Third Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT301-18	Biostatistics	3	1	-	40	60	100	4
BTBT302-18	Foundations of Biotechnology	3	-	-	40	60	100	3
BTBT303-18	Microbiology	3	-	-	40	60	100	3
BTBT304-18	Biochemistry	4	-	-	40	60	100	4
BTBT305-18	Transport Phenomenon	3	1	-	40	60	100	4
BTBT306-18	Biotech Lab –I (FBT lab)	-	-	4	30	20	50	2
BTBT307-18	Biotech Lab –II (MB lab)	-	-	4	30	20	50	2
BTBT308-18	Training of 4 weeks duration after 2nd semester	-	-	-	60	40	100	2
BMPD301-18	Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
TOTAL		**16**	**2**	**8**	**320**	**380**	**700**	**24**

Fourth Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT401-18	Industrial Microbiology	4	0	0	40	60	100	4
BTBT402-18	Immunology and Immunotechnology	4	0	0	40	60	100	4
BTBT403-18	Cell & Molecular Biology	4	0	0	40	60	100	4
BTBT404-18	Intellectual Proprietary Rights Bioethics and Biosafety	3	0	0	40	60	100	3
BTBT XXX-18	Elective-I	4	0	0	40	60	100	4
BTBT405-18	Biotech Lab –III (IMB lab)	-	0	4	30	20	50	2
BTBT406-18	Biotech Lab –IV (IIT lab)	-	0	4	30	20	50	2
BMPD401-18	Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	General Fitness				100	00	100	S/US
TOTAL		**19**	**0**	**8**	**360**	**340**	**700**	**23**

Elective-I:

BTBT407-18	Biophysics
BTBT408-18	Environmental Biotechnology
BTBT409-18	Dairy Technology
BTBT410-18	Biodiversity, bioprospecting and organic farming

Plan for the Institutional Summer Vacation Training after 2nd semester			
Sr. No.	**Module**	**Contents to be covered**	**No. of Days**
1	I	**i) Introduction to the basics of computers** **ii) C++ computer language**	5
2	II	**i. Introduction to the subject and its scope, Introduction to various instruments in different labs**	2
		ii. Hands on training on the formation of solutions of different concentrations, calibration of different devices and their use.	3
3	III		1
		i) Expert lecture and Discussion	
		ii) Introduction to basic instruments like autoclave, laminar air flow, centrifuge, incubator, hot air oven and learning of simple techniques used in Biotechnology.	3
		iii) Various team and personality developing exercises and events.	2
4	IV	**ii.** Visit to industry related to discipline/branch.	1
5	V	**i.** Visit to local NGO/village/city to identify socio-economic/ environmental issues and identify a problem and prepare a 'Problem fomulation report'. **ii.** To have group discussion on the issues identified with faculty and to propose requisite solution / remedies/innovative solutions based on engineering.	3

Guidelines regarding Mentoring and Professional Development

The objective of mentoring will be development of:

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities.
For achieving the above, suggestive list of activities to be conducted are:

Part – A
(Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B
(Outdoor Activities)

1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

BTBT301-18 Biostatistics

Objective: The course provides students a firm foundation in statistical methods

Course Outcomes (CO): Students will be able to

1. classify various types of data and apply basic statistical tools such as sampling, measures of central tendencies, measures of dispersion and hypothesis tests to the experimental / research data.

2. use concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis.

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 (5)

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

Unit –III Probability: Permutations and Combinations, Probability of an event, addition and multiplication of probabilities (4)

Unit – IV Distributions: Normal distribution, , binomial distribution, Poisson distribution, skewness, moments and kurtosis (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) (9)

Unit – VI Paired sample hypothesis (testing mean difference), Wilcoxon paired sample test, single factor ANOVA, Kruskal-Wallis test, two factor ANOVA (10)

Unit – VII Correlation and Regression: Linear regression, correlation and Pearson coefficient of correlation, rank correlation and Spearman rank correlation coefficient (5)

Suggested Readings / Books:

