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

B Tech Biotechnology 2018 onwards

Fifth Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Int	Ext		
BTBT501/18	Genetic Engineering	4	-	-	40	60	100	4
BTBT502/ 18	Animal Cell Culture & Biotechnology	3	-	-	40	60	100	3
BTBT503/ 18	Bioinformatics	3	1	-	40	60	100	4
XXXXXX	Interdisciplinary Elective-I	3	-	-	40	60	100	3
YYYYYY	Elective-II	3	-	-	40	60	100	3
BTBT504/18	Biotech Lab –V	-	-	4	30	20	50	2
BTBT505/18	Biotech Lab –VI	-	-	4	30	20	50	2
BTBT506/18	Training of 4 weeks duration after 4th semester				60	40	100	2
TOTAL		**16**	**1**	**08**	**320**	**380**	**700**	**23**

Interdisciplinary Elective-I

BSBT 141/18 IPR, Entrepreneurship Bioethics & Biosafety
BSBT 137/18 Human Behaviour & Psychology
BSBT 501/18Organic Farming

Elective -II

BTBT 507/18 Nano biotechnology
BTBT 508/18 Pharmaceutical Biotechnology
BTBT 509/18 Molecular Diagnostics

Sixth Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT601/18	Fundamentals of Biochemical Engineering	3	1	-	40	60	100	4
BTBT602/18	Plant Biotechnology	3		-	40	60	100	3
BTBT603/18	Bioenergetics and Enzyme Technology	3	-	-	40	60	100	3
	Interdisciplinary Elective-II	3	-	-	40	60	100	3
	Elective-III	3			40	60	100	3
BTBT 604/18	Total Quality Management and Entrepreneurship	1	2		40	60	100	3
BTBT605/18	Biotech Lab –VII (PBT lab)	-	-	4	30	20	50	2
BTBT606/18	Biotech Lab –VIII (EET& BC lab)	-	-	4	30	20	50	2
	General Fitness				100		100	S/US
TOTAL		**16**	**03**	**08**	**400**	**400**	**800**	**23**

Interdisciplinary Elective-II:

BTBT 607/18 Introduction to Food Technology
BTBT 608/18 Bioterrorism and National Security
BTBT 609/18 Biomaterials

Elective-III:

BTBT 610/18 Biosimilars Technology
BTBT 611/18 Waste Management & Upcycling
BTBT 612/18 Gene Expression and Transgenics

Seventh Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT701/18	Food Biotechnology	3	1	-	40	60	100	4
BTBT702/18	Instrumentation and Process Control	3	1	-	40	60	100	4
BTBT703/18	Fermentation Technology	3	1	-	40	60	100	4
	Interdisciplinary Elective -III	3	-	-	40	60	100	3
	Elective -IV	3	-	-	40	60	100	3
BTBT704/18	Biotech Lab- IX	-	-	4	20	30	50	2
BTBT705/18	Biotech Lab -X	-	-	4	20	30	50	2

Interdisciplinary Elective -III

BTBT 706/18 Genomics and Proteomics

BTBT 707/18 Good Manufacturing and Laboratory Practice

BTBT 708/18 Synthetic Biology

Elective -IV

BTBT 709/18 Brewing Science and Practice

BTBT 710/18 Nutrition in Health and Disease

BTBT 711/18 Stem-Cell Technology

Eighth Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT 801/18	(Biotech Industrial or Biotech Inhouse Project	-	-	32	300	200	500	16

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, 5th 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

B Tech Biotechnology 2018 onwards

Fifth Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Int	Ext		
BTBT501/18	Genetic Engineering	4	-	-	40	60	100	4
BTBT502/ 18	Animal Cell Culture & Biotechnology	3	-	-	40	60	100	3
BTBT503/ 18	Bioinformatics	3	1	-	40	60	100	4
XXXXXX	Interdisciplinary Elective-I	3	-	-	40	60	100	3
YYYYYY	Elective-II	3	-	-	40	60	100	3
BTBT504/18	Biotech Lab –V	-	-	4	30	20	50	2
BTBT505/18	Biotech Lab –VI	-	-	4	30	20	50	2
BTBT506/18	Training of 4 weeks duration after 4th semester				60	40	100	2
TOTAL		**16**	**1**	**08**	**320**	**380**	**700**	**23**

