell Culture: Principles and Procedure, Roller bottles, Reactors and Fermenters and various adaptations; Factors affecting scale up; Growth monitoring during scale up. (6)

Unit–VI Contamination: Sources of contamination, Cross contamination, Type of microbial contamination, Eradication and Cryopreservation (5)

Unit–VII Transgenic Animals: Embryonic Stem Cell method, Microinjection method, Retroviral vector method, Transgenesis; Knock- out, Knock-in, Conditional Knock out mouse, Mouse as a Model; Gene Therapy for human genetic disorders, Animal as Bioreactors. (7)

Course Outcomes:

1. Successfully maintain cultures of animal cells and established cell lines with good viability, minimal contamination and appropriate documentation.
2. Perform supportive or episodic tasks relevant to cell culture, including preparation and evaluation of media, cryopreservation and recovery, and assessment of cell growth/health.
3. Recognize and troubleshoot problems common to routine cell culture.

Suggested Books:

1. Culture of animal cells: A Manual of Basic Technique and specialised applications, by Freshney R. Ian, Willey-Liss Publisher, 7th edition (2015).
2. Mammalian Cell Biotechnology- A Practical Approach, by Butler, M, IRL Oxford University Press (1991)
3. Animal Cell Biotechnology vol 6, 6th edition(2012). R. Spire, J. Griffths, Academic press.
4. Textbook of Biotechnology by H.K. Das, Wiley India, 4 th edition, (2010).

BTBT-18404 Transport Phenomena

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 1 0**

Objective: The course is designed to impart knowledge of momentum, heat and mass transfer in chemical, biotechnology system and their analogous behaviour. The concept concepts will enhance the lateral thinking capabilities of the students and seamlessly integrate the concepts for their use in a multitude of processes and problems.

Unit–I Molecular Transport Phenomena: Molecular transport of momentum, heat and mass, laws of molecular transport: Newton's law of viscosity, Fourier's law of conduction and Fick's law of diffusion. Transport coefficients – viscosity, thermal conductivity and mass diffusivity and their analogous behaviour. Estimation of transport coefficients and temperature/pressure dependence. Macroscopic balance for mass, momentum and energy. (7L+3T)

Unit–II Non-Newtonian Fluids: Time Dependent, Time Dependent and Visco-elastic fluids, Consecutive Equations and Rheological Characteristics. (4 L+1T)

Unit–III Equations of Change under Laminar Flow Conditions: Equation of Continuity, Motion and Energy. Simple Shell Balance Method for Momentum, Heat and Mass Transport, Velocity Distribution in Circular Conduits and Parallel Plates. Generalized form of Equations and Simplifications. (7 L+3T)

Unit–IV Turbulence Phenomena: Basic Theory of Turbulence, Time Averaging, Intensity and Correlation Coefficients, Isotropic Turbulence. Equation of continuity, motion and energy for turbulent condition. Reynolds stresses. Phenomenological theories of turbulence, velocity profile in circular conduits. (7 L+2T)

Unit–V Diffusion Phenomena: Diffusion of gases and liquids in porous solids, Knudsen diffusion, multicomponent diffusion and effective diffusivity. (5 L+1T)

Unit–VI Convective Transport: Free and forced convective heat and mass transfer, interphase mass transport, mass transfer coefficients – individual and overall, mass transfer theories-film, penetration and surface renewal. (6 L+2T)

Course Outcomes:

1. To be able to define and explain the concepts of momentum, heat and mass transfer.
2. Apply momentum, heat and mass transfer knowledge by solving problems theoretically and practically.
3. Apply momentum, mass and heat transfer simultaneously on the biological system by solving problems theoretically**.**
4. Understand mass transfer operations absorption, distillation, extraction, drying.

Suggested Books:

1. R.B.Bird, W.E.Stewart and E.W.Lightfoot - Transport Phenomena, John Wiley & Sons.
2. Basic Concepts In Transport Phenomena, A Unified Approach". Vol.-I by Brodkey, R.S., Hershey H.C.,Brodkey Publishing (2003).
3. Nickolas J. Themelis, Transport and Chemical Rate Phenomena, Gordon Breach, New York.
4. Beek W.J. and Mutzall K.M.K., - Transport Phenomena, John Willey and Sons Ltd.

BTHS-18901 Fundamentals of Management for Engineers

Internal Marks: 40
External Marks: 60 **L T P**
Total Marks: 100 **3 0 0**

Unit 1. Definition, functions, and significance of Management. Levels of management, Douglas Mcregor Theory X and Theory Y. Difference between management and Administration.

Unit 2. Evolution of Management, thought, approaches of management. principles of Henry Fayol and
F.W Taylor.

Unit3. Planning and organization nature, objectives and significance of planning, types and steps of planning. Span of control. Methods and types of training, Various organizational structures. Formal and informal organizations.

Unit 4. Concept of motivation, theories of motivation - Maslow need hierarchy theory & Herzberg two factor theory, Concepts of leadership and styles. Steps of Controlling .

Suggested Books:

1. General Management - C.B. Gupta Sultan Chand

2. Principal and Practice of management- L.M. Prasad Sultan Chand

3. Essential of Management -Koontz & O, Donnel Tata Mc Graw

4. Essential Of Management – Koontz and Weihrich Tata Mc Graw 5. Management : James Stoner, R Edward Freeman, Daniel R. Gilbert, Jr. Prentice Hall of India

BTBT-18405 Biotech Lab – III (Immunology Lab)

Internal Marks: 30
External Marks: 20 **L T P**
Total Marks: 50 **0 0 4**

1. To perform Immuno diffusion (Ouchterlony).
2. To perform Immunoelectrophoresis
3. To perform Quantitative precipitation assay
4. To perform Latex Agglutination test
5. To perform Dot- ELISA
6. To perform Hapten conjugation and quantization
7. To perform Plate ELISA
8. To perform Western Blotting
9. To perform RBCs, WBCs count, Hb estimation, Blood group determination.

BTBT-18406 Biotech Lab – IV (Animal Cell Culture and Biotechnology Lab)

Internal Marks: 30
External Marks: 20 **L T P**
Total Marks: 50 **0 0 4**

1. To separate serum and plasma from blood.
2. Preparation and sterilization of Media for animal cell culturing.
3. Testing of complete and incomplete media for animal cell culture.
4. Sterilization of media and instruments for animal cell culture
5. Culturing and subculturing of adherent and suspension cell.
6. To perform staining of animal cells.
7. To isolate Lymphocytes from blood sample.
8. Cell counting and viability by Trypan Blue dye exclusion test.
9. Cryo-preservation of cells.
10. Thawing of cryo-preserved cells

BTBT-18501 Chemical Engineering Principles

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

Course Objectives: Objectives: To impart basic knowledge of mass balance, kinetics, reactor design and process control in chemical engineering system and their analogous behavior.

1. Mass and Energy Balance: Units and dimensions, Dimensional analysis, simple problems on material balance, calculations involving unit process and reactive systems, available electron balances. **(7)**

2. Chemical reaction engineering: Kinetics of homogenous reaction, concepts of reaction rate, order of reaction and Molecularity, Factors affecting reaction kinetics, Searching for a mechanism, Prediction of Reaction Rate from Theory. **(7)**

3. Interpretation of Batch Reactor Data: Analysis of batch reactors for kinetic interpretation of the data, Constant-volume Batch Reactor, Varying-volume Batch Reactor, Search for a Rate Equation **(7)**

4. Reactor Design for Single and Multiple Reactions: Introduction to Reactor Design, Ideal Batch Reactors, Steady State Mixed Flow Reactors, Steady-State Plug Flow Reactors for a single reaction, Design equation of Mixed Flow Reactors (CSTR) and Plug Flow Reactor, Design for Multiple Reactions. **(9)**

5. Heterogeneous system: Introduction to design of heterogeneous reacting system, concept of non-ideality, age distribution function and inter relationship. **(6)**

6. Instrumentation: Principles of measurement: error, accuracy and sensitivity, measurement of flow, pressure, temperature level, pH, viscosity and chemical composition. **(5)**

7. Process Control: Basic concepts of feedback control, control loop and its element, Dynamic behavior of first, second, higher order physical systems, controller hardware, choice of controllers and settings, Introduction to advanced control system: feedback, forward, cascade and ratio control. **(7)**

Course Outcomes:
1.Build basic knowledge of classification of reactions.
2. Understand kinetics of competing reactions and their influence on product yield and selectivity
3. Understand fundamentals of kinetics including definitions of rate and forms of rate expressions and relationships between moles, concentration, extent of reaction and conversion.
4. Develop skills to choose the right reactor among single, multiple, recycle reactors etc.

Suggested Books:
1. Basic principles and calculation of Chemical Engineering by D.M. Himmelblau Publisher: Prentice Hall, 8th edition (2012)
2. Chemical Process Control, an introduction to theory and practice by G. Stephanopoulos. Publisher: Prentice Hall Inc. (1984)
3. Chemical reaction engineering by O. Levenspiel. Publisher: John Wiley and Sons Inc. 3rd edition (2006)

BTBT-18502 Genetic Engineering

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Objective: To develop an understanding about tools and techniques for gene manipulation and gene exploration. At the end of the course, the students will be able to utilize the knowledge for creation of genetically modified organisms.

1. Introduction: Scope of genetic engineering, Milestones in genetic engineering, cloning and patenting of life forms, genetic engineering guidelines **(3)**

2. Molecular tools and their applications: DNA & RNA modifying enzymes: Restriction enzymes and other endonucleases, Exonucleases, Polymerases, Kinases, Methylases and Ligases. **(4)**

3. Molecular Techniques: Restriction analysis of DNA, Restriction map, electrophoretic techniques for nucleic acid protein analyses, DNA sequencing (Next generation sequencing, shot gun sequencing), Chemical synthesis of oligonucleotides, Southern, Northern and Western blotting techniques. **(7)**

4. Different vectors for molecular cloning: Plasmids, Bacteriophages, Phagemids, Cosmids; YAC and BAC, Transformation Techniques, Methods of gene transfer in Plants and Animals: Chemical, Physical & Viral mediated DNA transfer **(7)**

5. Nucleic acid libraries: Construction of genomic and cDNA libraries; Gene specific probes; Screening strategies for isolation of genes **(5)**

6. Alternative strategies of gene cloning: PCR techniques and their applications, introduction to two and three hybrid systems, nucleic acids microarrays. Reporter Gene Assays, DNA Protein Interactions: EMSA, DNA Footprinting, DNA Fingerprinting **(4)**

7. Applications: Random and site-directed mutagenesis, Expression strategies for heterologous genes: Expression of recombinant recombinant proteins in Bacteria, Yeast, Insect cells, Mammalian and Plant cells. Targetted Genome editing (ZFNs, TALENs, CRISPRs /Cas9). **(6)**

Course Outcomes:

Students will be able to

1. apply landmark discoveries in developing a number of facile molecular techniques used in rDNA technology.
2. learn how to select the suitable hosts for the individual vectors for different purposes.
3. perform application of PCR in rDNA technology.
4. perform expression of the cloned gene (s) for basic and applied research.
5. gain hands-on training in various molecular techniques for gene manipulation.

Suggested Books:

1.Gene Cloning and DNA Analysis: An Introduction (7th edition) 2015, by T A Brown, Wiley – Blackwell Publications.

2.Recombinant DNA by Watson.J.D. et al, 1993, Scientific American Books, New York.

3.Principles of Gene Manipulation and Genomics (7th edition), by S.B. Promorose and R.M. Twyman, Blackwell Publishing (2006)

4.Molecular Biotechnology by Bernard R.Glick, Jack J,(4th edition), 2010, ASM press.

5. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).

6. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T., Lewin's GENES X, Jones and Bartlett Publishers (2011).

7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2008).

8. Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).

BTBT-18503 Cell and Molecular Biology

L T P
3 0 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles. Students will understand how these cellular components are used to generate and utilize energy in cells. Students will understand the cellular components underlying mitotic cell division. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

1. **Cell**: Structural & functional unit of life, prokaryotic & eukaryotic. Cell organelles – structure & functions, Cytoskeleton & ECM. (6)

2. Cell Division: Binary fission, Mitosis & Meiosis, cell cycle & its regulation. (5)

3. Genetic Material: Architecture of Prokaryotic & Eukaryotic chromosome, Structure and functional properties (Chargaff's rules, sequence complementarity and other properties. (4)

4. DNA replication–Phages, bacteria and eukaryotic systems: initiation, elongation & termination, replication errors & proof reading; DNA damage & repair systems, various models of recombination. (5)

5. Transcription: RNA polymerases & other proteins involved in initiation elongation & termination. Differences between prokaryotic & eukaryotic promoters, cis-regulatory sequence, enhancers/silencers. Cognate transcription factors; RNA processing : capping, tailing, splicing, RNA editing; Operon models & their regulation: the lac operon , The Trp – operon. (7)

6. Translation: Genetic Code & Its important attributes, structure and functions of ribosomes, tRNA & mRNAs.; Prokaryotc & eukaryotic inititation, elongation & termination of transtation ; Post translational modifications: enzymatic cleavage, acetylation, phosphorytation, methylation, ubiquitization, function of signal peptide and transport. (5)

7. RNA interference, epigenetic regulation of genes (DNA methylation & histone modifications), tumour suppressor genes & apoptosis, oncogenes & cancer. (4)

Course Outcomes:

1.Exhibit a knowledge base in genetics, cell and molecular biology, and anatomy and physiology
2. Represent and illustrate the structural organization of genes and the control of gene expression
3.Conceptualize and describe protein structure, folding and sorting
4.Relate how cell movement and cell-cell communication occur and discuss mechanisms of signal transduction
5. Outline the processes that control eukaryotic cell cycle and cell death.

Suggested Books:

1.Cell and Molecular Biology, Sixth Edition, Gerald Karp.
2.Molecular cell biology, Fifth Edition, Lodish.
3.Molecular Biology of the Cell, Fifth Edition, Bruce Alberts, Alexander Johnson, Julian Lewis,
4.Martin Raff, Keith Roberts, Peter Walter, December 2007.
5.James Watson, Molecular Biology of the Gene, Pearson, 6th Edition, 2008.

BTMC-II Constitution of India

Internal Marks: 00 **L T P**
External Marks: 00 **2 0 0**
Total Marks: 00

Course Objectives: The objective of the course is to provide students about the meaning of constitution, salient features and characteristics of the Constitution of India, Fundamental rights, Constitutional Powers and Procedure, Parliamentary Form of Government in India.

Course Contents: Meaning of the constitution law and constitutionalism
Historical perspective of the Constitution of India
Salient features and characteristics of the Constitution of India
Scheme of the fundamental rights
The scheme of the Fundamental Duties and its legal status
The Directive Principles of State Policy – Its importance and implementation
Federal structure and distribution of legislative and financial powers between the Union and the States
Parliamentary Form of Government in India – The constitution powers and status of the President of India
Amendment of the Constitutional Powers and Procedure
The historical perspectives of the constitutional amendments in India
Emergency Provisions: National Emergency, President Rule, Financial Emergency
Local Self Government – Constitutional Scheme in India
Scheme of the Fundamental Right to Equality
Scheme of the Fundamental Right to certain Freedom under Article 19
Scope of the Right to Life and Personal Liberty under Article 21.

Suggested Books:

1. Introduction to Constitution of India, D.D. Basu, Lexis Nexus,23rd Edition

2.The Constitution of India, PM Bhakshi, Universal Law,14th edition

BTHS-18902: Entrepreneurship and Project Management

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Unit1: Entrepreneurship definition, classification of Entrepreneur, Features of Entrepreneurship, Need and importance of Entrepreneurship and Scope of Entrepreneurship in India.

Unit2: Entrepreneurship: Skills and characteristics, Technical, Business, Marketing, Personal Entrepreneurial skills, Project characteristics, Project life cycle phases.

Unit3: Market and Demand Analysis, Collection of market survey, characteristics of market, Demand Forecasting, Market Planning, Product mix, Performance appraisal methods.

Unit4: Project Management, steps in Project Management, Job description of Project Manager, Constraints of project Management, Feasibility study, Steps in feasibility study.

Recommended Books:

1.Chandra, P. (2002). Projects Planning,Analysis,Selection,Financing,Implementation and Review. New Delhi: Tata McGraw-Hill.

2.Gray F.Clifford, L. W. (2008). Project Management The Managerial Process. McGraw Hill

BTBT-18504 Biotech Lab-V Genetic Engineering Lab

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 4**
Total Marks: 50

1. To extract genomic DNA from prokaryotes.
2. To extract genomic DNA from eukaryotes.
3. To analyse nucleic acids qualitatively (agarose gel electrophoresis) and quantitatively (photometry).
4. To isolate Plasmid DNA from bacterial cultures.
5. To isolate RNA from bacterial cultures.
6. To perform Restriction digestion of isolated nucleic acids.
7. To perform basic molecular cloning of DNA.
8. To amplify DNA using polymerase chain reaction.
9. To perform Western Blotting of protein samples.

BTBT-18505 Biotech Lab- VI Cell and Molecular Biology Lab

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 4**
Total Marks: 50

1. Microscopic study of shape and size of bacterial, fungal and plant cells.
2. Microscopic study of dividing cells in different phases of mitosis.
3. To study the cell membrane properties.
4. To perform lignin staining.
5. Isolation and quantification of total proteins of the cells.
6. Isolation and quantification of carbohydrates and lipids from different biological sources.
7. Purification of fibronectin from human plasma by gelatin affinity chromatography and analysis by SDS-PAGE.
8. Demonstration of inducible expression of genes in bacteria.

BTBT-18601 Fundamentals of Biochemical Engineering

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
Total Marks: 100

Course Objectives: The objective of this course is to familiarize students about the bioprocesses as well as to impart knowledge of mass and energy balance in biological systems, growth kinetics of microorganism and scale up in bioreactor, bioreactor design, and process control in biochemical engineering system. After the study of this course, a student is expected to analyze as well as select different processes and process parameters.

1. Introduction & Stoichiometry of Microbial Growth: Biochemical processes vs Chemical processes, Advantages & Disadvantages, Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients, energetic analysis of microbial growth and product formation. **(8)**

2. Kinetics of Microbial Growth: Monod growth kinetics, other forms of growth kinetics, unstructured batch growth models, kinetics for balanced growth cycle phases for batch, growth of filamentous organisms, structured kinetic models. **(7)**

3. Sterilization: Introduction, sterilization of air, medium, bioreactor, kinetics of death, theory of depth filters, design of depth filters, design of batch sterilization & continuous sterilization process. **(7)**

4. Cell Cultivation & Inoculum Development: Inoculum Development & Aseptic transfer, Criteria for inoculum transfer, aseptic inoculation, different types of pumps and valves used in biochemical processes. **(7)**

5. Growth Kinetics in Bioreactor: Ideal reactors for kinetics measurement: chemostat, turbidostat, batch, fed batch and continuous cultivation, chemostat with recycle. **(7)**

6. Scale-up in Bioreactors: Overview of reactor, types of bioreactor, their parts and functions, aeration and agitation of bioreactor, mass transfer, molecular diffusion, diffusion theory, film theory, gas-liquid mass transfer, oxygen transfer from gas bubble to cell, oxygen uptake rate, Crabtree effect, experimental determination of KL_a values, factors affecting KL_a value, scale- up principles and its difficulties, scale down. **(7)**

7. Instrumentation and Control of Bioprocesses: Methods of measuring process variables, online and offline analytical methods, control systems. **(5)**

Course Outcomes:
1. Calculate and analyze the kinetic parameters for microbial growth.
2. Calculate the kinetic parameters of enzymatic reactions.
3. Analyze bioprocess design and operation.
4. Select suitable bioreactor.

Suggested Books:

1. Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of Fermentation Technology. Butterworth-Heinemann, 2016.

2. Aiba, Shuichi, Arthur E. Humphrey, and Nancy F. Millis. "Biochemical engineering." Biochemical Engineering. University of Tokyo, 1965.

3. Shuler, Michael L., and Fikret Kargi. "Bioprocess Engineering: Basic Concepts, 2001. Doran, P. M. "Bioprocess engineering principles." 2013.

4. Nielsen, Jens, John Villadsen, and Gunnar Lidén. "Bioreaction Engineering Principles." 1994.

5. Coulson, John Metcalfe, John Francis Richardson, and D. G. Peacock. Chemical and Biochemical Reactors and Process Control. Vol. 3. Elsevier, 1994.

BTBT-18602 Plant Biotechnology

L T P
4 0 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives: The objective of the course to familiarize the students to understand the concepts of plant tissue culture, Genetic engineering in plant, Development of transgenic plants and its industrial application. Along with the technological aspects, this course also focuses on different ethical issues related to transgenic crops.

1. Introduction: Plant tissue culture and scope of plant biotechnology, plasticity and totipotency, various media formulations, plant growth regulators, callus and suspension cultures. (5)

2. Plant Propagation: Micropropagation, organogenesis and somatic embryogenesis, haploid plants and homozygous lines, embryo culture and rescue. (7)

3. Plant regeneration: Protoplast isolation, culture and fusion, selection of hybrid cells, regeneration of hybrid plants, bioresource conservation. (8)

4. Gene expression in plants: Architecture of plant nuclear, chloroplast and mitochondrial genomes, structural aspects of plant genes, regulation of gene expression, transposons, cytoplasmic male sterility, molecular markers. (7)

5. Transgenic plants: Introduction to plant genetic engineering; strategies of molecular cloning and manipulation of plant genes, various methods of plant genetic transformation, Agrobacterium mediated genetic transformation of plants (Ti and Ri-plasmid vectors), direct transformation of plants, introducing resistance to herbicides, virus, pest and fungal pathogens, abiotic and biotic stress in plants, improvement of plant starch, storage proteins and oils, genetic engineering of chloroplast. (9)

6. Applications of transgenic plants: Control mechanisms and manipulation of biosynthetic pathways of the aromatic amino acids tryptophan, tyrosine and phenylalanine in plants; introduction to secondary metabolites, plant cell culture techniques for production of secondary metabolites, commercially important enzymes, therapeutic proteins, edible vaccines, bioplastics, and other novel compounds. (8)

7. Ethical issues: Plant transgenics: issues and concerns, biosafety, societal and ethical aspects of genetically modified foods and crops. (4)

Course Outcomes:

1. Recall the basic concepts of Biotechnology and explain fundamental cellular events during the process of plant cell culture development.
2. Apply learned techniques in new or similar situations**.**
3. Determine the factors influencing plant cell differentiation**.**
4. Translate the concepts in future studies and debate on the issue related to GMOs and evaluate its significance.

Suggested Books:

1. Plant Biotechnology by Slater, A., Scott, N.W., and Fowler, M.R., Oxford Univ Press (2008)
2. Introduction to Plant Tissue Culture by Razdan, M.K., Oxford & IBH Publishing Co.(2003)
3. Principles of Gene Manipulation and Genomics by Primrose, S.B., Twyman, R.M., 7thEdition, Blackwell Publishing (2006)
4. Concepts in Biotechnology by Balasubramanian, D., Bryce, C.F.A., Dharmalingam,K.,
5. Green, J., and Jayaraman, K., Revised Edition, COSTED-IBN, Universities Press (2007)
6. Biotechnology by Satyanarayana, U., Books and Allied (P) Ltd, (2005).

BTBT-18603 Food and Fermentation Technology

L T P
3 0 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives: This course will give in-depth knowledge of various natural sources as food and the formulation, processing, manufacturing and packaging of functional foods for prevention and cure of diseases.

1. Introduction: Current status of food processing industry, Role and significance of microorganisms in foods. Concept of Nutraceuticals. Nutraceuticals bridging the gap between food and drug. Single cell protein, mushroom, yeast/algal proteins. (5)

2. Antioxidants and Additives: Concepts of free radicals and antioxidants, Food additives like colors, flavors and vitamins. Humectants, anti-caking agents, pH control agents, thickeners. (3)

3. Processing of beverages: Tea, coffee and cocoa, Production of alcoholic beverages. Enzyme catalytic actions in food process waste- whey, molasses, starch substrates and other food waste for bioconversion to useful products. Application of enzymes for production in biochemical and food processing industries. (6)

4. Processing of grains and vegetables: rice and rice products. Milling of wheat, corn, barley, oat; Production of wheat products (flour, semolina etc.) Production of starch, modified starch. Production of fruits and vegetable juices, Preparation of jam, jelly, marmalade and tomato products (sauce and ketchup). (6)

5. Meat processing: Fish byproducts - production of fish meal, fish protein concentrate, fish protein hydrolysate fish liver oil and fish silage; Production of non-food items from fish processing wastes. Meat processing - curing and smoking; Fermented meat products (sausages and sauces); By-products from meat industries and their utilization. Egg processing and Byproduct Utilization. (6)

6. Fermentation of milk and fermented milk products: Cheese, yogurt, etc including probiotic dairy products. Dairy processing by-products–Fermented, condensed and dried products from whey. Processing of oils and plastic fat. Pyrolysis of fats, toxicity of frying oil. (6)

7. Food preservation techniques & Quality control: Preservation principle, Stability Food Preservation with Low Temperatures and High Temperatures, Preservation of Foods by Drying, Ionization radiation; Use of preservatives in foods. Miscellaneous Food Preservation Methods, Quality control, food safety standards. (4)

Course Outcomes:

1. Understand the important genera of microorganisms associated with food and their characteristics, their growth pattern and parameters.
2. Knowledge about the beneficial role of microorganisms and different types of fermented foods
3. Identify the role of microorganisms in food borne diseases and control measures

Suggested Books:

1. Food Microbiology by Frazier, W.C. and Westhofff, D.C., Tata McGraw Hill.
2. Food Biotechnology: Principles and Practices,by Vinod K. Joshi,I K International Publishing House Pvt. Ltd; First Edition edition 2013
3. Food Biotechnology by Ulf Stahl, Ute E.B. Donalies, Elke Nevoigt,Springer 2008
4. Food Biotechnology by Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, Talyor and Francis Group,2005

BTHS-18903 Human Resource Management

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Unit 1. Introduction:
Introduction to Human Resource Management and its definition, functions of Human Resource Management & its relation to other managerial functions. Nature, Scope and Importance of Human Resource Management in Industry, Role & position of Personnel function in the organization.

Unit 2. Procurement and Placement:
Process of Human Resource Planning; Methods of Recruitment; Types tests and interviewing, Selection and its procedure Meaning and Importance of Placement and Induction,

Unit 3. Training & Development:
Difference between training and development; Principles of Training, Performance Appraisal, Career Development & Planning.

Unit 4. Job analysis & Design:
Job Analysis: Job Description & Job Description, Job Specification.

Unit 5. Job Satisfaction:
Job satisfaction and its importance; Motivation, Factors affecting motivation, introduction to Motivation Theory; Workers ' Participation, Quality of work life.

Suggested Books:

1. T.N.Chhabra- Human Resource Management (Dhanpat Rai & Co.)
2. Lowin B. Flippo - Principles of personnel Management (Mc Graw-Hill)
3. R.C. Saxena - Labour Problems and social welfare (K.Math & Co.)
4. A Minappa and M. S. Saiyada - Personnel Management (Tata Mc. Graw-Hill)
5. C.B. Mamoria - Personnel Management (Himalaya Publishing House, Bombay)
6. T.N. Bhagotiwal - Economics of Labour and Industrial Relations (Sahitya Bhawan Agra)

BTBT-18604 Biotech Lab-VII (Plant Biotechnology Lab)

Internal Marks: 30 **L T P**

External Marks: 20 **0 0 3**

Total Marks: 50

1. Preparation of stock solutions of MS basal media
2. Collection and surface sterilization of different explants and establishment of plant germplasm under in vitro condition
3. To induce Callus from the explant of avialable plant (Solanum lycopersicum) regeneration and morphogenesis study.
4. To prepare hydrated synthetic seeds from embryo of Brassica juncea seeds in vitro.
5. Protoplast isolation techniques (Mechanical and Enzymatic method).
6. Micropropagation, hardening and acclimatization
7. Cell suspension culture of Seedlings of Phaseolus mungo
8. Direct Organogenesis – From Shoot Tip Culture Bougainvillea

BTBT-18605 Biotech Lab-VIII (Bioprocess Engineering Lab)

Internal Marks: 30 **L T P**

External Marks: 20 **0 0 4**

Total Marks: 50

1. Isolation of industrially important microorganisms (amylase producing bacteria from potato field soil) for microbial processes.
2. Determination of thermal death point and thermal death time of microorganisms for design of a sterilizer.
3. Determination of growth curve of a supplied microorganism.
4. To study the batch growth kinetics and establish the key kinetic parameters (Monod Parameters).
5. Cultivation of microorganism in batch reactor.
6. Comparative studies of ethanol production using different substrates (grape juice, sucrose, glucose) and its qualitative analysis.
7. Isolation of bacterial exhibiting antimicrobial activity.
8. Production and estimation of alkaline protease.
9. Sauerkraut fermentation from cabbage
10. Use of alginate for cell immobilization (*Saccharomyces cerevisiae*) used to enhance ethanol production in industry.
11. To estimate the antibiotic sensitivity of microorganisms using Disk Diffusion Method

BTBT-18701 Enzymology and Enzyme Technology

L T P
3 1 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives: The students will learn about enzymes, nomenclature of proteins, enzyme assay, and different hypotheses of enzyme and substrate interactions. They will have understanding of kinetics of enzyme catalyzed reaction and enzyme inhibition reaction along with mechanism. They will also learn different methods of immobilization of enzyme, different types of enzyme reactor and understanding mass transfer effect in enzyme reactor.

1. Introduction to Enzyme: Introduction, scope, nomenclature, mechanism of catalysis, monomeric and oligomeric enzyme, metalloenzymes industrial applications. (4)

2. Enzymes Specificity and Assay: Types of specificity, active site, Fischer lock and key hypothesis, Koshland induced-fit hypothesis, hypothesis involving strain or transition-state stabilization, enzyme assay; activity and specific activity, effect of temperature and pH on enzyme activity. (6)

3. Enzyme Kinetics: Method used for investigating the kinetics of enzyme-catalysed reactions: initial velocity studies, rapid-reaction techniques , single substrate steady state kinetics: Henri and MichaelisMenten equation, Briggs-Haldane modification of the Michaelis Menten equation, significance of M-M equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot, Haldane relationship for reversible reactions, Deviation from Hyperbolic enzyme kinetic, Inhibitors and activators, reversible and irreversible enzyme inhibition kinetics, multi-substrate systems, Allosteric enzymes. (10)

4. Enzyme Reactors: Reactors for batch/continuous enzymatic processing, choice of reactor type, idealized enzyme reactor systems (7)

5. Immobilization of Enzymes: Advantages, carriers, adsorption, covalent coupling, cross linking and entrapments, and Effect of immobilization on enzymes. Mass transfer in enzyme reactors, steady state analysis of mass transfer (10)

6. Extraction and Purification of Enzymes: Methods of production of enzymes, Extraction of Enzymes-soluble enzymes- membrane bound enzymes-Nature of Extraction medium-Purification of enzymes-Determination of Molecular weight of enzymes. (6)

7. Challenges and Future trends: Enzyme catalysis in organic media, catalytic antibodies, non-protein biomolecules as catalysts, biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria, Analytical Applications of enzymes (5)

Course Outcomes:

1. Students will obtain basic knowledge about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.
2. They should be able to characterize the enzymes in each enzymatic class, examples of such enzymes and their application in practice.
3. They should understand the regulatory mechanisms of enzyme activity, enzyme inducers and repressors.

Suggested Books:

1. Palmer, Trevor, and P. L. Bonner. Enzymes: Biochemistry, biotechnology, clinical chemistry. Elsevier,2007.

2. Aehle, Wolfgang, ed. Enzymes in industry: Products and applications. John Wiley & Sons, 2006.

3. Illanes, Andrés, ed. Enzyme biocatalysis: Principles and applications. Springer Science & Business Media,2008.

4. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger Principles of Biochemistry. Macmillan, 7th Edition 2017.

BTBT-18702 Bioinformatics

L T P
3 0 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives: The objective is to help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics tools to solve the problems in their own research. Also the student should obtain the basic skill required to survive in the industry

1. Introduction to Biological Database: Overview, Types of biological databases, Nucleic acid databases (NCBI, EMBL etc); Protein Databases: Database Searching, Description of the entries and Sequence Data File, Sample Sequence Data File, Representation of sequence. (3)

2. Sequence Analysis & Alignment: Statistical significance of alignment; Sequence assembly Analysis; Global & Local Alignment and their algorithms, Pair-wise and Multiple sequence alignment: Scoring matrices- PAM, BLOSUM, PSSM, HMM etc., Gaps & gap penalties. Programs and methods for sequence alignment. Dot plots, Dynamic programming algorithms, Heuristics FASTA, BLAST. (6)

3. Phylogenetic Analysis: Elements of phylogenetic models, phylogenetic data analysis: alignment, substitution, parsimony, model building, building the data model (alignment), determining substitution model, phylogenetic prediction, evolutionary tree construction, tree building methods, searching for trees, rooting trees, evaluation tree & data phylogenetic software like PHYLIP, CLUSTAL W, Tcofee, Phylogenetics on the web, Synteny (comparison of grass genomes), COGS (Cluster of Orthologous genes. (8)

4. Predictive methods using nucleotide sequence: Annotation of DNA and protein sequences, Codon bias detection, Detecting functional site in DNA, ESTs, Polymorphism, finding RNA genes (5)

5. Predictive methods using protein sequence: protein identity based on composition, physical properties based on sequence, secondary structure, specialized structures or features, tertiary and quaternary structures. (5)

6. Protein structure prediction: Protein structure classification, 3D proteins structure file formats: PDB, CIF, MMDB; secondary & tertiary structure predictions: threading, Fold recognition, Homology modelling, Protein visualization tools: Rasmol, Swiss-PDB etc. (6)

7. Applications of Bioinformatics in Biotechnology: gene prediction in prokaryotes, eukaryotes; other applications in the areas of health, food and medicine. (3)

Course Outcomes:

1. Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
2. Existing software effectively to extract information from large databases and to use this information in computer modeling
3. Problem-solving skills, including the ability to develop new algorithms and analysis methods
4. An understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries

Suggested Books:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, By Andreas D, Baxevanis, B.F, Francis O, Wiley –Interscience, 4th Edition, 2013.

2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press, U.S.; 2nd Revised edition edition 2004.

3.Bioinformatics and the genome projects by Smith DW, Academic Press, 2006

4.Bioinformatics: A Biological Guide to computing and the Internet by Stuart M and Brown NYU, Mecical Centre, NY USA, 2000.Textbook of Biotechnology, H K Das, Wiley- India (P) Ltd., New Delhi (2005).

BTBT-18703 Biomedical Instrumentation

L T P
3 0 0

Internal Marks: 40
External Marks: 60
Total Marks: 100

Course Objectives: The main objective of this course is to introduce student to basic biomedical engineering technology. As a result, student can understand and evaluate systems and devices that can measure, test and/or acquire biological information from the human body as well as interpret that information to make diagnosis.

1. Introduction: Introduction to the physiology of cardiac systems, physiology of respiratory systems, physiology of nervous systems. (6)

2. Basic Transducer Principles: Transducer principles and different types of transducers (active & passive transducers), transducers for biomedical applications (5)

3. Electrodes: Electrode theory, bio potential electrodes, biochemical transducers. (4)

4. Cardiovascular Measurements: Electrocardiography, measurement of blood pressure, (indirect measurement), measurement of blood flow & cardiac output (blood flow-magnetic blood flow meter, ultrasonic blood flow meter), plethysmography, cardiac pacemaker, measurement of heart sound. (7)

5. Measurements in the Respiratory System: Respiratory mechanism, measurement of gas volumes & flow rate, instrument for measuring the mechanism of breathing, spirometer (5)

6**. Noninvasive Diagnostic Instrumentation**: Temperature measurement-systemic body temperature, skin temperature, principles of ultrasonic measurement properties, principles of ultrasonic measurement basic modes, MRI (Principle and application) (5)

7. The Nervous System: Electroencephalograph and Electromyography. (4)

Course Outcomes:
After the successful completion of the course the students will be able to:
1. Differentiate and analyse the biomedical signal sources.
2. Elucidate cardiovascular system and related measurements.
3. Explain the respiratory and nervous systems and related measurements
4. measure non-invasive diagnostic parameters.

Suggested Books:

1. Anandanatarajan, R.Biomedical instrumentation and measurements. PHI Learning Pvt. Ltd., 2011.
2. Bronzino, Joseph D. "The Biomedical Engineering Handbook; Biomedical Engineering Fundamentals." 2006.
3. Webster, John G. Bioinstrumentation. Wiley, 2004.
4. Khandpur, R. S. "Handbook of Biomedical Instrumentation." 2011.
5. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.

BTBT-18704 Biotech Lab-IX (Enzymology and enzyme Technology Lab)

Internal Marks: 30 **L T P**
External Marks: 20 **0 0 4**
Total Marks: 50

1. Isolation of amylase from bacteria/ protease from pulse/ cellulase from fungi
2. Determination of specificity of amylase or cellulase or protease enzyme.
3. Partial purification of enzyme by ammonium sulphate fractionation
4. To perform enzyme assay to find enzyme activity of amylase or cellulase or protease.
5. Determination of protein content of purified enzyme to get specific activity.
6. Kinetics of enzyme catalaysed reactions: Effect of varying substrate concentration on enzyme activity.
7. Determination of Michaelis-Menten constant (K_m) and Maximum Velocity (V_{max}.) using LineweaverBurk plot

8 Determination of effect of temperature and pH on enzyme activity

9. Immobilization of enzyme using sodium alginate beads.

BTBT-18705 Biotech Lab-X (Bioinformatics Lab)

L T P
0 0 4

Internal Marks: 30
External Marks: 20
Total Marks: 50

1. Search, retrieval of biological database (PUBMED)
2. Sequence retrieval of Nucleotide and protein databases
3. Interconversion of different file formats
4. Database homology with query sequences using BLAST and its applications.
5. Pairwise alignment of sequences
6. Multiple sequence alignment and phylogenetic analysis.
7. HMM for sequence analysis (expand HMM)
8. Sequence analysis packages: EMBOSS, NCBI Tool Kit
9. Secondary Structure prediction of the protein sequences.
10. Tertiary Structure prediction of the protein sequences.
11. Structure visualization tools: Rasmol, Pymol, SPD viewer.

BTBT-18706 Summer Internship

Internal Marks: 00
External Marks: 100
Total Marks: 100

L	T	P
0	0	0

Each student will be required to submit a report after the completion of Industrial training. The reports will be assessed by teachers in-charge of the training. The student has to appear in external Viva- Voce examination.

BTBT-18801 Industrial Training

External Marks: 200 **L T P**
Internal Marks: 200 **0 0 0**
Total Marks: 400

Each student will be required to submit a report after the completion of Industrial / institutional training. The reports will be assessed by teachers in-charge of the training. The student has to appear in internal and external Viva- Voce examination.

BTBT-18951 IPR Management in Biotechnology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: Understand IP laws that directly affect the creation, transfer, and licensing of IP with specific reference to patenting issues in biotechnology and pharmaceuticals fields and International Agreements pertaining to IP protection and relate them to the current issues.

1. **Introduction**: General introduction, Patent claims, the legal decision-making process. Ownership of tangible and intellectual property (5)

2. **Basic Requirement of Patentability**: Patentable subject matter, novelty and public domain, non obviousness (5)

3. **Special issue in Biotechnological Patents:** Disclosure requirements, collaborative research, competitive research, plant biotechnology, foreign patents. (5)

4. **Patent Litigation:** Substantive aspects of patent litigation, procedural aspects of patent litigation, recent developments in patent system and patentability of biotechnology invention. IPR issues in the Indian context current patent laws. (5)

5. **Public acceptance issue for Biotech,** case studies/ experience from developing and developed countries. Biotechnology and hunger. Challenges for the Indian, biotechnological research and industries. (6)

6. The Cartagena protocol on biosafety. (5)

7. **Biosafety Management:** Key to the environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques (5)

Course Outcomes:
Students will be able to
1. interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life
2. recognize importance of biosafety practices and guidelines in research
3. comprehend benefits of GM technology and related issues
4. recognize importance of protection of new knowledge and innovations and its role in business

Suggested Books:
1. Sign KC : Intellectual Property Rights on Biotechnology , BCIL, New Delhi
2. .BAREACT, Indian Patent ACT 1970 Acts & Rules, Universal Law Publishing Co.Pvt Ltd., 2007.
3. Biotechnology and IPR by Dr. T. Ramakrishna, NLSIU, Bangalore.
4. Intellectual Property by Bently, Lionel, Oxford University Press, 2001.
5. T. M Murray and M.J. Mehlman,Encyclopedia of Ethical, Legal and Policy issues in
6. Biotechnology, John Wiley & Sons 2000.
7. Intellectual Property Rights in the WTO and developing country by Watal Jayashree, Oxford University Press, 2001.

BTBT-18952 Stem Cell Technology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Objective: To impart students knowledge of wide-ranging topics related to stem cells and regenerative biology, including a brief history of the field, research on animal models of regeneration, tissue engineering, social and ethical issues related to stem cell research.

1. Introduction to Stem Cells: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells. **(3)**

2. Stem Cell Niche: Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues **(5)**

3. Cell Cycle and Development: Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self renewal **(7)**

4. Epigenetic Control: DNA-methylation and histone modifications, genomicimprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications **(7)**

5. Types and Regeneration: Stem cells derived from amniotic fluid, extra embryonic membrane, germ cells, hematopoietic organs, neurons and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, bone marrow and cord blood collection procedures and cryopreservation **(6)**

6. Experimental Methods: Isolation and differentiation of human adult stem cells, embryonic stem cells and mouse stem cells, stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging. **(5)**

7. Applications: Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns **(3)**

Course Outcomes:
Students will be able to
1. comprehend the concept of stem cells, different types of stem cells
2. describe the concept of stem cell cloning and its applications
3. recognize treatment of human diseases connected to stem cell therapy.

Suggested Books:
1. Essentials of Stem Cell Biology by Lanza, R., 3rd Edition, 2013 Academic Press
2. Stem Cells: From Bench to Bedside by Bongso and Ariff. 3rd edition 2010 World scientific.
3. Hematopietic Stem Cell Transplantation by Treleaven, J., first edition 2009
4. Molecular Cell Biology by Lodish et al., eighth Ed., W.H. Freeman & Co. 2016

BTBT 18953 Advances in Drug Design and Pharmacogenomics

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: The objective of this course is to provide comprehensive knowledge of the basics of the drug discovery and development in the area of pharmacogenomics and natural products traditional and complementary medicine, synthetic medicinal chemistry and development of modern and innovative therapeutic substances.

1. Introduction: Definition of drugs, Overview of drug discovery process, Economics of drug discovery process, Trends in drug discovery process. Medical needs, Target identification, Target validation, Receptors and assay development. Docking Principles and its types. (6)

2. Screening Strategies for Drug Leads: Bioprospecting, plant natural products, Microbial secondary metabolites, Marine natural products**:** Bioassay guided isolation, High throughput assays for antimicrobial, anticancer, anti-diabetic and anti-hypercholesterolemia, combinatorial chemogenomics, combinatorial chemistry. Characterization of drug molecules using integrated technology (TLC, HPLC, MS, IR, NMR) (6).

3. Drug Development and Pre-Clinical Studies: Introduction to structure–activity relationships (SAR), Drug receptor interactions; enzyme inhibition and inactivation, In vitro and in vivo pharmacodynamic models, Therapeutic index, Pharmacokinetics - Microbial and animal models, Lipinski's rule, In vitro and in silico toxicological models, Drug formulations. (7)

4. Biosimilar: Introduction to biologics, defining biosimilar, differences between biosimilars and generics, selected examples of approved biosimilars, technical challenges associated with production of biosimilar molecules, regulatory aspects of biosimilar molecules. Current status of biosimilars in different countries (Europe, USA). (6)

5. Pharmacogenomics: Basic concepts of pharmacogenomics and genetic diseases and its necessity in drug designing. Tools for pharmacogenomics analysis, pharmacokinetics, pharmacodynamics. (7)

6. **Drug Regulatory Operations and Drug Manufacturing:** Role of Regulatory Authorities, US FDA, Regulatory applications viz. investigational new drug (IND), new drug application (NDA), Abbreviated New Drug Application (ANDA). (4)

Course Outcomes:
1. Demonstrate current approaches and steps of global drug discovery, their advantages and limitations.
2. Demonstrate awareness of different disciplines which play an integral role in drug discovery and development process.
3.Comprehend the key role played by natural products and pharmacogenomics in shaping the pharmaceutical industry

Suggested Books:
1.Benjamin B Basic Principles of Drug Discovery and Development, Academic Press, Ist Edition, ISBN: 9780124115088 (2015)
2. Larsen PK, Leljifore T and Medsan U, Text books of Drug Design and Discovery, CRC Press (2016) 5th Ed
3. Hillisch A and Hilgenfeld R, Modern Methods of Drug Discovery, Birkhauser 1st Edition (2003)
4. Rapley ,R.&Harbron, S'Molecular analysis and Genome discovery'John Willey &sons. Ltd (2011)2nd Ed.

BTBT-18954 Biological Waste Treatment

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: This course is to provide basic understanding of fundamental principles of existing and emerging technologies for the treatment of waste and recovery of value from waste. It provides detailed knowledge and skills in the management, treatment, disposal and recycling options for Biological Waste. Appreciate the increasing importance of waste and resource management in achieving environmental sustainability.

1. Introduction to waste: Types of wastes, Municipal waste, Industrial waste, Agricultural waste and residues, Hazardous waste, Sources of wastes and Environmental impact of waste, characterization of waste- Liquid waste characterization, solid waste characterization, ultimate analysis and proximate analysis. **(5)**

2. Municipal Solid Waste Management: Segregation and recycling and reuse of wastes; Collection, transportation and storage of municipal solid waste; Resource recovery from wastes; waste exchanges; Composting and Vermi-composting of wastes. **(6)**

3. Biomedical Waste Treatment and Disposal: Categories and Classification of biomedical wastes, Major and minor sources, Hazards, Need for disposal of biomedical waste, Waste minimization, Waste segregation and Labeling, Waste handling, collection, storage and transportation, Treatment and disposal. **(6)**

4. Biological Waste Treatment: Role of micro-organisms, microbial metabolism- Respiratory and fermentative, biological treatment processes- Aerobic, Anoxic, Anaerobic and Combined processes. Waste treatment and useful byproducts, solid waste treatment saccharification - gasification - composting- liquid waste treatment - aerobic, anaerobic methods. **(6)**

5. Waste to Energy conversion: Biomass characterization (proximate and ultimate analysis); Biomass pyrolysis and gasification; Biomethanation and biogas plants; biogas enrichment and conditioning, Biofuels – biodiesel, bioethanol, Biobutanol; Algae and biofuels; Hydrolysis & hydrogenation; Solvent extraction of hydrocarbons; Pellets and brikets of biomass; Biomass based thermal power plants; Biomass as boiler fuel; Biomass fuels and GHG emissions. **(8)**

6. **Legal Requirements:** Municipal solid waste rules; Hazardous waste rules; Biomedical waste rules; E-waste rules; Rules related to recycled plastics, used batteries, fly ash, etc. **(5)**

Course Outcomes:
1. Understand the basic concepts of waste generation, its characterization and effective management.
2. Familiar with the recent methods and technologies for characterization and treatment of waste.
3. Aware of Indian rules and regulations about different waste and its management.

Suggested Books:
1. Bio-Medical Waste Management, Sushma Sahai, Published by APH Publishing Corporation, 2009.
2. W.W. Eckenfelder, JR AND D.J.O'Connor, "Biological Waste Treatment" Pergamon Press.
3. Waste Management: A Reference Handbook By Jacqueline Vaughn, ABC-CLIO, Inc.
4. George Tchobanoglous, Frank Kreith, Handbook of Solid waste Management, Second Edition, The McGraw-Hill Companies, Inc.
5. Ram Chandra, Environmental waste management, CRC Press, Taylor & Francis Group, 2015.

BTBT-18955 Introduction to Cancer Biology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: The objective of this course is to introduce current concepts and advances in the area of cancer biology. The students will understand the role of oncogenes and suppressor genes and get knowledge on cancer related mutagens and pathways and cancer therapy

1. Fundamentals of cancer biology: Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers, diet and cancer. **(5)**

2. Principles of carcinogenesis: Theory of carcinogenesis, Chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation-mechanisms of radiation carcinogenesis**.** **(8)**

3. Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes. Oncogenes/proto oncogene activity. Growth factors related to transformation. Telomerases. **(7)**

4. Principles of cancer metastasis: Clinical significances of invasion, heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinases and tumor cell invasion. **(7)**

5. Cancer diagnostic and therapy: Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Role of papilloma, HIV, Epstein Barr Virus, HTLV and herpes in pathogenesis of cancers, diagnosis and prevention. **(9)**

Course Outcomes:
Students will be able to
1. comprehend pathogenesis, molecular mechanisms and identification of cancer
2. explain cancer metastasis microenvironment and cancer therapy
3. explain pathogenesis viral disease and its treatment.

Suggested Books:

1. Sverre Heim, Felix, Mitelman. Cancer Cytogenetics 4th Edition Willy- Blackwell 2015.
2. Robin Hesketh. Introduction to Cancer Biology Cambridge, University Press 2013.
3. Fred Bunz. Principles of Cancer Genetics, Springer; 2016 2nd edition
4. Edward K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini, Basic Virology 3rd edition, Wiley-Blackwell 2007.

BTBT-18956 Protein Engineering

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: To make Students learn structural and functional relationships in proteins and altering their structure in order to function 'better'. To provide basic knowledge of enzyme technology and use of enzymes as tools in industry, agriculture and medicine.

1. Protein structure and function: Salient features of amino acids and their –R groups; information of proteins, the Ramachandran plot, folding, tertiary structure and structural domains and motifs of proteins; relationship between structure and function. **(4)**

2. Characterization of Proteins structure: Crystallography and X-Ray Diffraction, Spectroscopy (UV-VIS, NMR, MALDI-TOF, CD Spectroscopy and Fluorescence Spectroscopy) and Calorimetric Methods, Prediction of protein structure and conformation from sequence data. **(5)**

3. Protein stability and folding: Protein stability, Mechanism of protein folding (types, level, thermodynamics, Anfinsen's dogma & Levinthol paradox& kinetics), Folding Rate, Molten globule; Techniques for studying of protein folding (NMR, CD spectroscopy, Proteolysis, Optical tweezers), Computational method. Protein folding errors: Alzheimer's, prions and Mad Cow (BSE, CJD), Cystic Fibrosis and cancer. (**6)**

4. Protein Folding- Examples and Applications: Location and functions of Molecular chaperones, chaperonin and co-chaperons, HSP chaperone system in *E.coli* & Human; Proteasomes and proteosome mediated protein degradation. Polyketides and non-ribosomal peptides; Combinational manipulation of polyketides and non-ribosomal peptides; application of protein folding to design new drug. **(6)**

5. Protein Engineering and Design-I: Methods in protein engineering and design – physical, computational, biochemical and molecular techniques; protein engineering in lysozyme and pepsin class of enzymes; chemical modifications of proteins; protein design, design of peptide and protein mimics. **(7)**

6. Protein Engineering and Design-II: protein splicing and its application; Solid phase peptide synthesis, Production of Novel Proteins; Random and site directed mutagenesis, Methods for Expressing Recombinant Proteins; Industrial applications of Protein Engineering (Engineering of Stability, affinity for substrate, Protease Specificity, Cofactor requirements of Protein). **(8)**

Course Outcomes:
Students will be able to
1. comprehend the importance of R groups of the amino acids in any protein/enzyme.
2. know about domains and motifs in a protein and the basis of their prediction
3. know relationship between structure and function of a protein
4. design different strategies for protein engineering and protein design
5. know the principles of isolation and purification of enzymes from various sources
6. comprehend various methods involved in enzyme technology and their commercial applications.

Suggested Books:

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, and Jayaraman R, Concepts in Biotechnology, Universities Press (2007).

2. Rastogi SC, Mendiratta N and Rastogi P, Bioinformatics - Methods and Applications, PHI 4th edition 2013.

3. Satyanarayana, U, Biotechnology, Books and Allied (P) Ltd. (2013).

4. Smith JE, Biotechnology, Cambridge University Press 5th edition (2012).

BTBT-18957 Molecular Farming

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: The students will learn about molecular farming an emerging branch of plant biotechnology and wide range of products for molecular farming of various biomolecules, secondary products and commercially important molecules using plant systems as 'bioreactors'.

1. I**ntroduction: Definition,** common perception and the milestones of plant molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance and advantages of plant-based molecular farming. (6)

2. **Plant Transformation Techniques:** Advantages of various strategies for genetic transformation of plants-stable nuclear and plastid transformation, plant cell-suspension cultures, introduction to transient expression systems. (5)

3. **Factors Affecting Transgene Expression:** Limitations and optimization of plant production systems-choice of suitable host plants, optimizing expression and stability of recombinant proteins, glycosylation aspects, downstream processing of the plant-derived products (7)

4. **Case Studies:** Strategic details of various molecular farming techniques, production of carbohydrates, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose, production of lipids, medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, production of rare fatty acids, production of biodegradable plastics in plants. (7)

5. **Commercially Useful Products:** Genetically engineered plants as protein factories: Enzymes for industrial and agricultural uses, plantibodies and subunit vaccines. (5)

6. S**ocial and Ethical Concerns:** Critical evaluation of various case studies on molecular farming and their future prospects; Economic and regulatory considerations of plant molecular farming. (6)

Course Outcomes:
Students will be able to:
1. develop strategies for modification of plants for production of important molecules.
2. take decision to select the expression system in plants for various proteins and enzymes.
3. Biotransform the existing bio-molecules.

Suggested Books:
1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University Press (2008).
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
3. Biotechnology-an Introduction by Barnum, S.R., Thompson Brooks/Cole (2007).
4. Biotechnology by Satyanarayana, U., Books and Allied (P) Ltd. (2005)

BTBT-18958 Environmental Biotechnology

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Course Objectives: The course content aims to make the student understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or development of stress-tolerant plants which can minimize the harmful impact of pollutants thereby making the planet earth a better dwelling place.

1. Introduction: Environment, Types of Environmental pollution: Air, Water, Land, Radioactive pollution, Measurement of environmental pollution, Microbiology and biochemistry of pollution abatement, Biodegradation methods, Aerobic and anaerobic treatment methods of solid and liquid wastes, Minimum National Standards for Waste Disposal. **(4)**

2. Biodegradation of Xenobiotic Compounds: Xenobiotic compounds–Definition, examples and sources. Biodegradation- Introduction, effect of chemical structure on biodegradation, recalcitrance, co metabolism and biotransformation. Factors affecting biodegradation, microbial degradation of hydrocarbons: long chain aliphatic, aromatic, halogenated, sulfonated compounds, surfactants, pesticides and oil spills **(4)**

3. Bioremediation, Biorestoration and Biotransformation: Introduction and types of bioremediation, bioremediation of surface soil and sludge, subsurface material, In situ and Ex-situ technologies, phytoremediation. Biorestoration: reforestation through micropropagation, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals. Biotransformation: toichiometry, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants **(5)**

4. Microbiology of waste water treatment: Aerobic processes-Activated sludge, Oxidation ditches, Trickling filters, Towers, Rotating discs, Rotating drums, Oxidation ponds, Anaerobic processes: Anaerobic digestion, Anaerobic filters, Upflow anaerobic sludge blanket reactor, Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industry. **(7)**

5. Eco-Friendly Bioproducts from Renewable Sources: Fundamentals of composting process: composting technologies, composting systems and compost quality, scientific aspects and prospects of biofuel production: methanogenic, acetogenic, and fermentative bacteria, anaerobic and aerobic digestion processes and conditions, bioethanol, biohydrogen and biodiesel; biofertilizers and biopesticides. **(6)**

6. Biotechnology in Environment Protection: Current status of biotechnology in environment protection and its future, plasmid borne metabolic activities, bioaugmentation, packaged microorganisms, degradative plasmids, release of genetically engineered organisms in environment **(5)**

7. **Biodiversity:** Definition, species and ecosystem diversity, biogeographical classification of India, value of biodiversity, biodiversity at global, national and local levels. India as a mega-diversity nation, hot-spots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, red data book, rare, endangered, vulnerable and endemic species, conservation of biodiversity: In-situ and Ex-situ conservation, germplasm conservation **(5)**

Course Outcomes: By the end of the course, the student should be able to

1. Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, into consideration.
2. Classify microbes according to energy source and carbon source and evaluate energy outcome of the energy metabolism, treatment technologies of wastewater.
3. Familiar with basic concepts of Renewable Energy, Advancements in renewable energy generation, concept of waste water and its treatment methods.
4. Define basic concepts in microbial ecology, biological diversity and its conservation.

Suggested Books:

1. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications.
2. Introduction to Waste Water Treatment- R. S. Ramalho, Academic Press.
3. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.
4. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press,2007.
5. Environmental Biotech, Pradipta Krimar, I.K. International Pvt. Ltd., 2006.
6. Environmental Microbiology & Biotechnology, D.P. Singh, S.K. Dwivedi, New Age International Publishers, 2004.
7. Biodegradation and Bioremediation 1999 (2nd editon). Martin Alexander, Elsevier Science & Technology.
8. Environmental Biotechnology by Bruce Rittmann and Perry McCarty

BTBT-18959 Pharmaceutical Biotechnology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: The objective of this course is to make students understand the basic concepts involved in pharmaceutical industry. The course will give knowledge about new drug development and approval process, ADMET of drugs, about the manufacturing and quality control of conventional, new type of dosage forms and biotechnology derived pharmaceuticals.

1.Introduction to drugs and pharmacy: An overview and history of pharmaceutical industry. The business and the future of Biopharmaceuticals. Drug regulation and control. Scope and applications of biotechnology in pharmacy. **(7)**

2. New drug development and approval process: Strategies for new drug discovery, finding a lead compound, combinatorial approaches to new drug discovery, pre-clinical and clinical trials. **(6)**

3. Drug pharmacokinetics & pharmacodynamics: Routes of drug administration, membrane transport of drugs, absorption, distribution, metabolism and excretion of drugs. Factors modifying drug action, mechanism of drug action on human beings, receptor theory of drug action, pharmacogenomics, adverse effects of drugs and toxicology, Drug interactions. **(8)**

4. Pharmaceutical manufacturing: Drug dosage forms and their classification. Sterile dosage forms-parenteral and biologics, novel dosage forms and targeted drug delivery systems. Current good manufacturing practices and issues. Packaging material and techniques. Quality control of pharmaceutical products as per pharmacopoeia. Microbial assays of vitamins and antibiotics. Stability studies, Method validation. **(7)**

5. Biotechnology derived pharmaceuticals. Production of pharmaceuticals by genetically engineered cells-hormones and vaccines. Regulatory issues in pharmaceutical products. Quality control of antibiotic and non-antibiotic formulations using titrimetric, spectrophotometric, chromatographic methods as per IP/US Pharmacopoeia. Microbiological assays of vitamins and antibiotics. Sterility testing and stability testing of parenteral formulations. **(8)**

Course Outcomes :

Students will be able to

1. explain the strategies and various steps of new drug discovery process.
2. explain the concept of pharmacodynamics and pharmacokinetics
3. apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones
4. carry out the quality control procedures in the production of various biopharmaceuticals
5. explain the regulatory aspects in the development of pharmaceuticals.

Suggested Books:

1. Allen, L.V., Popovich, N.G. and Ansel, H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins 11th edition (2018).

2. Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, Wiley 2ne edition (2009).

3. Gennaro, A.R., Remington: The Science and Practice of Pharmacy. Lippincott Williams and Wilkins 21st edition (2008).

4. Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers 8th edition (2018).

BTBT-18960 Agricultural Biotechnology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Objective: The objective of the course is to familiarize the students with basic concept, advanced research areas and Industrial application of Agriculture Biotechnology. At the end of the course, the students will have sufficient scientific understanding of Agriculture Biotechnology and apply this knowledge to research and industrial related activities to increase the productivity.

1. Introduction: Introduction and importance of agriculture in national economy. Basic techniques and tools in plant tissue culture, Establishment of callus, suspension cultures, organogenesis and embryogenesis, Meristem tip culture, Hardening of plants, Techniques of anther, embryo and ovule culture. Protoplast isolation, culture and fusion. Artificial seed (synthetic seed) and its importance **(6)**

2. Methods of Crop Improvement: Conventional methods for crop improvement (Pedigree breeding, Heterosis breeding, Mutation breeding). Tissue culture in crop improvement, Micropropagation for virus-free plants, Somaclonal variation, Somatic hybridization, Haploids in plant breeding, Recombinant DNA technology, Genetic Engineering of Crop Plants, Methods of plant transformation, Transgenic Plants, Molecular Markers, QTL Mapping. **(10)**

3. Microbes in Agriculture and Food: Applied Microbiology in the future of mankind, moving frontiers of applied microbiology, microbial enzymes and their applications in food processing and agrochemical industries, agro-waste utilization, biodegradable polymers and their applications, microbial polysaccharides; Production and utilization of essential amino-acids, chemicals from microalgae. **(7)**

4. Secondary Metabolite Production: Production of Secondary Metabolites, Production of foreign compounds in transgenic plant, Achievements and recent developments of genetic engineering in agriculture. Microbial Biopesticides, Biofungicides, Herbicides, and Agricultural antibiotic. **(7)**

5. Ethical Issues, Acceptance and Developments in India: Ethical Aspects and Public Acceptance, Animal farming. Important rural development programmes in India; organizational set up agricultural research, education and extension in India. **(6)**

Course Outcomes:
Students will be able to:
1. undertake propagation of plant in culture and plan commercial production of plants through micropropagation
2. certify tissue culture raised plants
3. undertake trade specific modification through plant genetic manipulation and somatic hybridization
4. develop various gene constructs and their expression in plants

Suggested Books:
1. Agricultural Biotechnology by Arie Altman. Marcel Dekker, Inc. (2001).
2. Biotechnology by B.D.Singh, Kalyani Publication.
3. Agriculture Biotechnology-Hemant Rawat, Oxford Book Company
4. M J Chrispeels, Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers, Inc., 2nd Sub Edition, 2002.
5. B Shmaefsky, Biotechnology on the Farm and in the Factory: Agricultural and Industrial Applications (Biotechnology in the 21stCentury), Chelsea House Publications, 2005.
6. Plant Biotechnology and Agriculture: Prospects for the 21st Century, Altman, Arie (EDT)/ Hasegawa, Paul Michael (EDT) Elsevier Science Publishing Co Inc 2011-12-13, San Diego, 2011

BTBT-18970 Industrial Waste Management

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Course Objectives: This course will provide an introduction about the polluting potential of major industries in the country and the methods of controlling the same. To familiarize the methods of pollution prevention in industries, life cycle assessment of products and design for environment.

1. Introduction: Pollution Index, Types of industries and Industrial pollution – Characteristics of industrial wastes- Physical, Chemical and Biological characteristics, effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health. Environmental legislations related to prevention and control of industrial effluents and hazardous wastes. **(6)**

2. Pollution from Major Industries: Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants, Wastewater reclamation concepts. **(9)**

3. Authorities and Regulations: Environment friendly chemical processes, Material and process modifications, Concept of Green Chemistry, Regulations for clean environment and implications for industries- International Environmental Standards-Environmental technology assessment. **(6)**

4. Source Reduction and Treatment Technologies: Waste management Approach – Waste Audit – Volume and strength reduction, Recycle, reuse and byproduct recovery – Applications, residuals Management-Economic recovery and recycling of wastes. Equalization, Neutralization, Removal of suspended and dissolved organic solids – Chemical oxidation – Adsorption - Removal of dissolved in-organics, Combined treatment of industrial and municipal wastes, Dewatering – Disposal. **(9)**

5. Hazardous Waste Management: Hazardous wastes, Physico chemical treatment, solidification, Incineration, Secured landfills, Industrial applications of pollution prevention, Life cycle assessment, and technology assessments **(6)**

Course Outcomes:
1. An insight into the pollution from major industries including the sources and characteristics of pollutants.
2. Understand the concept of pollution prevention and its related technologies.
3. Familiar with concepts for the processing and reclamation of Industrial waste water.

Suggested Books:
1. Melcalf & Eddy, George Tchobanoglous, Wastewater Engineering: Treatment and Resource Recovery, McGraw-Hill Education; 5 edition (2013)
2. James G. Mann and Y.A.Liu, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 2009.
3. Eckenfelder .W.W, "Industrial Water Pollution Control", McGraw-Hill, 2009.
4. M.N.Rao & A.K.Dutta, “Wastewater Treatment”, Oxford - IBH Publication, 1995.
5. Freeman H.M., "Industrial Pollution Prevention Hand Book", McGraw Hill, 2005.

BTBT-18971 Bioinformatics

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: The objective is to help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics tools to solve the problems in their own research. Also the student should obtain the basic skill required to survive in the industry

1. Basic Biology: Biological macromolecules (DNA, RNA, Proteins) **G**enomics, Proteomics, Metabolomics (6)

2. Introduction to Biological Database: Overview, Types of biological databases, Nucleic acid databases (NCBI, EMBL etc); Protein Databases: Database Searching, Description of the entries and Sequence Data File, Sample Sequence Data File, Representation of sequence. (5)

3. Sequence Analysis & Alignment: Statistical significance of alignment; Sequence assembly Analysis; Global & Local Alignment and their algorithms, Pair-wise and Multiple sequence alignment: Scoring matrices- PAM, BLOSUM, PSSM, HMM etc., Gaps & gap penalties. Programs and methods for sequence alignment. Dot plots, Dynamic programming algorithms, Heuristics FASTA, BLAST. (7)

4. Phylogenetic Analysis: Phylogenetic prediction, evolutionary tree construction, tree building methods, searching for trees, rooting trees, evaluation tree & data phylogenetic software like PHYLIP, CLUSTAL W, Tcofee, Phylogenetics on the web, Synteny (comparison of grass genomes), COGS (Cluster of Orthologous genes. (7)

5. Protein structure prediction: Protein structure classification, 3D proteins structure file formats: PDB, CIF, MMDB; secondary & tertiary structure predictions: threading, Fold recognition, Homology modelling, Protein visualization tools: Rasmol, Swiss-PDB etc. (6)

6. Applications of Bioinformatics in Biotechnology: gene prediction in prokaryotes, eukaryotes; other applications in the areas of health, food and medicine. (5)

Course Outcomes:

1. Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
2. Existing software effectively to extract information from large databases and to use this information in computer modeling
3. Problem-solving skills, including the ability to develop new algorithms and analysis methods

Suggested Books:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, By Andreas D, Baxevanis, B.F, Francis O, Wiley –Interscience , 4th Edition, 2013.
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount ,Cold Spring Harbor Laboratory Press,U.S.; 2nd Revised edition edition 2004.
3. Bioinformatics and the genome projects by Smith DW, Academic Press, 2006 4.Bioinformatics: A Biological Guide to computing and the Internet by Stuart M and Brown NYU, Mecical Centre, NY USA, 2000.Textbook of Biotechnology, H K Das, Wiley- India (P) Ltd., New Delhi (2005).

BTBT 18972 Food Safety

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: To impart knowledge about the various areas related to food science as a discipline. To develop an understanding of food composition, principles of preservation, new product development, food quality and analysis and food safety laws.

1. Introduction: Definition, its role in food industry, Physical properties: Color, viscosity, size and shape: Color measurement techniques by spectrophotometer, Munsell color system and Lovibond tintometer; Role of viscosity and consistency in food quality: Weight, volume, weight volume ratio, length, width, diameter, symmetry, curvature, area. (6)

2. Food Quality and Maintenance: Food quality, different factors inside and outside the food, Objective and subjective evaluation of food quality, analytical instruments used in food analysis, their working and principle. Maintenance of quality through mandatory and voluntary standards; their working set up and application in foods. (6)

3. Role of QC and QA Quality: Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries. Quality Improvement Total Quality management: Quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map. Quality improvement tools, customer focus, cost of quality. (7)

4. Food Security: Reviewing the global food situation with emphasis on Food security, Nutritional security, Factors influencing nutritional security, Causes of food insecurity and solution in India as well as around the world. (6)

5. Food Laws and Standards: National and International food laws Mandatory and voluntary food laws. FSSAI Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities.

6. AGMARK, BIS, FPO, Weights and Measures Act , CODEX : Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards(BIS) and their certification, FPO –standards and certification process Weights and Measures Act and Packaged commodity rules Role of CODEX in food safety and standards ,Food safety issues and risk analysis. (6)

(6)

7. Food safety issues of new biotechnologies: National and international norms, Traceability, HACCP, GMP, GAP, SPS, TQM, Six sigma, EIA and ISO. (5)

Course Outcomes:

1.Explain importance of different techniques of food quality measurement and maintenance. **2**.Correlate basic food science with food safety laws and standards

3.Determine food quality by food analysis as per food laws and their importance in food industry

Suggested Books:

1.S. Suzanne Nielsen-Food Analysis:Food Science Texts Series, Springer; 5th . Edition (2017)

2.Shetty, K., Plaiyath, G., Pometto, A. and Levin, R.E., Functional Foods & Biotechnology, CRC Press (2019).

3.Avantina Sharma Textbook of Food Science & Technology, International Book Distributing Company, 3rd ed. (2017)

4.Yasmine Motarjemi and Huub Lelieveld Food Safety Management Elseiver1st Edition(2013)

BTBT-18973 Intellectual Property Rights

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: To introduce basic concepts of ethics and safety that are essential for various branches of science involving technical procedures and protection of intellectual property and related rights. To understand balanced integration of scientific and social knowledge in sustainable development.

1. Introduction: General introduction, Patent claims, the legal decision-making process. Ownership of tangible and intellectual property, introduction to WTO, WIPO, TRIPS (6)

2. Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer. (7)

3. Basic Requirement of Patentability: Patentable subject matter, novelty and public domain, non obviousness (5)

4. Patent Litigation: Substantive aspects of patent litigation, procedural aspects of patent litigation, recent developments in patent system. IPR issues in the Indian context current patent laws. (5)

5. Case studies/ experience from developing and developed countries. (7)

Course Outcomes:
Students will be able to
1. recognize importance of IPR practices and guidelines in research
2. comprehend benefits of copy rights in technology and related issues
3. recognize importance of protection of new knowledge and innovations and its role in business

Suggested Books:

1. Sign KC : Intellectual Property Rights on Biotechnology , BCIL, New Delhi
2. BAREACT, Indian Patent ACT 1970 Acts & Rules, Universal Law Publishing Co.Pvt Ltd., 2007.
3. Biotechnology and IPR by Dr. T. Ramakrishna, NLSIU, Bangalore.
4. Intellectual Property by Bently, Lionel, Oxford University Press, 2001.
5. T. M Murray and M.J. Mehlman,Encyclopedia of Ethical, Legal and Policy issues in
6. Biotechnology, John Wiley & Sons 2000.
7. Intellectual Property Rights in the WTO and developing country by Watal Jayashree, Oxford University Press, 2001.

BTBT-18974 Biomedical Instrumentation

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: The main objective of this course is to introduce student to basic biomedical engineering technology. Student can understand and evaluate systems and devices that can measure, test and/or acquire biological information from the human body as well as interpret that information to make diagnosis.

1. Introduction: Introduction to the physiology of cardiac systems, physiology of respiratory systems, physiology of nervous systems. (6)

2. Basic Transducer Principles: Transducer principles and different types of transducers (active & passive transducers), transducers for biomedical applications (6)

3. Electrodes: Electrode theory, bio potential electrodes, biochemical transducers. (5)

4. Cardiovascular Measurements: Electrocardiography, measurement of blood pressure, (indirect measurement), measurement of blood flow & cardiac output (blood flow-magnetic blood flow meter, ultrasonic blood flow meter), plethysmography, cardiac pacemaker, measurement of heart sound. (7)

5. Measurements in the Respiratory System: Respiratory mechanism, measurement of gas volumes & flow rate, instrument for measuring the mechanism of breathing, spirometer (7)

6. The Nervous System: Electroencephalograph, MRI (Principle) and Electromyography. (5)

Course Outcomes:
After the successful completion of the course the students will be able to:
1. differentiate and analyze the biomedical signal sources.
2. elucidate cardiovascular system and related measurements.
3. explain the respiratory and nervous systems and related measurements
4. measure non-invasive diagnostic parameters.

Suggested Books:

1. Anandanatarajan, R.Biomedical instrumentation and measurements. PHI Learning Pvt. Ltd., 2011.
2. Bronzino, Joseph D. "The Biomedical Engineering Handbook; Biomedical Engineering Fundamentals." 2006.
3. Webster, John G. Bioinstrumentation. Wiley, 2004.
4. Khandpur, R. S. "Handbook of Biomedical Instrumentation." 2011.
5. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.

BTBT -18975 Human Disease and Control

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Objective: The objective of this subject is to impart knowledge about various human diseases, their cause, risk factor, clinical features, prevention and treatment.

1. Introduction: Human diseases, types of human disease, cause of human disease, preventions and treatment. (4)

2. Diseases spread by food and water: Diarrheal disease, typhoid, parathyphoid fever, Hepatitis A, Hepatitis B (Mode of transmission, manifestation, risk factors, diagnosis, prevention and treatment). (6)

3. Diseases spread by animals and insects: Anthrax, Hantavirus, Legionnaires disease, Leishmaniasis, malaria, rabies, tetanus, west nile fever, prevention and control (6)

4. Diseases spread by person to person contact: Diphtheria, Influenza, Pertussis, Mumps, rubella, *Haemophilus influenzae*, Pneumococcal pneumonia, prevention and control (6)

5. Tuberculosis: Definition, modes of transmission, WHO strategy of TB, risk factors, diagnosis, treatment, directly observed therapy (DOTS), immunization, prevention and control. (4)

6. Diseases spread by sexual contact, blood and body fluids: Chlamydia, Gonorrhea, Syphilis, Genital herpes, HIV/AIDS, Social perception of HIV/AIDS, social action on HIV/AIDS, Hepatitis B, prevention and control (6)

7. Cancer: Definitions, types, symptoms, cause, screening, diagnosis, prevention, Social perception of cancer, social awareness, Vaccines and antibiotics to control and prevent various diseases. (4)

Suggested Books:

1. Diseases , Disorders and Injuries by Marshell Cavendish (2010); Publisher: Cavendish Square Publishing.
2. Infectious Diseases by Sherwood L.Gorbach, John G.Bartlelt, Neil R. Blacklow(2003); Publisher: Lippincott Williams and Wilkins.
3. Cancer: its causes, symptoms and treatment by ELI G. Jones(2009); Publisher: B.Jain Regular.
4. HIV/AIDS by Kathy Furgang (2015); Publisher: Greenwood Publishing group.
5. Diseases and Disorders by J Victoria , Laurence and Elizabeth (2007); Publisher: Marshall Cavendish Corp.

BTBT-18976 Bio fertilizer Technology

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Course Objectives: This course will provide an overview of technology and techniques for the production of biofertilizers. It will explore the different aspects and factors responsible for bio fertilizer production. It will provide useful information about the role of biological factors in bio fertilizer production.

1. Introduction to biofertilizers: Structure and characteristic features of the following biofertilizer organisms: Bacteria: Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium. Cyanobacteria: Anabaena, Nostoc, Hapalosiphon. Fungi: Glomus, Gigaspora, Sclerocystis, Amanita, Laccaria. (7)

2. Bio-fertilization processes: Decomposition of organic matter and soil fertility and vermi composting. Nitrogen fixation- Free living and symbiotic nitrogen fixation. Biotechnological application in nitrogen fixation. (7)

3. Nitrogenous Biofertilizers: Bacteria - Isolation and purification of Azospirillum and Azotobacter, mass multiplication of Azospirillum and Azotobacter, formulation of inoculum of Azospirillum and Azotobacter, application of inoculants of Azospirillum and Azotobacter. Isolation and purification of Rhizobium, mass multiplication and inoculum production of Rhizobium. Methods of application of Rhizobium inoculants. (7)

4. Isolation and purification of Cyanobacteria. Mass multiplication of cyanobacterial bioinoculants - Trough or Tank method, Pit method, Field method; methods of application of cyanobacterial inoculum. Azolla - mass cultivation and application in rice fields. (8)

5. Mycorrhizal Biofertilizers- Ecto and endomycorrhizae and their importance in agriculture. Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM. Bio fertilizers - Storage, shelf life, quality control and marketing. (7)

Course Outcomes:
1. Understand the concept of biochemical processes in bio fertilizer production.
2. Recognize the role of different biotic factors in the synthesis of bio fertilizers.
3. The use of theoretical concepts of biofuel production technology at commercial level.

Suggested Books:

1.Reddy, S.M. et. al. Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
2. Purohit, S.S., P.R. Kothari and S.K. Mathur. Basic and Agricultural Biotechnology, Agro Botanical Pub. India.
3. Kannaiyan, S. Bioetchnology of Biofertilizers, CHIPS, Texas.
4. Subba Rao, N.S., G.S. Venkataraman and S. Kannaiyan. Biological nitrogen fixation, ICAR Pub., New Delhi.
5. Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. Biofertilizers, Scientific Publishers – Jodhpur.

BTBT-18977 Bio Nanotechnology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Course Objectives: This course is designed to make students understand the intersection of nanotechnology and biology. It will also acquaint the students with nanodevices of biomedical applications. Students will know about the use of nanotechnology in diagnostic biology and learn about health and environmental impacts of nanotechnology.

1. **Basic Concepts of Nanoscience:** Importance of "Nano" dimension, size matters: bulk vs nanomaterials, nanotechnology exists in nature, brief history of nanotechnology, applications of nanotechnology, challenges and future prospects, effect of 'nano' scale on material properties (electrical, thermal, mechanical, optical, chemical), quantum structures, quantum confinement, classification of nanostructured materials, surface effects of nanomaterials. (7)

2. **Synthesis and Characterization of Nanomaterials**: Bottom-up and bottom-down approaches: milling, arc discharge, laser ablation, spray pyrolysis, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembled monolayer, Characterization of nanostructures, Spectroscopy: UV-Vis, FTIR; Electron microscopy: Scanning electron microscopy, EDX, Transmission electron microscopy, Atomic force microscopy. (7)

3. I**ntroduction to Nanostructures:** Carbon nanotubes (CNT), fullerene ('C60'), quantum dots and semiconductor nanoparticles, metal-based nanostructures, nanowires, polymer-based nanostructures, gold nanostructures. (7)

4. **Biological Applications:** Biological Nano machines: ribosomes, photosynthesis systems, Bionanomotors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and bio-pesticides delivery applications. Biomedical Applications and Nano-toxicity: Biopolymers, Polymeric biomaterials, lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, DNA nanotechnology, Nano-biosensors: fabrication, fictionalization, applications, Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry. (8)

5. **Health and Environmental Impacts of Nanotechnology:** Engineered nanomaterial of relevance to human health, routes of entry into the body, toxic effects on health, plants and microbes are nanofactories. (7)

Course Outcomes:

Students will be able to:
1. Comprehend the concept of "nanotechnology" and its interdisciplinary aspects.
2. learn various approaches of synthesizing nanomaterials, their advantages and limitations.
3. gain knowledge about various techniques used for characterizing nanomaterials.
4. comprehend the importance of engineered nanomaterials for biomedical, therapeutic and environmental applications.
5. evaluate the potential toxic effects of nanotechnology on living organisms and the environment.

Suggested Books:

1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009)

2. Nanobiotechnology by Balaji S, MJP Publishers (2010)

3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wile VCH

4. Introduction to Nanoscience by Lindsay SM, Oxford University Press (2010)

BTBT-18978 Biofuels

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 0**
Total Marks: 100

Course Objectives: This course will provide an overview of existing energy utilization, production and infrastructure. It will helpful to understand the chemistry of biofuels, the biology of important feedstock's, the biochemical, genetic and molecular approaches being developed to advance the next generation of biofuels and the economical and global impacts of biofuel production. Overall the course will emphasize the importance of biofuel development as a contributor to replacing the diminishing supplies of fossil fuels, and on reducing the consequences of carbon dioxide release into the environment.

1. Introduction: Fossil versus renewable energy resources, economic impact of biofuels, Comparison of Bio-energy Sources, Biorefinery, Biofuel production and applications, alternative energies, environmental impact of biofuel. (6)

2. Biofuel Feedstock's and Production of biofuel: Various types of feedstocks, starch feedstocks, sugar feedstocks, lignocellulosic feedstocks and other feedstocks. (7)

3. Harvesting Energy from Biochemical Reaction: Biochemical Pathways for Various Metabolic process, Chemical oxygen demand and Biological Oxygen demand. Ethanol production from sugar and starch feedstock ethanol production from lignocellulosic feedstock's, fermentation process and fermenter types. (8)

4. Bioenergy from biomass as source of alternative energy: Chemistry of Biodiesel production, Oil sources and production by plants and other sources, methods of biodiesel production. Wet milling of grain for alcohol production, grain dry milling cooking for alcohol production, use of cellulosic feed stocks for alcohol production. (8)

5. Microbial Fuel Cells and its role in energy production: Microbiology of methane production, biomass sources for methane production, biogas composition and use, biochemical basis of fuel cell design. Environmental issues associated with biofuels. (7)

Course Outcomes:
1. Explain fundamental and principles for chemical and biochemical biofuel synthesis.
2. Differentiate between various renewable and non-renewable energy resources.
3. Recognize the use of theoretical concepts of biofuel production technology at commercial level.

Suggested Books:

1. Biofuels by WIM SOETAERT, ERICK J. VANDAMME, WILEY.
2. Biofuels Engineering process Technology by CAYE M. DRAPCHO, TERRY H. WALKER, M.G. Hills.
3. Khanal, S.K.; Surampalli, R.Y.; Zhang, T.C.; Lamsal, B.P.; Tyagi, R.D.; Kao, C.M.. Bioenergy and Biofuels from Biowastes and Biomass. Virginia, USA: American Society of Civil Engineers, 2010.
4. Mousdale, D.M.. Biofuels : Biotechnology, Chemistry, and Sustainable Development. Boca Raton, USA: CRC Press, 2008. ISBN 9781420051247

BTBT-18979 Computational Biology

External Marks: 60 **L T P**
Internal Marks: 40 **3 0 0**
Total Marks: 100

Objective: To understand the basics of computational science and apply it to solve biological problems. To learn about developing algorithms for solving complex biological problems as theoretical. To develop software for predicting structure of protein, DNA and RNA and analysis of genetic and signalling pathways.

1. Biomolecular Structure Dynamics: Computational methods for pathways and systems biology, databases of metabolic pathways, Kyoto Encyclopedia of Genes and Genomes (KEGG), analysis of pathways, Glycolysis, signaling pathways, genetic pathways (4)

2. Gene Prediction: Computational gene mapping and gene hunting, genetic mapping, physical mapping, sequencing similarity search, gene prediction, mutational analysis, introduction to restriction mapping and map assembly, gene prediction methods, gene prediction tools, gene expression (5)

3. Gene Mapping: DNA double digest problem, multiple solutions to double digest problem, alternating cycles in colored graphs, physical maps and alternating Eulerian cycles, transformations in Eulerian cycles, partial digest problem, probed partial digest problem, homometric sets. Gene mapping, mapping with unique and non-unique probes, optical mapping, interval graphs, mapping with restriction fragment fingerprints, Lander-Waterman statistics, screening clone libraries, radiation hybrid mapping (7)

4. Computer Aided Drug Design: Computer aided drug design, methods of computer aided drug design, ligand design methods, docking algorithms and programs, drug design approaches, absorption, distribution, metabolism, and excretion (ADME) property prediction, computer based tools for drug design (5)

5. Soft Computation: Hidden Markov Model (HMM), Neural networks, machine learning, support vector machines, fuzzy logic, Evolutionary computing and genetic algorithms –application to data mining and bioinformatics, machine learning tools (MATLAB) (5)

6. Structure Databases: PDB and MMDB, structure file formats, visualizing information, advance structure modeling, Internal and external co-ordinate system and cylindrical polar co-ordinate system, potential energy calculations using semiempirical potential energy function, Electrostatic energy surface generation, three dimensional structure using dynamic programming methods, Molecular mechanics and dynamics (6)

7. RNA Secondary Structure and Perl Language: RNA secondary structure – combinatories, minimum free – energy structures, consensus folding, Unusual DNA structures, Perl language and Perl Programming (4)

Course Outcomes:
Students will be able to:
1. perform programming in Bio Perl programming language.
2. explain various types of algorithms with their possible application in solving biological problems.
3. explain underlying algorithms for sequence analysis
4. use HMM and other algorithms
5. explain the computational aspects of complex biotechnological analyses.

Suggested Books:

1. Computation Biology and Bioinformatics: Gene regulation by Ka- Chun Wong (2016). CRC Press, Taylor and Francis group, Science Publisher book, ISBN 9781498724975.

2. Bioinformatics Algorithm: An elective learning Approach, 2nd Edition, Vol. 1 by Phillip Compeau and Pavel Pevzner (2016). Active Learning Publishers, ISBN 10: 0990374610

3. Algebraic Statistics for Computational Biology edited by Lior Patcher and Bernd Sturmfels (2005), Cambridge Publishers ISBN: 10- 0521857007.

4. Computaional Molecular Biology: An Algorithm approach by P.A. Pevzner (2000). Publisher MIT Press, London, U.K, ISBN: 00- 032461