1. Mishra G., Mohanty P.K. *Chainy* GBN; Biostatistics (2010)
2. Zar, JH, Biostatistical Analysis, Pearson-Prentice Hall (2007).
3. Rao K Visweswara, Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition & Anthropology, Jaypee Brothers Publishers (2007)
4. Pagano, M. and Gauvreau, K., Principles of Biostatistics, Thomson Learning (2005)
5. Mahajan BK, Methods in Biostatistics, Jaypee Brothers Publishers (2002)

BTBT302-18 Foundations of Biotechnology

Objective:

To provide a foundation in biology with engineering of living systems and to apply various tools of traditional engineering fields such as mechanical, material, electrical and chemical to understand and solve biomedical and biological problems and harness potential of living systems for the benefit of human mankind.

Course Outcomes (CO): Students will be able to

1. define biotechnology and list some basic applications.

2. apply systems engineering to living systems with applications across a wide domain of biological sciences.

3. explain process for particular technique in development of biotechnology product

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

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

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

Unit IV: Application of Biotechnology in Environment- waste water and sewage treatment, bio fuels, Bioremediation with special reference to metals, oil spills, pesticides B. Tech. Biotechnology Batch- 2011 onwards

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

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

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

Suggested Readings and Books:

1. Biotechnology by J.E Smith 3rd Ed (1996), Published by Cambridge University Press.
2. Biotechnology by H.K. Das, 4th edition 2010 Tata Mc Graw Hill

3. Biophysical Chemistry Upadhayay, Upadhayay and Nath 4th edition 2007 Himalaya Publishing House Molecular-Biotechnology by Glick & Pasternak 2nd Edition ASM Press Washington DC
4. Text book of Biotechnology H.D. Kumar, 2nd Edition

BTBT303-18 Microbiology

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.

Course Outcomes (CO): Students will be able to

1. define the science of microbiology, its development and importance in human welfare.

2. describe historical concept of spontaneous generation and the experiments performed to disprove.

3. describe some of the general methods used in the study of microorganisms.

4. recognize and compare structure and function of microbes and factors affecting microbial growth.

5. demonstrate aseptic microbiological techniques in the laboratory and check sources of microbial contamination and their control.

Unit I: History and classification: Brief History on development & scope of microbiology, characterization, classification & identification of microbes, numerical taxonomy & molecular approaches, Microscopic examination of microbes, bacterial staining.

Unit II: 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.

Unit III: Bacteriological Techniques: Pure culture techniques, isolation, cultivation, maintenance and preservation of pure cultures, culture banks and sterilization techniques

Unit IV: Bacterial Nutrition & Growth: Types of culture media, 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.

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

Unit VI: Fermentation Processes: Isolation of industrially important microbial strains, strain improvement, 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.

Unit –VII Micro-organisms & Diseases: Major diseases caused by different microbes in human, animals & plants.

Suggested Readings / Books:

1. ***Microbiology: An Introduction (9th Ed.)*** by Tortora GJ, Funke BR, and Case CL, Pearson Education, 2008.
2. ***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. ***Microbial Biotechnology: Fundamentals of Applied Microbiology*** by Glazer & Nikaido, W.H. Freeman and Co., New York, 1995.
5. ***Biotechnology - Applying the Genetic Revolution*** by Clark DP and Pazdernik NJ. Academic Press, USA, 2009.
6. ***Molecular Biotechnology (3rd Ed.)*** by Glick BR and Pasternak JJ, ASM Press, Washington D.C., 2003.
7. ***General Microbiology,*** R.Y. Stanier, J.L. Ingraham, M.L.Wheelis and P.R. Painter, Macmillian
8. ***Microbiology VI Edition,*** M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill Microbiology by Prescott.

BTBT 304-18 Biochemistry

Objectives: 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

Course Outcomes (CO): Students will be able to

1. know the chemical constituents of cells, the basic units of living organisms.

2. explain various types of weak interactions between the biomolecules.

3. know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.

4. correlate the structure-function relationship in various biomolecules

5. realize that all the cellular/biochemical changes obey the basic thermodynamic principles.

6. explain release of free energy during catabolic breakdown of the substances and its utilization during anabolic pathways.

Unit –I

Biomolecules: Chemistry and Properties of Amino Acids, Proteins, Carbohydrates, Lipids, Purines, Pyrimidines and Vitamins. Chemical Bonds: Covalent Bonds, Ionic Bonds, Coordinate Bonds, Hydrogen Bonds, Vander Waal Forces, Hydrophobic Interactions, Diode Interactions.

Unit –II

Proteins: Primary, Secondary, Tertiary and Quaternary Structure, Proteins Analysis, Methods for Isolation and Purification of Proteins. Amino acid Metabolism: Oxidative degradation and synthesis of amino acids, estimation of amino acids

Unit –III

Fat Metabolism: Oxidation of fatty acids, ketone bodies &Ketogenesis, synthesis of fatty acids (fatty acid synthesis complex system)Cholesterol Biosynthesis-Lipoproteins

Unit IV:

Carbohydrates Metabolism: Glycolysis, glycogenolysis, glycogenesis and their regulations, citric acid cycle Structure of mitochondria, organization of respiratory chain, oxidative phosphorylation and its inhibitors

Unit –V.

Nucleic Acid Metabolism: Biosynthesis of purines and pyrimidines, their regulation and catabolism

Unit –VI

Plant Photosynthesis, C3,C4,CAM pathways,Photorespiration.

Unit-VII

N2- Fixation: Role of Various Enzymes in Nitrogen Cycle.

Suggested Readings / Books:

1. L. Stryer: Biochemistry, W.H. Freeman and Company, New York (2006)
2. A.L. Lehninger: Principles of Biochemistry, Worth Publishers, New York (2007)
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).
5. Jain, J L, Jain, Nitin, Sunjay Jain, “Fundamentals of Biochemistry”, S. Chand Group,
6. Satyanarayana.U & U. Chakrapani, “Biochemistry” Books and Allied (p) Ltd.

BTBT305-18 Transport Phenomenon

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

Course Outcomes (CO): The students will be able to

1. get acquainted with the basic laws used in transport phenomenon (heat, mass and momentum transfer).
2. gain knowledge about the different types of fluids, its behavior in terms of laminar, turbulence, diffusion etc.
3. explore their knowledge in designing and working of various instruments in any field related to flow, and to design various kinetic models in relation to process and instrument.

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.

Unit –II Non-Newtonian Fluids: Time Dependent, Time Dependent and Visco-elastic fluids, Consecutive Equations and Rheological Characteristics.

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.

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.

Unit –V Diffusion Phenomena: Diffusion of gases and liquids in porous solids, Knudsen diffusion, multicomponent diffusion and effective diffusivity.

Unit –VI Methods of Analysis of Transport Problems: General integral balance using macroscopic concepts, integral balance for mass, momentum and energy.

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.

Suggested Readings / Books:

1. **"Transport Phenomena", 2nd Edition** by Bird R.B., Stewart W.E. and Lightfoot E.N., John Wiley and Sons (2002).
2. **"Transport Processes and Separation Process Principles", 4th Edition,** by Geankoplis C.J., Prentice-Hall of India. (2004).
3. **Basic Concepts In Transport Phenomena, A Unified Approach". Vol.-I** by Brodkey, R.S., Hershey H.C., Brodkey Publishing (2003).

BTBT 306-18 Biotech Lab –I (FBT lab)

1. To study the prokaryotic cell (*Lactobacillus*).

2. To study the eukaryotic cell (Plant and Animal cell).

3. To study the various stages of mitosis from onion root tip.

4. To study the various stages of mitosis through permanent slides.

5. Demonstration of various laboratory techniques: centrifugation, electrophoresis, chromatography, sterilization.

6. To demonstrate the antigen - antibody interaction through haemagglutination (i.e. blood grouping).

7. To demonstrate the activity of salivary enzyme amylase on starch.

9. To demonstrate the effect of temperature and pH on the activity of salivary amylase.

10. To measure the various Water Quality Parameters:

a. TDS (Total Dissolved Solds)

b. pH

c.Conductivity

BTBT 307-18 Biotech Lab –II (MB lab)

1. Microscopic Examination of Microorganisms by various staining methods

- Simple staining
- Gram staining
- 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

BTBT401-18 Industrial Microbiology

Objective: 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.

Course Outcomes (CO): Students will be able to

1. understand characteristics of industrially important microbes.

2. know the production aspects of pharmaceuticals and fine chemicals.

3. apply knowledge of microorganisms in commercial production of flavours and microbial pigment in textile and industry.

4. apply the process for commercial production of enzyme.

Unit-I: Introduction: Aim and scope. Industrially important microbes, Characteristics of Industrially important microbes, Primary and secondary screening of microbes, Strategies involved in the isolation of desired microbes from the environment.

Unit-II: Strain improvement techniques and preservation and maintenance of microbes

Unit-III: Microbial Enzymes: General account of Enzymes, Immobilization of enzymes, desirable attributes of industrial grade enzymes like lipase, protease, cellulase, and amylase

Unit-IV: Biofuels: Criterion for selection of raw material: ethanol, biogas, biohydrogen and biodiesel

Unit-V: Health Care Products: Natural sources and underlying principles for the production of Antibiotics, vaccines, vitamins, amino acids, alkaloids, steroids

Unit-VI: Food and Beverages: Alcoholic Production; Types (solid and submerged) and role of fermentation, 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

Unit-VII: Biodegradation of pollutants, use of microbes in biodegradation , Bio-plastics : brief introduction , production and biochemical attributes, Biosensors: role of various bio-molecules their sources and applications, production and applications of bio-fertilizers, production and application of bio-insecticides.

Suggested Books:

1. Alcamo's Microbiology: J C Pommerville. 2010. Jones and Bartlett, USA
2. Microbiology: Prescott, Harley and Kleins. 2008. McGraw Hill, USA.
3. Microbiology: B R Funke. 2006. Addison-Wesley Longman, ISBN 080537809X
4. Microbiology: Pelczar, Chan and Kreig. 2001. Tata-McGraw Hill, New Delhi.

BTBT402-18 Immunology and Immunotechnology

Objective: The overall learning goals for the course are to acquire a fundamental knowledge of the basic principles of immunobiology and a complete understanding of the principles and applications of immunotechniques.

Course Outcomes (CO): Students will be able to

1. explain the role of immune cells and their mechanism in body defense mechanism.
2. apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. demonstrate immunological techniques.
4. interpret association of immune system with cancer, autoimmunity, transplantation and infectious disease.

Unit I.

Introduction and overview of immune system: Types of immunity-innate and adaptive, active and passive. Cells and organs of the immune system: T cell, B cell, Macrophage, Neutrophil, NK cell, Dendritic cell, Stem cells; Immune organs- Bone marrow, Spleen, Thymus, Lymph node, GALT. (6)

Unit-II.

Characteristics of an antigen (foreignness, molecular size and heterogeneity), haptens, epitopes, adjuvants. Immunoglubulins: Structure, types, properties and functions; VDJ rearrangements, Complement system. (4)

Unit-III

Polyclonal and monoclonal antibodies. Monoclonal antibodies- productions and applications. Cytokines – types and immune response. Complement System. Roles of cytokines and complement in inflammation. Antibody-dependent protection mechanisms. Leukocyte migration and inflammation (6)

Unit-IV.

Major Histocompatibility Complex (MHC) and its role. Antigen processing and Presentation. BCR and TCR genes structure. B lymphocyte and T lymphocyte development, activation and functions. (8)

Unit-V.

Antigen and antibody interactions, affinity and avidity, agglutination and precipitation reactions, immunoassays, Immunodiagnostics: principles and applications. Radio Immuno Assay, ELISA, Western blotting, Immunoprecipitation, Immunofluorescence, Fluorescence activated cell sorting analysis. (8)

Unit-VI.
Transplantation and tumor immunology, relationship between donor and recipient, role of MHC molecules in Allograft rejection, bone marrow and haematopoietic stem cell transplantation. Tumor immunology. (5)

Unit-VII. Autoimmunity, criteria and causes of autoimmune diseases Hypersensitivity. Immunodeficiency: Primary and Secondary: AIDS (4)

Suggested Books:

1. Kuby's Immunology (6th edition) by Thomas J. Kindt, Richard A. Goldsby, Barbara Anne Osborne, W.H. Freeman and Company,New York (2007)
2. Roitt's Essential Immunology (11th Ed.) by Delves P, Martin S, Burton D, Roitt IM. Wiley- Blackwell Scientific Publication, Oxford (2011)
3. Immunology (6th Ed.) by Richard C, Geiffrey S. Wiley- Blackwell Scientific Publication, Oxford (2009)
4. Cellular and Molecular Immunology (6th Ed.) by A K Abbas, A H Lichtman, Shiv Pillai. Saunders Publication, Philadelphia, (2007)
5. Kenneth Murphy, "Janeway's Immunobiology", Garland Science 2011
6. A.K. Chakravarty, "Immunology and Immunotechnology",Oxford University Press 2006.

BTBT403-18 Cell & Molecular Biology

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

Course Outcomes (CO): Students will be able to

1. explain the properties of genetic materials and storage and processing of genetic information.

2. apply mechanisms of DNA replication, damage and repair in applied molecular genetics.

3. explain mechanisms involved in gene expression.

4. explain molecular basis of complex metabolic diseases.

Unit-I Overview of cell structure and cell division, Cytoskeleton & ECM, Cell cycle & its regulation

Unit-II Architecture of Prokaryotic & Eukaryotic chromosome- Structure and functional properties Structure of DNA-Nucleoside, Nucleotide, Base pairing, Base stacking, Double Helix, features of Watson and Crick model, major and minor groove, Forms of DNA- A, B, Z ; Chargaff's rules, sequence complementarity and other properties; Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA.

Unit-III DNA replication – Phages, bacteria and eukaryotic systems: initiation, elongation & termination, replication errors & proof reading; DNA damage & repair systems, various models of recombination; Transpogenesis

Unit-IV 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.

Unit-V Translation : Genetic Code & Its important attributes, structure and functions of ribosomes; Prokaryotic & eukaryotic initiation, elongation & termination of translation ; Post translational modifications: enzymatic cleavage, acetylation, phosphorylation, methylation, ubiquitization, function of signal peptide and transport.

Unit-VI Signal transduction: types of receptors (Tyrosine Kinases, G-protein, Ion channel), overview of signaling pathways (tumorigenesis, nitric oxide and cyclic GMP, calcium induced and calcium released); Phosphorylation cascade, Caspase cascade, apoptosis

Unit-VII Introduction to stem cells & cellular differentiation; RNA interference, epigenetics: Phenomenon (with emphasis on X chromosome inactivation); tumour suppressor genes & apoptosis.

Suggested Books:

1. Molecular Biology of the Cell, Fifth Edition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, December 2007
2. Cell and Molecular Biology, Sixth Edition, Gerald Karp
3. Molecular Biology of the gene, 5^{th} ed. By J. Watson, T. A. Baker, S.P.Bell, A. Gann, M. Levine & R. Losick, Pearson education, 2006

BTBT404-18 Intellectual Property Rights, Bioethics & Biosafety

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

Course Outcomes (CO): Students will be able to

1. interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life

2. recognize importance of biosafety practices and guidelines in research

3. comprehend benefits of GM technology and related issues

4. recognize importance of protection of new knowledge and innovations and its role in business

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

Unit-II Basic Requirement of Patentability: Patentable subject matter, novelty and public domain, non obviousness

Unit-III Special issue in Biotechnological Patents: Disclosure requirements, collaborative research, competitive research, plant biotechnology, foreign patents.

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.

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.

Unit-VI The Cartagena protocol on biosafety.

Unit-VII Biosafety Management: Key to the environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques; Social and ethical implications of biological weapons; Good safety practices, GLP standards, lab contaminants.

Suggested Books:

1.Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)
2. Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).
3. Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)

BTBT405-18 Biotech Lab III (IMB lab)

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.

BTBT406-18 Biotech Lab –IV (IIT Lab)

1. To prepare blood smear and identification of different types of immune cells.
2. To perform TLC, DLC
3. To perform Immunodiffusion (Ouchterlony)
4. To perform Immunoelectrophoresis
5. To study Quantitative precipitation assay
6. To perform Latex Agglutination test
7. To perform DOT ELISA or Plate ELISA
8. To perform Western Blotting

BTBT407-18 BIOPHYSICS

Objective: To introduce the theories and concepts of biophysics of biomolecules which are considered important in biotechnology applications. They will learn the structures of biological molecules and will understand the concept of structural analysis They will also learn the techniques for analysis and determination of structure of biomolecules

Course Outcomes (CO): Students will be able to

1. evaluate appropriate physical scale (length, force, time, energy, etc.) that is applicable in living systems.

2. apply laws of thermodynamics in biological processes like protein folding, metabolism, DNA melting, phase transitions in membrane, etc.

3. apply discrete and continuous distributions in biological systems.

4. explain the significance of low Reynold numbers in biological systems and their role in transport phenomenon in living systems.

5. draw electrical network equivalence of nerve signals.

UNIT I STRUCTURES OF BIOLOGICAL MACROMOLECULES - Levels of structures in proteins, nucleic acids and polysaccharides - primary, secondary, tertiary and quaternary structures

UNIT II CONFORMATIONAL ANALYSIS OF PROTEINS: PROTEIN STRUCTURE - Polypeptide chain geometries, internal rotation angles, Ramachandran plot, potential energy calculations, forces that determine protein structure – hydrogen bonding, hydrophobic interactions, ionic interactions, disulphide bonds – prediction of protein structure.

UNIT III CONFORMATIONAL ANALYSIS OF NUCLEIC ACIDS - General characteristics of nucleic acid structure, backbone rotation angles and steric hindrances – forces stabilizing ordered forms – base pairing and base stacking

UNIT IV TECHNIQUES FOR THE STUDY OF BIOLOGICAL STRUCTURE- Electron Microscopy, Ultracentrifuge, Viscometry, Molecular –sieve chromatography, electrophoresis, NMR and EPR.

UNIT V OTHER TECHNIQUES: X-Ray crystallography, X-ray fiber diffraction, light scattering, Neutron scattering

Suggested Readings / Books

1. Cantor, C. R. and Schimmel, P.R., "Biophysical Chemistry, Part -I and Part III", W H Freeman & Co. 2008
2. Van Holde, K E, Johnson W C, Ho P S, Principles of Physical Biochemistry, Prentice Hall Intl. 1998
3. Donald Voet and Judith G Voet, Biochemistry, John Wiley 2004
4. W Hoppe, W Lohmann, H Markl, H Ziegler, Ed. Biophysics, Springer Verlag Berlin 1982

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BTBT408-18 Environmental Biotechnology

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.

Course Outcomes (CO): Students will be able to:

1. comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments

2. comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals

3. apply biotechnological processes in waste water and solid waste management.

4. comprehend biofuels/bioenergy systems; attributes for biofuel / bioenergy production.

5. demonstrate innovative biotechnological interventions to combat environmental challenges.

Unit I – Biological Waste Treatment:

Biological waste water treatment: Principles and design aspects of various waste treatment methods with advanced bioreactor configuration: activated sludge process, trickling filter, fluidized expanded bed reactor, up flow anaerobic sludge blanket reactor, contact process, fixed/packed bed reactor, hybrid reactor, sequential batch reactor. Solid waste management: landfills, recycling and processing of organic residues, minimal national standards for waste disposal

Unit II – 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

Unit III – Biotransformations and Biocatalysts:

Basic organic reaction mechanism- Common prejudices against enzymes, advantages & disadvantages of biocatalysts, isolated enzymes versus whole cell systems, biocatalytic application, catalytic antibodies; stoichiometry, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants

Unit IV – Bioremediation and Biorestoration:

Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, *In situ* and *Ex-situ* technologies, phytoremediation-restoration of coal mines a case study. 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

Unit V – 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

Unit VI – 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

Unit VII – 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

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

BTBT409-18 DAIRY TECHNOLOGY

Objectives: introduce students to different systems of breeding and methods of selection of dairy animals; processing of milk and its products and provide students with information about the importance of quality control in dairy science

Course Outcomes (CO):

the student will be able to:

1. Know about general dairy farm practices
2. classify and explain the different types of milk products
3. explain processes involved in production of milk and milk products
4. application of biotechnology in food and dairy industry
5. understand purpose and functions of hygiene in dairy industry

UNIT-I

Introduction to Animal Husbandry. Distinguishing characteristics of Indian and exotic breeds of dairy animals and their performance. Methods of selection of dairy animals. General dairy farm practices - identification, dehorning, castration, exercising, grooming, weighing. Care of animals at calving and management of neonates. Management of lactating and dry cows and buffaloes. Methods of milking, milking procedure and practices for quality milk production.

Unit-II

Chemical composition, nutritive value and physico-chemical characteristics of milk. Microbiology of Milk. Processing of liquid milk- methods of milk collection, filtration, pasteurization, homogenization, packaging and distribution. Types of milks. Synthetic milk and its detection. Various analytical techniques for determination of milk quality.

UNIT-III

Chemistry and technology of cream, butter, margarine and ghee manufacture Production of ice cream and other frozen desserts. Chemistry and technology of: Evaporated milk , Condensed milk. Chemistry and Technology of Milk Powders (full fat, Skim-milk and instantized milk powders) Production of infant milk food.

UNIT-IV

Technology of cheese and other fermented milk products. Indigenous milk products & their technology. Fortification of milk products with different nutrients. Byproducts of dairy industry. Milk plant hygiene, sanitation and waste utilization.

Unit-V

Protoplast fusion & Tissue culture in dairy cultures. Application of biotechnology in food and dairy industry, dairy effluents. Genetic manipulation of dairy starters for improved attributes

of commercial value. Dairy enzymes and whole cell immobilization. Ethical issues related to dairy technology

Suggested Books:

1. Technology of Dairy Products by Early, R.
2. Outlines of Dairy Technology by De. S.
3. Chemistry & Testing of Dairy Products by Atherten

BTBT410-18 Biodiversity, Bioprospecting and Organic-farming

Objectives: To teach the basic of evolution that causes biodiversity among microbes, plants and animals their survival, domestication and further improvement.

Course Outcomes (CO): Students will be able to:

1. Name, classify organisms in their local environment
2. Understand the importance of biodiversity and the importance of their sustainable use
3. Apply various methods for conservation
4. Understand the importance of organic farming

Unit I.
Nomenclature and classification of organisms and major ecosystems of their flora and fauna (2)

Unit II.
Analysis of biodiversity and co-evolution, symbiosis and interaction among organisms. (6)

Unit III.
On farm, ex situ, in situ and gene bank conservation (4)

Unit IV.
Geological and human activities endangering biodiversity (4)

Unit V.
Domestication and utilization of biodiversity and bioprospecting, biodiversity for food, feed, health care and other products (8)

Unit VI.
Organic farming and sustainable use of natural and bioresources organic standards and certification of organic produce and products (8)

Unit VII.
Ethnobiology, IPRs and patenting and global initiatives on future prospects (4)

Suggested Books:

1. Wrigley, S. K., Hayes M. A., Thomas, R, Chrystal, E. J. T., and Nicholson, L., "Biodiversity: New leads for the Pharmaceutical and Agrochemical Industries:, Royal Society of Chemistry 2000
2. Tripathi, G. and Tripathi, Y. C. (ed), "Biological and Biotechnological Resources", Campus Books International 2002
3. Tiwari, G.S., "Sustainbale Development and Conservation of Biodiversity", Anamaya Publishers 2006
4. Krishnamurthy, K.V., " Text Book of Biodiversity", Science Publisher 2003
5. McManis, C.R., "Biodiversity and the Law: Intellectual Property, Biotechnology and Traditional Knowledge. 2007