Interdisciplinary Elective-I

BSBT 141/18 IPR, Entrepreneurship Bioethics & Biosafety
BSBT 137/18 Human Behaviour & Psychology
BSBT 501/18Organic Farming

Elective -II

BTBT 507/18 Nano biotechnology
BTBT 508/18 Pharmaceutical Biotechnology
BTBT 509/18 Molecular Diagnostics

BTBT 501/18 Genetic Engineering

Unit -I

Introduction: Scope of genetic engineering, Milestones in genetic engineering: isolation of enzymes, DNA sequencing, synthesis and mutation, molecular cloning, gene expression, cloning and patenting of life forms, genetic engineering guidelines.

Unit -II

Principles and techniques of recombinant DNA technology: Basic molecular techniques, Different hosts for molecular cloning, Host restriction and modification, Restriction and other enzymes; Cloning vectors: plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, YAC, BAC, Restriction mapping of DNA fragments, Genomic and cDNA libraries

Unit -III

Molecular techniques for cloning, screening, expression and regulation studies of genes, DNA labelling, DNA and protein sequencing

Unit -IV

Polymerase Chain Reactions (PCR), DNA fingerprinting, RAPD, Site-directed mutagenesis, Expression strategies for heterologous genes in bacteria, yeast, insect cells and mammalian cells, Molecular markers, Detecting protein-protein interactions, High-throughput techniques, Gene therapy

Suggested Readings/ Books

- Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
- Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T., Lewin's GENES X, Jones and Bartlett Publishers (2011).
- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, 5th Edition, Garland Science Publishing (2008).
- Fritsch, J. and Maniatis, E.F., Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laboratory (1999).

BTBT 502/18 Animal Cell Culture and Biotechnology

Unit -I

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation. Layout of animal tissue culture laboratory. Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages, and their applications.

Unit -II

Primary Culture and Culture of Specific Cell Types: Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines

Unit III

Cell transformation. Cell cloning and Cell separation, Cell synchronization. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity Characterization, Contamination and Cryopreservation of Cell Line: Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labeling Index, Generation Time, Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cell banks, Transporting cells.

Unit -IV

Gene transfer technology in animals: Gene transfer techniques in mammalian cells, Viral and nonviral methods, Production of transgenic animals, ES and microinjection, retroviral method and molecular pharming, applications of transgenic animal technology

Suggested Readings/ Books

- R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, 4th Edition" 2000.
- Ranga, M.M., Animal Biotechnology, Agrobios (2007) 2nded.
- Masters, J. R.W., Animal Cell Culture, Oxford (2000) 3rded.
- Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).

BTBT 503/18 Bioinformatics

Unit -I

Introduction: Goals, applications and limitations of Bioinformatics, Biological sequence and molecule file formats

Unit -II

DNA and protein sequence databases, Structure databases Pairwise sequence alignment and database searching: Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Dot matrix method, Scoring matrices,

Unit -III

Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA, BLAST

Unit IV

Multiple sequence alignment and phylogenetics: Scoring multiple sequence alignments, Progressive alignment method, Iterative alignment method, Block-based alignment, Molecular evolution and phylogenetics, Phylogenetic analysis

Suggested Readings/ Books

- Xiong J, Essential Bioinformatics, Cambridge University Press (2006)
- Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed
- Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2008)
- Zar, J. H., Biostatistical analysis (Fifth edition), Pearson Prentice Hall publication, ISBN 978-0-13-100846-5
- Rao, K. V., Biostatistics – A manual of statistical methods for use in health, nutrition and anthropology (Second edition), JAYPEE Brothers Medical Publishers Pvt. Ltd., ISBN 81-8448-055-5
- Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks-A Practical Approach, Oxford University Press (2000).
- Gupta S. C. and Kapoor, V. K., Elements of mathematical statistics (Third edition), Sultan Chand & Sons Publishers, ISBN 81-7014-290-3
- Mahajan, B. K., Methods in biostatistics (Sixth edition), JAYPEE Brothers Medical Publishers Pvt. Ltd., ISBN 81-7179-520-X

BSBT 141/18 IPR, Entrepreneurship Bioethics & Biosafety

UNIT-I

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

UNIT II

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies.

UNIT IV

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

Suggested Readings/ Books

- Entrepreneurship: New Venture Creation : David H. Holt
- Patterns of Entrepreneurship : Jack M. Kaplan
- Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
- Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
- Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

BSBT 137/18 Human Behaviour and Psychology

Unit -I

Psychological Perspectives and Approaches: Nature and Scope of psychology; historical perspective; sub-fields and applications; methods of psychology. Introduction to the science of human behaviour

Unit -II

Perception: Sensory and perceptual processes; pattern recognition; attention; perception of objects, space, and time; feature and attribute perception; Learning: Models and theories of learning; Memory: Functions and processes; models and theoretical views

Unit -III

Motivation and Emotion: Physiological and cognitive bases of motivation; expression and perception of emotions; physiological correlates and theories of emotion. Intelligence: Nature of intelligence; theories and models of intelligence; psychological tests and assessment of intelligence; Issues in intelligence testing; creativity.

Unit -IV

Personality: Nature and theories of personality; personality assessment; determinants of personality; psychological conflict and conflict handling mechanisms. Individual Differences: Genetic and environmental bases of individual differences in human behaviour.

Suggested Readings/ Books:

- Baron, R.A. Psychology. New Delhi: Prentice Hall of India
- Atkinson, R.L., Atkinson, R.C., and Hilgard, E.R. Introduction to Psychology. Harcourt Brace Jovanovich Inc.
- Atkinson, R.L., Atkinson, R.C., and Hilgard, E.R. Introduction to Psychology. Harcourt Brace Jovanovich Inc.

BSBT 501/18 Organic Farming

Unit -I

Organic farming – Introduction, Significance and practices. Organic farming for sustainable agriculture- Manures (Bulky and concentrated)

Unit -II

Sewage and sludge, green manures – potentials and limitations. Quality parameters of organic manures and specifications.

Unit -III

Bio remediation and phytoremediation. Role of microorganisms in degradation of pesticides.

Unit -IV

Biofertilizers, Soil health, Soil Health Card, Soil enzymes: biological tests and harmful effect of non-judicious chemical fertilization.

Suggested Readings/ Books

- Sharma A. 2002. Hand Book of Organic Farming. Agrobios
- Lampin N. 1990. Organic Farming. Press Books, lpswitch, UK.
- 2. Palaniappan SP & Anandurai K. 1999. Organic Farming – Theory and Practice. Scientific Publ.

BTBT 507/18 Nanobiotechnology

Unit -I

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

Unit -II

Synthesis and Characterization of Nanomaterials: Bottom-up and bottom-down approaches: milling, arc discharge, laser ablation, spray pyrolysis, chemical vapor deposition, physical vapor deposition, wet chemical synthesis of nanoparticles, self-assembled monolayer, Characterization of nanostructures,

Unit -III

Spectroscopy: UV-Vis, FTIR; Electron microscopy: Scanning electron microscopy, EDX, Transmission electron microscopy, Atomic force microscopy. Engineered Nanomaterials for Biological Applications: Current status of nanobiotechnology, biogenic synthesis of nanoparticles: microbial and plant mediated, surface functionalization of nanomaterials, biological applications of functionalized nanomaterials, Biological nanomachines: ribosomes, photosynthesis systems, Bionano motors, Nano-antimicrobials, Immobilized nanoparticles for water disinfection and biopesticides delivery applications.

Unit -IV

Biomedical Applications and Nanotoxicity: Biopolymers, Polymeric biomaterials, lipid nanoparticles for drug delivery applications, magnetic nanoparticles based hyperthermia treatment of cancer, DNA nanotechnology, Nano-biosensors: fabrication, functionalization, applications, Cytotoxic and genotoxic effects of nanomaterials, toxic effects on environment, impact of nanotechnology on society and industry.

Suggested Readings/Books

- "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", G. Cao, Imperial College Press (2004)
- Nanobiotechnology; Concepts, Applications and Perspectives", C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004)

- " Bionanotechnology: In Nanoscale Science and Technology", G. J. Leggett, R. A. L. Jones, John Wiley & Sons, (2005)
- "Textbook of Nanoscience and Nanotechnology", B. S. Murthy, P. Shankar, B. Raj, B. B. Rath and J. Murday, