For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)
BEANT COLLEGE OF ENGINEERING & TECHNOLOGY, GURDASPUR

Scheme & Syllabus of
B. Tech. Biotechnology
[BT]

By
Department of Academics
BEANT COLLEGE OF ENGINEERING & TECHNOLOGY
GURDASPUR

Batch 2015 onwards

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi
3rd semester

Contact Hours:30

Course code	Course name	Load allocation			Marks distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT 301*	Engineering Mathematics-I	4	1	-	40	60	100	5
BTBT 302	Foundations of Biotechnology	4	-	-	40	60	100	4
BTBT 303	Microbiology	4	-	-	40	60	100	4
BTBT 304	Biochemistry	3	1	-	40	60	100	4
BTBT 305	Transport Phenomena	4	1	-	40	60	100	5
BTBT 306	Biotech Lab-I (Microbiology and Biotechnology Lab)	-	-	4	30	20	50	2
BTBT 307	Biotech Lab-II (Biochemistry Lab)	-	-	4	30	20	50	2
BTBT 308	** Institutional Practical Training				60	40	100	1
Total		19	3	8	320	380	700	27

Minimum Subjects: 08 Maximum Subjects: 08
* This subject shall be taught by faculty of Mathematics Department.
** Institutional Practical Training (during summer vacations for 4 weeks) after second semester.

For Batches 2015 & Onwards
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Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi
4th semester

Contact Hours: 30

Course code	Course name	Load allocation			Marks distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT 401	Biostatistics*	4	1	-	40	60	100	5
BTBT 402	Industrial Microbiology	3	-	-	40	60	100	3
BTBT 403	Immunology & Immunotechnology	4	-	-	40	60	100	4
BTBT 404	Cell and Molecular Biology	3	-	-	40	60	100	3
BTBT 405	Intellectual Property rights: Bioethics and Biosafety	3	-	-	40	60	100	3
BTBT 406	Biotech Lab-III (Industrial Microbiology Lab)	-	-	4	30	20	50	2
BTBT 407	Biotech Lab-IV (Immunology Lab)	-	-	4	30	20	50	2
BTBT 408	Biotech Lab-V (Cell and Molecular Biology Lab)	-	-	4	30	20	50	2
BTGF 400	General Fitness				100	-	100	1
Total		17	1	12	390	360	750	25

Minimum Subjects: 08 Maximum Subjects: 08
* This subject shall be taught by faculty of Mathematics Department.

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology
Scheme of Syllabi
5th semester

Contact Hours: 30

Course code	Course name	Load allocation			Marks distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT 501	Chemical Engineering Principles	3	1	-	40	60	100	4
BTBT 502	Bioinformatics	3	-	-	40	60	100	3
BTBT 503	Genetic Engineering	3	-	-	40	60	100	3
BTBT 504	Animal Cell Culture and Biotechnology	3	-	-	40	60	100	3
BTBT XXX*	DE-I	3	-	-	40	60	100	3
BTBT XXX*	OE-I	3	-	-	40	60	100	3
BTBT 505	Biotech Lab-VI (Genetic Engineering lab)	-	-	4	30	20	50	2
BTBT 506	Biotech Lab-VII (Animal Cell Culture Lab)	-	-	3	30	20	50	2
BTBT 507	Biotech Lab-VIII (Bioinformatics Lab)	-	-	4	30	20	50	2
BTBT 508	*** Industrial\Institutional Training				60	40	100	1
Total		18	1	11	390	460	850	26

Minimum Subjects : 10 Maximum Subjects : 10
*** There should be Industrial\ Institutional training of six weeks duration in summer vacation after fourth semester.
* These are Departmental and Open electives to be chosen by the student, whose codes are provided.

For Batches 2015 & Onwards

Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi
6th Semester

Contact Hours: 30

Course code	Course name	Load allocation			Marks distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT 601	Fundamentals of Biochemical Engineering	3	1	-	40	60	100	4
BTBT 602	Plant Biotechnology	4	-	-	40	60	100	4
BTBT 603	Bioanalytical Techniques	3	-	-	40	60	100	3
BTBT 604	Food Process Technology	3	-	-	40	60	100	3
BTBT XXX*	OE-II	3	-	-	40	60	100	3
BTBT 605	Biotech Lab-IX (Plant Biotechnology Lab)	-	--	3	30	20	50	2
BTBT 606	Biotech Lab-X (Bioanalytical Techniques Lab)	-	-	4	30	20	50	2
BTBT 607	Biotech Lab-XI (Bioprocess Engineering Lab)	-	-	4	30	20	50	2
BTBT 608	Minor Project	-	-	2	30	20	50	1
BTGF 600	General Fitness				100	-	100	1
Total		16	1	13	420	380	800	25

Minimum Subjects: 10 Maximum Subjects: 10
* These are Open electives to be chosen by the student, whose codes are provided.

For Batches 2015 & Onwards

Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi
7th / 8th Semester

Contact Hours: 30

Course code	Course name	Load allocation			Marks distribution		Total marks	Credits
		L	T	P	Internal	External		
BTBT 701	Enzymology and Enzyme Technology	3	1	-	40	60	100	4
BTBT 702	Downstream Processing	3	-	-	40	60	100	3
BTBT 703	Genomics and Proteomics	3	-	-	40	60	100	3
BTBT XXX	DE-II*	3	-	-	40	60	100	3
BTBT XXX	DE-III*	3	-	-	40	60	100	3
BTBT 704	Biotech Lab-XII (Enzymology and enzyme Technology Lab)	-	-	4	30	20	50	2
BTBT 705	Biotech Lab-XIII (Genomics and Proteomics)	-	-	3	30	20	50	2
BTBT 706	Biotech Lab-XIV (Downstream Processing Lab)	-	-	4	30	20	50	2
BTBT 707	Major Project	-	-	3	30	20	50	2
BTGF 800	General Fitness				100	-	100	1
Total		15	1	14	420	380	800	25

Minimum Subjects: 10 Maximum Subjects: 10
* These are Departmental electives to be chosen by the student, whose codes are provided.

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Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi
7th /8th Semester

Course code	Course name	Load allocation	Marks distribution		Total marks	Credits
			Internal	External		
BTBT 801	Industrial Training (one semester)	30hrs\ week	400	400	800	24

Minimum Subjects: 01 Maximum Subjects: 01

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi
Departmental Elective I (5th Semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTBT 901	Stem cell Technology	3	-	-	3
BTBT 902	Advances in Drug Design and Pharmacogenomics	3	-	-	3
BTBT 903	Biological Waste Treatment	3	-	-	3

Departmental Elective-II (7^{th}/8^{th} semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTBT 931	Protein Engineering	3	-	-	3
BTBT 932	Molecular Farming	3	-	-	3
BTBT 933	Environmental Biotechnology	3	-	-	3

Departmental Elective III (7^{th}/8^{th} semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTBT 934	Pharmaceutical Biotechnology	3	-	-	3
BTBT 935	Agricultural Biotechnology	3	-	-	3
BTBT 936	Computational Biology	3	-	-	3

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Scheme of Syllabi

List of Open Electives (5th semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTBT 951	Industrial Waste Management	3	-	-	3
BTBT 952	Bioinformatics	3	-	-	3

List of Open Electives (6th semester)

Course Code	Course Name	Load Distribution			Credits
		L	T	P	
BTBT 961	Biomedical Instrumentation	3	-	-	3
BTBT 962	Human Disease and Control	3	-	-	3

Beant College of Engineering & Technology, Gurdaspur
Department of Bio Technology

Third Semester

BTBT 301 Mathematics-I

	L	T	P
Internal Marks: 40			
External Marks: 60	**4**	**1**	**0**
Total Marks: 100			

Objective/s and Expected outcome

"Math and basic science are certainly the foundations of any engineering program. This fact will not change in the foreseeable future" said by Ellis et al. Engineering Mathematics is an essential tool for describing and analyzing engineering processes and systems. Mathematics also enables precise representation and communication of knowledge. Core mathematics courses have broader objectives than just supporting engineering programs. The learning objectives of core mathematics courses can be put into three categories: (1) Content Objectives: Students should learn fundamental mathematical concepts and how to apply them. (2) Skill Objectives: Students should learn critical thinking, modeling/problem solving and effective uses of technology. (3) Communication Objectives: Students should learn how to read mathematics and use it to communicate knowledge. The students are expected to understand the fundamentals of the mathematics to apply while designing technology and creating innovations.

1. **Differential Calculus:**
Curve tracing: Tracing of Standard Cartesian; Parametric and Polar curves (Astroids, Cycloids, Folium Tubes Cardiods, Lemniscate, Helix); Curvature of Cartesian, Parametric and Polar curves. (6)

2. Integral Calculus:
Rectification of standard curves; Areas bounded by standard curves, Applications of integral calculus to find centre of gravity and moment of inertia. (6)

3. Partial Derivatives:
Function of two or more variables; Partial differentiation; Homogeneous functions and Euler's theorem; Composite functions; Total derivative; Derivative of an implicit function; Change of variable; Jacobians (6)

4. Applications of Partial Differentiation:
Tangent and normal to a surface; Taylor's and Maclaurin's series for a function of two variables; Errors and approximations; Maxima and minima of function of several variables; Lagrange's method of undetermined multipliers (6)

5. Multiple Integrals:
Double and triple integral and their evaluation, change of order of integration, change of variable, Application of double and triple integration to find areas and volumes. (6)

6. Vector Calculus:
Scalar and vector fields, differentiation of vectors, velocity and acceleration. Vector differential operators: Del, Gradient, Divergence and Curl, their physical interpretations. Formulae involving Del applied to point functions and their products. Line, surface and volume integrals. (8)

7. Application of Vector Calculus:
Flux, Solenoidal and Irrotational vectors. Gauss Divergence theorem. Green‟s theorem in plane, Stoke‟s theorem (without proofs) and their applications. (4)

Suggested Readings / Books

1.Thomes, G.B, Finney, R.L. Calculus and Analytic Gemetry, Ninth Edition,Peason Education.
2.Kreyszig, E., Advanced Engineering Mathematics, Eighth edition, John wiley.
3.Jain, R.K and Lyengar, S.R.K., Advanced Engineering Mathematics, Narosa Publishing Company.
4.Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers,New Delhi.
5. B. V. Ramana, Higher Engineering mathematics,Tata Mcgraw Hills, New Delhi.

BTBT 302 Foundations of Biotechnology

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

L	T	P
4	0	0

Objective: This course is focused on the basics of Biotechnology and its applications. This provides a brief preview of the scope of the field of Biotechnology.

Unit I: Introduction to Biotechnology, Historical Perspectives Modern and Old Biotechnology, Biotechnology an interdisciplinary Pursuit, Scope & Future of Biotechnology. (5)

Unit II: Introduction to basic unit of life i.e. cell structure of prokaryotic and eukaryotic cell in detail, cell division; Structure of chromosome and DNA; Basic Techniques used in biotechnology Principles and applications of centrifugation, electrophoresis, chromatography, sterilization (7)

Unit III: Application of biotechnology in medicine antibiotics, vaccines, monoclonal antibodies, gene therapy, bio pharmaceuticals. (6)

Unit IV: Application of Biotechnology in Environment- waste water and sewage treatment, bio fuels, Bioremediation with special reference to metals, oil spills, pesticides. (5)

Unit V: Application of Biotechnology in Food and beverage fermentations, plant and animal biotechnology, Biological control, Bio fertilizers. (6)

Unit VI: Enzyme technology - nature of enzymes, application of enzymes, genetic Engineering and Protein engineering of enzymes, Technology of enzymes production. (6)

Unit VII: Safety in Biotechnology- Problem of Organism Pathogenicity, Problem of Biologically Active Biotechnology Products, and Release of GMO's in the Environment (6)

Suggested Reading and Books:

1. Biotechnology by J.E Smith 3 rd Ed (1996), Published by Cambridge University Press.
2. Biotechnology by H.K. Das, 4 th edition 2010 Tata Mc Graw Hill
3. Biophysical Chemistry Upadhayay, Upadhayay and Nath 4 th edition 2007 Himalaya Publishing House
4. Molecular-Biotechnology by Glick & Pasternak 2 nd Edition ASM Press Washington DC
5. Text book of Biotechnology H.D. Kumar, 2 nd Edition

BTBT 303 Microbiology

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

L	T	P
4	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.

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: Pure culture techniques, isolation, cultivation, maintenance and preservation of pure cultures and sterilization techniques. (5)
Unit –III
Bacterial Nutrition & Growth: 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. 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. (7)
Unit –IV
Bacterial Reproduction: Asexual reproduction, DNA replication in bacterial cell, general principles of bacterial recombination - transformation, transduction and conjugation. (6)
Unit –V
Medical Microbiology: Characteristics of major pathogens (*Mycobacterium tuberculosis*, Plasmodium sp., etc) their modes of transmission, mechanisms of infection and growth. (6)
Unit –VI
Isolation of industrially important microbial strains, strain improvement, maintenance and preservation of industrial microbes. (5)
Unit –VII
Agricultural & Environmental Microbial Biotechnology: Basic understanding and large-scale production of microbial inoculants for agriculture, mycorrhiza, microbial insecticides; treatment of urban (sewage) and industrial effluents. (6)

Suggested Reading and Books:

1. Microbiology VI Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill Microbiology by Prescott.
2. Brock Biology of Microorganisms (12th Ed.) by Madigan MT, Martinko JM and Parker J, Pearson/Benjamin Cummings, 2009. Microbiology: An Introduction (9th Ed.) by Tortora GJ, Funke BR, and Case CL, Pearson Education, 2008. Prescott, Harley and Klein's Microbiology (7th Ed.) by Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education, 2008.
3. Principles of Fermentation Technology (2nd Ed.) by Stanbury PF, Whitaker A and Hall SJ, Elsevier Science Ltd, 2006.
4. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield,

USA, 2007.
5. Environmental Microbiology (2nd Ed.) by R. Mitchel, Wiley-Blackwell, 2009.
6. Microbial Physiology (3rd Ed.) by Albert G. Moat and John W. Foster, John Wiley and Sons, 20 02.
7. Microbial Biotechnology: Fundamentals of Applied Microbiology by Glazer & Nikaido, W.H. Freeman and Co., New York, 1995.
8. Biotechnology - Applying the Genetic Revolution by Clark DP and Pazdernik NJ. Academic Press, USA, 2009.
9. Molecular Biotechnology (3rd Ed.) by Glick BR and Pasternak JJ, ASM Press, Washington D.C., 2003.

BTBT 304 Biochemistry

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

L	T	P
3	1	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), 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 (6)
Unit VI
Plant & Microbial Biochemistry: Photosynthesis, differences in respiratory mechanisms and anaerobes. (4)
Unit VII
N_2- Fixation: Role of Various Enzymes in Nitrogen Cycle. (3)

Suggested Reading and Books:

1. A.L. Lehninger: Principles of Biochemistry, Worth Publishers, New York (2007)
2. L. Stryer: Biochemistry, W.H. Freeman and Company, New York (2006)
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 305 Transport Phenomena

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

L	T	P
4	1	0

Objective: To impart knowledge of momentum, heat and mass transfer in chemical engineering system and their analogous behavior.

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. (8)

Unit –II

Non-Newtonian Fluids: Time Dependent, Time Dependent and Visco-elastic fluids, Consecutive Equations and Rheological Characteristics. (5)

Unit –III

Equations of Change under Laminar Flow Conditions: Equation of Continuity, Motion, Mechanical Energy, Energy and Mass Transport. Simple Shell Balance Method for Momentum, Heat and Mass Transport, Velocity Distribution in Circular Conduits and Parallel Plates. Generalized form of Equations and Simplifications. (8)

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. (9)

Unit –V

Diffusion Phenomena: Diffusion of gases and liquids in porous solids, Knudsen diffusion, multicomponent diffusion and effective diffusivity. (6)

Unit –VI

Methods of Analysis of Transport Problems: General integral balance using macroscopic concepts, integral balance for mass, momentum and energy. (7)

Unit –VII

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. (7)

Suggested Reading and Books:

1."Transport Phenomena", 2 nd Edition by Bird R.B., Stewart W.E. and Lightfoot E.N., John Wiley and Sons (2002).

2. "Transport Processes and Separation Process Principles", 4 th Edition, by Geankoplis C.J., Prentice-Hallof India. (2004).

3. Basic Concepts In Transport Phenomena, A Unified Approach". Vol.-I by Brodkey, R.S., Hershey H.C.,Brodkey Publishing (2003).

BTBT 306 Biotech Lab –I
(Microbiology and Biotechnology Lab)

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

L	T	P
0	0	4

1. Microscopic Examination of Microorganisms :- Staining methods:
   - Simple staining of bacteria
   - Gram staining of bacteria
   - Endospore Staining
   - Capsule staining
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
   - Preparation of glycerol stock

Suggested Reading and Books:

Experiments in Microbiology Plant Pathology and Biotechnolgy by K.R. Aneja
Laboratory Manual In Microbiology By P. Gunasekaran

BTBT 307 Biotech Lab –II
(Biochemistry Lab)

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

L	T	P
0	0	4

1. Qualitative test for carbohydrates, proteins, amino acids and lipids
2. To test salivary amylase activity.
3. Quantitative estimation of proteins by lowery method or Bradford method.
4. Estimation of carbohydrates by anthrone method.
5. Estimation of amino acid by ninhydrin method.
6. Determination of saponification value and Iodine number of fats.
7. Titration curve for amino acids and determination of pK value.
8. Preparation of standard buffers & determination of pH.
9. Separation of amino acids & sugars using paper & thin layer chromatography

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Fourth Semester

BTBT 401 Biostatistics

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

L	T	P
4	1	0

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

Unit – I
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, populations, samples, random sampling, parameters and statistics (8)

Unit – II
Measures of central tendency and dispersion: Arithmetic mean, geometric mean, harmonic mean, median, quantiles, mode, range, variance, standard deviation, moments, coefficient of variation, Shannon-Weaver index (8)

Unit – III
Probability: Permutations and Combinations, Probability of an event, addition and multiplication of probabilities. (7)

Unit – IV
Distributions: Normal distribution, skewness and kurtosis, binomial distribution, Poisson distribution. (7)

Unit – V
Statistical hypothesis testing: Statistical testing, errors, one-tailed and two-tailed testing, t-test, Fisher exact test, chi square test, two sample hypothesis (testing difference between two means), Non parametric tests (Mann-Whitney test) (7)

Unit – VI
Paired sample hypothesis (testing mean difference), Wilcoxon paired sample test, single factor ANOVA, Kruskal-Wallis test, Tukey test, Newman-Keuls test, two factor ANOVA. (7)

Unit – VII
Correlation and Regression: Linear regression, correlation and Pearson coefficient of correlation, rank correlation and Spearman rank correlation coefficient. (6)

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 402 Industrial Microbiology

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

L	T	P
3	0	0

Objective/s and Expected Outcome: The course is designed to develop the student's ability to apply the techniques used in the different phases of industrial microbiology: discovery, production (including fermentation and scale-up), bioprocessing and cell banking. It includes the principles and practices in the main applications of micro-organisms to the industrial production of foods, pure chemicals, proteins and other useful products, including the use of genetically modified organisms. This course aims to enable graduates to enter industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product.

Unit-I
Introduction: aim and scope. Industrially important microbes, Strategies involved in the isolation of desired microbes from the environment. (3)
Unit-II
Fermentation Processes: Batch, fed-batch and continuous fermentations; solid state and submerged fermentations. Feed-stocks for industrial fermentation: Molasses, corn steep liquor, whey, malt, yeast extract and antifoams. (5)
Unit-III
Microbial Enzymes: desirable attributes of industrial grade enzymes like lipase, protease, cellulase, amylase; Immobilization of enzymes. (5)
Unit-IV
Biofuels: Criterion for selection of raw material: ethanol, biogas, biohydrogen and biodiesel. (4)
Unit-V
Health Care Products: Natural sources and underlying principles for the production of Antibiotics, vaccines, vitamins, amino acids, alkaloids, steroids. (4)
Unit-VI
Food and Beverages: Alcoholic Production: fermentative production of beer, whisky, wine, Bread; Dairy products: cheese, probiotics, yoghurt. SCP production, mass culture of Spirulina, Technology of mushroom production, uses , economic parameters and constraints. (5)
Unit-VII
Use of microbes in biodegradation of pollutants, Introduction, production and biochemical attributes of Bioplastics. Biosensors: role of various biomolecules their sources and applications. Production and applications of biofertilizers and bioinsecticides. (4)

Suggested Reading and Books:
1. Industrial Microbiology by Casida LE,1st Ed. Wiley Eastern Ltd., 2005
2.Industrial Microbiology: Michael J Waites, Neil L Morgan, Rockey & Higton.
3.Alcamo's Microbiology: J C Pommerville. 2010. Jones and Bartlett, USA
4.Microbiology: Prescott, Harley and Kleins. 2008. McGraw Hill, USA.

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BTBT 403 Immunology and Immunotechnology

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

L	T	P
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. (6)

Unit II:

Antigens and Antibodies: Characteristics of an antigen, haptens, epitopes, adjuvants. Structure, types, properties and functions of antibodies; VDJ rearrangements. (5)

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. (5)

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). (5)

Unit VI:

Applied Immunology: Immune system in health and disease, autoimmunity, hypersensitivity, tumor immunity, tissue and organ transplant, Immuno-toxins. (7)

Unit VII:

Hybridoma technology: Fusion of myeloma cells with lymphocytes, production of monoclonal antibodies and their application, chimeric antibodies. (4)

Suggested Reading and 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)
5. Janeway's Immunobiology (7 Ed.) by Murphy K, Travers P, Walport M. Garland Science Publishers, New York, (2008).

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

BTBT 404 Cell and Molecular Biology

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

L	T	P
3	0	0

Objective: 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 orlosses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Unit–I
Cell: Structural & functional unit of life, prokaryotic & eukaryotic. Cell organelles – structure & functions, Cytoskeleton & ECM. (5)

Unit–II
Cell Division: Binary fission, Mitosis & Meiosis, cell cycle & its regulation. (4)

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

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

Unit–V
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. (6)

Unit–VI
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. (4)

Unit–VII
Introduction to stem cells & cellular differentiation; RNA interference, epigenetic regulation of genes (DNA methylation & histone modifications), tumour suppressor genes & apoptosis, oncogenes & cancer. (3)

Suggested Reading and 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.

BTBT 405 Intellectual Property Rights, Bioethics & Bio safety

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

L	T	P
3	0	0

Objective: 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.

Unit–I
Introduction: General introduction, Patent claims, the legal decision-making process. Ownership of tangible and intellectual property (3)

Unit–II
Basic Requirement of Patentability: Patentable subject matter, novelty and public domain, non obviousness (3)

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

Unit–IV
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)

Unit–V Public acceptance issue for Biotech, case studies/ experience from developing and developed countries. Biotechnology and hunger. Challenges for the Indian, biotechnological research and industries. (4)

Unit–VI
The Cartagena protocol on biosafety. (2)

Unit–VII
Biosafety Management: Key to the environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques (4)

Suggested Reading and 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 406 Biotech Lab –III
(Industrial Microbiology Lab)

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

L	T	P
0	0	4

1. Isolation of cellulose/protease/lipase producing bacteria and fungi from soil
2. Purification and partial characterization of the desired microbes.
3. Quantification of the enzyme activity.
4. Preservation of the microbial culture.
5. Cell lysis techniques.
6. Batch culture fermentation-shake flask.
7. Solid state fermentation
8. Techniques used in Enzyme immobilization.

BTBT 407 Biotech Lab –IV
(Immunology Lab)

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

L	T	P
0	0	4

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

BTBT 408 Biotech Lab –V
(Cell & Molecular Biology Lab)

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

L	T	P
0	0	4

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. Genomic DNA isolation of E coli.
5. Qualitative and quantitative analysis of DNA by spectrophotometry.
6. Isolation and quantification of RNA from bacterial cells.
7. Isolation and quantification of total proteins of the cells.
8. Isolation and quantification of carbohydrates and lipids from different biological sources.
9. Demonstration of inducible expression of genes in bacteria.

Fifth Semester

BTBT-501 Chemical Engineering Principles

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

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. **(5)**

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. **(5)**

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 **(5)**

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. **(7)**

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

6. Instrumentation: Principles of measurement: error, accuracy and sensitivity, measurement of flow, pressure, temperature level, pH, viscosity and chemical composition. **(4)**

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. **(5)**

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-502 Bioinformatics

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

Objective: 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)**

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-503 Genetic Engineering

	L	T	P
Internal Marks: 40			
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, Milestones in Genetic Engineering **(2)**

2. Molecular tools and their applications: DNA & RNA modifying enzymes: Restriction enzymes and other endonucleases, Exonucleases, Polymerases, Kinases, Methylases and Ligases. **(5)**

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 **(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. **(4)**

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

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.

BTBT-504 Animal Cell Culture and Biotechnology

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

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.

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

2. Design, Layout and Equipment: Planning, Construction Layout, Essential Equipments, Aseptic Technique, Sterile Handling, Safety, Risk Assessment, biohazards **(4)**

3. Media: Physicochemical Properties, Balanced salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media **(5)**

4. 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)**

5. 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)**

6. Contamination: Sources of contamination, Cross contamination, Type of microbial contamination, Eradication and Cryopreservation **(5)**

7. 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)**

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.
Textbook of Biotechnology by H.K. Das, Wiley India, 4 th edition, (2010).

BTBT-505 Biotech Lab-VI (Genetic Engineering Lab)

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

L	T	P
0	0	4

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. Screening of clones by blue-white selection (i.e. α-complementation)
9. To amplify DNA using polymerase chain reaction.
10. To perform Western Blotting of protein samples.

BTBT-506 Biotech Lab-VII (Animal Cell Culture Lab)

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

L	T	P
0	0	3

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-507 Biotech Lab-VIII (Bioinformatics Lab)

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

L	T	P
0	0	4

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 FASTA analysis
5. Pairwise comparison of sequences
6. Multiple sequence analysis and phylogenetic analysis using CLUSTAL W
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

Sixth Semester

BTBT-601 Fundamentals of Biochemical Engineering

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

Objective: 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, heat evolution in aerobic cultures, and thermodynamic efficiency of growth. **(6)**

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. **(5)**

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. **(5)**

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. **(5)**

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

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 KLa values, factors affecting KLa value, scale- up principles and its difficulties, scale down. **(5)**

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

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-602 Plant Biotechnology

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

Objective: : At the end of this course, students would have learnt about the various aspects of modern plant biotechnology in a step-wise manner. 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)**

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., 7th Edition, Blackwell Publishing (2006)
4. Concepts in Biotechnology by Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Revised Edition,COSTED-IBN, Universities Press (2007)
5. Biotechnology by Satyanarayana, U., Books and Allied (P) Ltd, (2005)

BTBT 603 Bio analytical Techniques

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

Objective: Research in the field of biotechnology and its applications in development of technologies involves various kind 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.

1. 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)**

2. 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)**

3. 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)**

4. 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)**

5. 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)**

6. Spectroscopy-II: IR spectroscopy, Raman spectroscopy, ESR and NMR spectroscopy, X-ray crystallography. **(5)**

7. 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 (Geiger-Muller 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)**

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.

BTBT 604 Food Process Technology

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

Objective: 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 colours, flavours 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 hydrolyzate 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 dairyproducts. 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)**

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

BTBT 605 Biotech Lab-IX (Plant Biotechnology Lab)

	L	T	P
Internal Marks: 30			
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 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. Demonstration on molecular cloning of plant genes
9. Direct Organogenesis – From Shoot Tip Culture *Bougainvillea*
10. Direct DNA transfer to plants.

BTBT 606 Biotech Lab-X (Bioanalytical Techniques Lab)

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

1. To analyse amino acids by 2D-Thin layer chromatography.
2. To extract and separate biomolecules from plant tissue by coloumn chromatography.
3. GC & HPLC (demonstration)
4. Staining & size measurement of cells by microscopy.
5. To determine the concentration of DNA by UV – spectrophotometer.
6. To determine the concentration of protein samples by UV – spectrophotometer.
7. Determine λmax of DNA, protein, bromophenol blue solutions by wavelength scan
8. Comparison of Coomassie brilliant blue and silver staining methods for visualizing protein bands in SDS-PAGE
9. Comparison of ethidium bromide and silver staining methods for visualisation of small DNA fragments analyzed by native PAGE
10. Compare the centrifugation of bacterial culture and ethanol precipitated DNA and calculate relative centrifugal force for the two centrifugations

BTBT 607 Biotech Lab-XI (Bioprocess Engineering Lab)

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

L	T	P
0	0	4

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 and also estimation of substrate degradation profile to compute specific growth rate and growth yield from the data obtained.
4. To study the batch growth kinetics and establish the key kinetic parameters (Monod Parameters).
5. Cultivation of microorganism in batch reactor and continuous reactor.
6. Comparative studies of ethanol production using different substrates (grape juice, sucrose, glucose) and its qualitative analysis.
7. Isolation of antibiotic producer from soil.
8. Production and estimation of alkaline protease.
9. Sauerkraut fermentation from cabbage
10. Use of alginate for cell immobilisation (*Saccharomyces cerevisiae*) used to enhance ethanol production in industry.
11. To estimate the antibiotic sensitivity of microorganisms using Disk Diffusion Method.

BTBT-608 Minor Project

L	T	P
0	0	2

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

The problem of the minor project formulated during 6th Semester is to extended and executed in major project by the same group of students. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology of the project shall be decided in 6th semester. The same project problem is to be extended in the major project in 7th/8th semester. The minor project may be carried out by a group of students 2 to 4.
The student is to appear in a Viva-Voce Examination.

Departmental Elective I (5th Semester)
BTBT-901 Stem Cell Technology

Internal Marks: 40	**L T P**
External Marks: 60	**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)**

Suggested Books:

1. Essentials of Stem Cell Biology by Lanza, R., second Edition, 2009 Academic Press
2. Stem Cells: From Bench to Bedside by Bongso and Ariff. 2010 World scientific.
3. Hematopietic Stem Cell Transplantation by Treleaven, J., first edition 2009
4. Molecular Cell Biology by Lodish et al., sixth Ed., W.H. Freeman & Co. 2008

For Batches 2015 & Onwards
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Departmental Elective I (5th Semester)
BTBT-902 Advances in Drug Design and Pharmacogenomics

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

L	T	P
3	0	0

Objective: The course will provide an introduction to the application of genetic and genomic methods to the study of drug response and the genetic basis for variation in that response. It will give students a broad perspective on the emergence of Pharmacogenomics as a new field and provide them with insight into the growing importance it will play in clinical therapeutics and future drug design.

1. Molecular Modelling in Drug Discovery: Drug discovery process, Role of bioinformaics in drug design, Methods of computer aided drug design, ligand design methods, drug design approaches, Target identification and validation, lead optimization and validation, Structure and ligand based drug design, modelling of target-small molecule interactions, Molecular simulations. Protein Modelling. **(4)**

2. Quantum Mechanics and Molecular Dynamics simulation methods: Features of molecular mechanics, force fields; Bond structure and bending angles – electrostatic, van der Waals and non–bonded interactions, hydrogen bonding in molecular mechanics; Application of energy minimization. Molecular Dynamics simulation methods. **(6)**

3. Molecular Docking and lead optimization: Types of Molecular Docking, docking algorithms and programs, Structure-based methods to identify lead compounds; de novo ligand design; Applications of 3D Databases Searching and virtual Screening; Strategy for target identification and Validation, lead identification, optimization and validation. Combinatorial chemistry and library design, virtual screening, drug likeness and compound filtering, Absorption, distribution, metabolism, excretion and toxicity (ADMET) property prediction, computer based tools for drug design. **(7)**

4. Pharmacophore and QSAR: Pharmacophore derivation, 3D pharmacophore prediction and application in drug discovery; QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors. Use of Genetic Algorithms, Neural Networks and Principle Components Analysis in the QSAR equations

(6)

5. Pharmacogenomics: Overview, present status, Pharmacogenomics and Personalized medicine, Pharmacogenomics Case Study: example- Personalized anticoagulant therapy, role of bioinformatics in pharmacogenomics. Basic Principles; Approaches to pharmacogenomics studies; concepts of individualized medicine; how pharmacogenomics aims to improve drug efficacy and toxicity, genetics of drug metabolism **(6)**

6. The Pharmacogenetics and Pharmacogenomics knowledge Base: Systems for the Management of Pharmacogenomic Information, Ethnicity and Pharmacogenomics. Functional Analysis of Gene Variation: Human Genome and Genomic Applications, Genetic Polymorphism of Metabolic Reactions, SNPs, Association Studies in Pharmacogenomics, Study on industries developing pharmacogenomic research. **(7)**

Suggested Books:

1. Leach, A. R. (2001) “Molecular Modeling – Principles and Applications”; Second Edition, Prentice Hall, USA
2. Analytical methods in combitorial chemistry by Bing Yan, Bin Zhang, CRC Press, Taylor & Francis group, 2010
3. Mount, D. (2004) “Bioinformatics: Sequence and Genome Analysis”; Cold Spring Harbor Laboratory Press, New York.
4. Rapley, R. & Harbron, S. (2004) Molecular analysis and Genome discovery; John Willey & Sons, Ltd.

For Batches 2015 & Onwards
Academic Autonomous Status vide letter No. F22-1/2014 (AC)

Departmental Elective I (5th Semester)
BTBT-903 Biological Waste Treatment

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

L	T	P
3	0	0

Objective: To provide detailed knowledge and skills in the management, treatment, disposal and recycling options for Biological Waste. Understanding the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of value from waste. Appreciate the increasing importance of waste and resource management in achieving environmental sustainability. Transfer their knowledge and skills and contribute to "best practice" within the stakeholder environment.

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. **(4)**

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. **(5)**

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. **(5)**

4. Biological Processes: Role of micro-organisms, microbial metabolism- Respiratory and fermentative, biological treatment processes- Aerobic, Anoxic, Anaerobic and Combined processes. **(6)**

5. Biological Waste Treatment: Waste treatment and useful byproducts, solid waste treatment- saccharification - gasification - composting- liquid waste treatment - aerobic, anaerobic methods. **(6)**

6.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. **(6)**

7. 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. **(4)**

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.

Open Elective I (5th Semester)

BTBT-951 Industrial Waste Management

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

Objective: To provide an introduction about the polluting potential of major industries in the country and the methods of controlling the same. To know about the hazardous waste and disposal. To familiarize the methods of pollution prevention in industries, life cycle assessment of products and design for environment.

1. Introduction: Types of industries and industrial pollution – Characteristics of industrial wastes, 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 **(5)**

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-Properties of environmental contaminants-Regulations for clean environment and implications for industries-International environmental standards-Environmental technology assessment. **(5)**

4. Source Reduction And Treatment Technologies: Waste management Approach – Waste Audit – Volume and strength reduction – Material and process modifications – 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 inorganics – Combined treatment of industrial and municipal wastes – Residue management – Dewatering – Disposal. **(11)**

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)**

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.

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Open Elective I (5th Semester)
BTBT-952 Bioinformatics

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

Objective: 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. Intoduction: Biomolecules, Central Dogma of Molecular Biology; Abbreviations and Structures of bases & amino acids, Introduction to bioinformatics, Need for bioinformatics. **(3)**

2. Databases:Nucleotide databases; Protein databases; Family Databases; Sequence retrieval systems; Genome databases, Metabolic Pathway database; Specialized database; Structural database. **(4)**

3. Sequence Analysis & Alignment: Statistical significance of alignment; Sequence assembly Analysis; Global & Local Alignment and their algorithms, Pair-wise and Multiple sequence alignment: Programs and methods for sequence alignment. Dot plots, Dynamic programming algorithms, Heuristics- FASTA, BLAST. **(6)**

4. Machine learning algorithms : Dynamic programming- EM/ GEM algorithms-Markov chain Monte carlo methods- simulated annealing genetic algorithm-Neural networks. **(6)**

5. Phylogeny Evolutionary analysis distances: clustering methods – rooted and 5unrooted tree representation – distance based methods, Maximum Parsimony method, Maximum Likelihood method, Bootstrapping strategies. Tools for phylogeny analysis – Phylip, Paup. **(6)**

6. Structural bioinformatics : Levels of Protein structure, Methods for Prediction of Secondary and Tertiary structures of Proteins, Evaluation of the predicted models; Molecular Mechanics force field, Energy Minimization; Methods for comparison of 3D structures of proteins, Tools for secondary and tertiary structure prediction **(6)**

7. Drug designing : Introduction, Conventional drug design approaches, irrational vs. rational, various steps of drug design process- QSAR, Lipinski rule-pharmacokinetics and dynamics-ADME properties, Examples and uses of computer based drug discovery; pharmacophore and docking-scoring. **(5)**

Suggested Books:

1. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by Rastogi ,Prentice Hall India Learning Private Limited; 4th Revised edition edition , 2013
2. Introduction to Bioinformatics by Teresa Attwood,Pearson Education,2007
3. Essential Bioinformatics by Jin Xiong,Cambridge University 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).
5. Bioinformatics: Sequence and Genome Analysis by David W. Mount ,Cold Spring Harbor Laboratory Press,U.S.; 2nd Revised edition edition, 2004
6. Bionformatics: The Machine learning approach by Pierre Baldi and Soren Brunak,Affiliated East-West Press Pvt. Ltd , 2003

Open Elective II (6th semester)
BTBT 961 Biomedical Instrumentation

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

L	T	P
3	0	0

Objective: 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)**

Suggested Books:

1. Cromwell, Leslie, Fred J. Weibell, and Erich A. Pfeiffer. Biomedical instrumentation and measurements. Prentice Hall, 1980.
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. Enderle, John D. "Bioinstrumentation." Synthesis Lectures on Biomedical Engineering, 2006.

For Batches 2015 & Onwards
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Open Elective II (6th semester)
BTBT 962 Human Disease and Control

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

L	T	P
3	0	0

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: Diarrhoel disease, typhoid, parathyphoid fever, Hepatitis A, Hepatitis B (Mode of trasmission, 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 influenza, Pneumococcal pneumonia, prevention and control **(6)**

5. Tuberculosis: Defination, modes of transmission, WHO strategy of TB, risk factors, diagnosis,treatment, Directly observed therapy(DOTS), immunisation, prevention and control. **(4)**

6. Diseases spread by sexual contact, blood and body fluids: Chlamydia, Gonorrhoea, 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.

Seventh Semester

BTBT-701 Enzymology and Enzyme Technology

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

Objective: 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. They will understand techniques used for extraction and purification of different enzymes.

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 Michaelis-Menten 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)**

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, 2008.

BTBT-702 Downstream Processing

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

Objective: The student will learn the principles, instrumentation and application of techniques unique for recovery and purification of metabolic products from upstream process.

1. **Introduction to Downstream Processing**: Characterization of biomolecules and fermentation broth. Guidelines for recombinant protein purification **(4)**

2. Cell Disruption: Mechanical methods – Homogenization, sonication, chemical methods-enzymes & detergents, factors affecting disruption, Dynomill and French press-principle, batch and continuous operations **(5)**

3. Mechanical Methods of Separation: Flocculation and conditioning of broth, sedimentation, filtration and centrifugation- principle, instrumentation, types and applications **(5)**

4. Solid Liquid Separation: Protein precipitation and its separation, aqueous two phase extraction-principle, Instrumentation and application, Adsorption-desorption processes. **(5)**

5. Concentration and Purification: Liquid- liquid extraction – theory and practice with emphasis on aqueous two phase extraction. Solid liquid extraction, precipitation techniques using salt and solvent. Separation by ultrafiltration, dialysis, electrophoresis **(6)**

6. Isolation of proteins/metabolites by chromatographic techniques: Chromatographic methods of separation based on size, charge, hydrophobic interactions, biological affinity method . **(7)**

7. Polishing of final products: Crystallization and Drying, Case studies : Purification of lactic acid, penicillin, microbial lipase and protease, recombinant insulin **(4)**

Suggested Books

1. Bioseparations: Downstream Processing for Biotechnology by P.A. Belter et. al. (2011) Publisher: John Wiley and Sons Inc
2. . Bioseparations: Principles and Techniques by B.Sivasankar(2005); Publisher:Prentice Hall India Learning Private Limited
3 Principles of Bioseparation Engineering by Raja Ghosh(2006); Publisher: World Scientific Publishing Company.
4. Downstream Processing by J.P. Hamel, J.B. Hunter and S.K. Sikdar. Publisher Amercian Chemical Society.
5. Protein Downstream Processing by Nikolaos E. Labrou(2014); Publisher: Springer Nature
6. Bioseparatioins, P.A. Belter, E.L. Cussler and W.S. Hu, John Wiley and Sons Inc. Bioseparations: Downstream Processing for Biotechnology, P.A. Belter et al, John Wiley and Sons Inc.

BTBT-703 Genomics and Proteomics

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

Objective: This course is designed to give the students an insight into genomics as well as proteomics and their application in various emerging areas of biotechnology.

1. **Genome Mapping:** Introduction to genome mapping, Linkage and physical mapping, DNA Markers, Sequence tags, STS, EST, RFLP, SNP, RAPD, AFLP, radiation hybrid mapping, HAPPY mapping. **(5)**

2. Genome Sequencing: Sequencing genomes-high throughput sequencing, clone-by-clone approach, whole genome shot gun approach, the quality of genome sequence, annotation of genomes, human genome project and its significance in modern biology. **(6)**

3. Comparative Genomics: Comparative genomics of bacteria, eukaryotes, organelles and their applications. **(4)**

4. Analysis of Transcriptomes: Introduction to transcriptomics, differential gene expression, SAGE, various DNA microarrays and their applications in functional genomics, Next generation sequencing**. (5)**

5. Proteomics: Introduction to proteomics, protein arrays, protein chips and their applications, 2D gel electrophoresis and its application, multi-dimensional liquid chromatography, mass spectrometry and protein identification, role of bioinformatics in proteomics, proteomics databases. **(6)**

6. Structural Proteomics: High throughput solving of protein structures and their result analysis via various techniques (X-ray crystallography, NMR, homology modelling) and protein structure prediction methods, applications of structural proteomics.. **(6)**

7. Protein-Protein Interactions: Concepts, techniques –Yeast two hybrid system, rosetta stone method, Protein engineering, Applications of proteome analysis in drug discovery. **(4)**

Suggested Books

1. Principles of gene manipulation and genomics by Primrose, S.B. and Twyman, R.M., Blackwell Publishing 7th Edition (2006).
2. Introduction to Genomics by Lesk AM, Oxford University Press 2nd Edition (2012).
3. Proteomics: from protein sequence to function by Pennington, S.R. and Dunn, M. J., Viva Books (2002)

BTBT 704 Biotech Lab-XII (Enzymology and enzyme Technology Lab)

	L	T	P
Internal Marks: 30			
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 Lineweaver-Burk plot
8 Determination of effect of temperature and pH on enzyme activity
9. Immobilization of enzyme using sodium alginate beads.
10. To Study the microenvironmental effects on immobilised enzyme.

BTBT 705 Biotech Lab-XIII (Genomics and Proteomics Lab)

	L	T	P
Internal Marks: 30			
External Marks: 20	**0**	**0**	**3**
Total Marks: 50			

1. Comparison of genome attributes of different organisms (such as genome size, GC%, number of chromosomes, number of genes and number of encoded proteins)
2. Analyze average number of introns and their sizes (in comparison with exon sizes) in (different phyla of) eukaryotic organisms
3. ORF search in prokaryotic genomic DNA sequence to identify genes
4. To search for CpG islands in vertebrate genome sequences and investigate if they are present in 5' region of genes
5. To study SNPs in genes
6. RAPD analysis in search of polymorphism
7. To search orthologs and paralogs of genes
8. Theoretical determination of molecular mass, isoelectric point, phosphorylation and acetylation sites in proteins
9. Multiple sequence alignment of orthologous proteins for phylogenetic analysis
10. To simulate optical mapping by in silico digestion of phage DNA with hexamer cutter restriction enzyme
11. To search interaction partners of proteins

BTBT 706 Biotech Lab-XIV (Downstream Processing Lab)

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

L	T	P
0	0	4

1. To perform Direct filtration and Conventional filtration of waste water.
2. To use isoelectric precipitatyion technique for the purification of Casein.
3. To extract proteins by using Aqueous two phase separation .
4. To use gel filtration chromatography for the purification of proteins .
5. To use Ion exchange chromatography for the Purification of Proteins .
6. To perform the separation of proteins using Ultrafiltration.
7. To perform the separation of proteins using microfiltration.
8. To use the chemical methods of cell distruption.
9. To use the method of bead mill dor the distruction of cells.
10. To perform electrophoresis for the separation of biological sample

BTBT-707 Major Project

L	T	P
0	0	3

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

The problem of the minor project formulated during 6th Semester is to extended and executed in major project by the same group of students. Each student is required to submit 3 bound type written copies of a project report on a proposed research oriented work :- either theoretical or practical (design of sophisticated process plant, modeling & simulation of sophisticated bioprocess, optimization of sophisticated of biological process, biological process experimentation & data analysis) The object is to test the ability of the student to incorporate his entire knowledge of bio technology principles, to judge his knowledge, originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course. The student is to appear in a Viva-Voce Examination.

Departmental Elective-II (7th/8th semester)

BTBT 931 Protein Engineering

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

Objective: The objective of the course is to introduce to students the theory and practice of a variety of protein engineering methods. To learn specific examples of engineered proteins and their applications. Predict protein structure changes after site directed / random mutagenesis Carry out random mutagenesis and screening of proteins with desirable properties.

1. Protein Structure: Introduction to protein engineering, structure and properties of amino acids, primary, secondary, tertiary and quaternary structure of proteins, In-depth study behind protein folding and stability, Ramachandran plots. **(6)**

2. Analysis of protein structure: Analysis by CD spectroscopy, NMR, X ray diffraction crystallography, prediction of protein structure using bioinformatic approach, protein folding, protein sequence and structure relationship, predicting the conformation of proteins from sequence data. **(7)**

3. Protein Structure Prediction: Strategies for design of novel proteins-strategies for the design of structure and function, computer methods in protein modeling **(6)**

4. Mutagenesis and Expression of Proteins: Expression of proteins in bacteria, yeast, insect and mammalian cells, mutations and their effects on protein folding, random and site directed mutagenesis and its case studies, directed evolution **(6)**

5. Engineering the Proteins and Their Application: Effect of amino acids on structure of proteins, prediction of structure function relations of enzymes and other proteins, protein engineering - methodology, application and interpretation, gene shuffling methods such as RACHITT, ITCHY, SCRATCHY **(6)**

6. Applications: Application of protein engineering for stability, producing fusion proteins, engineering therapeutic antibodies and other proteins, engineering molecular probes, enzymes and biosensor engineering **(5)**

Suggested Books:

1. Cleland JL and Craik CS, Protein Engineering: Principles and Practice, WileyLiss. (1996).
2. Lutz S and Bornscheuer U T, Protein Engineering Handbook, Wiley-VCH (2009)
3. Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell Publishing (2012).

Departmental Elective-II (7th/8th semester)

BTBT 932 Molecular Farming

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

Objective: The main purpose of this subject is to create basic awareness about molecular farming. To create complete knowledge about the recombinant protein production. To create awareness about the production of pharmaceutical proteins in plants.

1. **Introduction And Foreign Protein Expression:** Introduction, foreign protein production systems- plant tissue culture, suspended cultures, hairy root cultures, shoot teratoma cultures. Strategies for improving FP production in tissue culture, expression systems, modifications to existing expression constructs, secretion of foreign proteins, foreign protein stability, stability inside the cells. **(7)**

2. **Novel Sprouting Technology For Recombinant Protein Production:** Biology of sprouting, dicotyledonous seeds, germination, sprout, rubisco synthesis, rubisco promoters, inhibition of endogenous gene expression, expression cassette design, sprouting- equipments, conditions, sterilization, time and temperature, light, inhibition of endogenous gene expression, growth regulators, nitrogen fertilizer, seed production, quality and environmental aspects **(7)**

3. **Monocot And Plant Viral Expression Systems:** Cereal production crops, Technical aspects, cereal transformation, expression construct design, Prodigene and Maize. Recombinant proteins expressed in Rice, Wheat, Barley. Plant RNA viruses as expression vectors- TMV, PVX, CPMV, AIMV. **(7)**

4.Chloroplast Derived Antibodies, Biopharmaceuticals And Edible Vaccines: Introduction, expression of therapeutic and human proteins in plants, transgenic chloroplast system, chloroplast derived human antibodies, biopharmaceuticals, Human Serum Albumin, Human insulin like growth factor-1, Human interferon, Antimicrobial peptides, chloroplast derived vaccine antigens, cholera toxin B subunit, *Bacillus anthracis* protective antigen, *Yersinia pestis* F1-V fusion antigen, *Canine Parvovirus* VP2 protein **(8)**

5. Downstream Processing Of Plant Derived Recombinant Therapeutic Proteins: Similarities and differences in the processing of pharmaceutical proteins from different sources, process scale, individual steps of a Downstream process, Initial processing and extraction, chromatographic purification, regulatory requirements for downstream processing of plant derived products. **(7)**

Suggested Books:

1. Molecular Farming – Plant-made Pharmaceuticals and Technical Proteins, Rainer Fischer and Stefan Schillberg. Wiley.VCH Verlag GmbH and Co. KGaA. 2004.
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
3. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University Press (2008).
4. Barnum, S.R., Biotechnology-an Introduction, Thompson Brooks/Cole (2007).

Departmental Elective-II (7th/8th semester)
BTBT 933 Environmental Biotechnology

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

Objective: 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: Introduction–Definition, species and ecosystem diversity, biogeographical classification of India, value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, 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)**

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

Departmental Elective III (7th/8th semester)
BTBT-934 Pharmaceutical Biotechnology

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

L	T	P
3	0	0

Objective: To acquire knowledge of steps of new drug discovery, development and approval process and drug manufacturing and its quality control in pharmaceutical industry.

1. Introduction: The business and the future of Biopharmaceuticals. Drug regulation and control. Scope and applications of biotechnology in pharmacy. Development of drugs and pharmaceutical industry–organic therapeutic agents uses and economics, biotechnologically derived therapeutics–approved and under development. **(5)**

2. Drug discovery: Strategies for new drug discovery,rational drug design, lead compound, combinatorial approaches, molecular modeling of drugs, pre-clinical and clinical trials. Approval processes for new drugs. **(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. **(7)**

4. **Pharmaceutical manufacturing**: Drug dosage forms and their classification. Sterile dosage forms-parenterals and biologics, novel dosage forms and targeted drug delivery systems. Current good manufacturing practices and issues. Packaging material and packing techniques. **(6)**

5. Biotechnology derived pharmaceuticals. Production of pharmaceuticals by genetically engineered cells-hormones, interferons, vaccines. Vacccines-classification, preparation, standardization, analysis and final storage. Methods involved in the production of different vaccines (BCG, DPT). Monoclonal antibodies, DNA vaccine, gene therapy, proteomics in drug development. Blood products and therapeutic enzymes. Regulatory issues in biotechnology products. **(7)**

6. Pharmaceutical Testing, Analysis and Control : Analysis of medicines using physical, chemical and biological methods, Quality assurance and control, Stability of pharmaceutical products, Bioavailability and bioequivalence testing, Quality control and testing as per Indian/US Pharmacopoeia.

(4)

Suggested Books:

1. Walsh G, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley and Sons (2007)
2. Groves MJ, Pharmaceutical Biotechnology, Second Edition, Taylor & Francis (2006)
3. Allen LV, Popovich NJ and Ansel HC, Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincot Williams and Wilkins (2005)
4. Gennaro, A.R., Remington: The Science and Practice of Pharmacy. Lippincott Williams and Wilkins (2005).
5. Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2008)

Departmental Elective III (7th/8th semester)
BTBT-935 Agricultural Biotechnology

Internal Marks: 40	**L**	**T**	**P**
External Marks: 60	**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 micro-algae. **(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. **(5)**

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.

Departmental Elective III (7th/8th semester)
BTBT-936 Computational Biology

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

Objective: The students will be able to develop software for predicting structure of protein, DNA and RNA and doing analysis of genetic and signaling pathways. They will also learn how to design drug computationally.

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)**

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 Stastics 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

Scheme of Syllabi
7th /8th Semester

Course Code	Course Name	Load Allocation	Marks Distribution		Total Marks	Credits
			Internal	External		
BTBT-801	Industrial Training	30hr/week	400	400	800	24
Total			400	400	800	

Minimum Subjects: 01	Maximum Subjects: 01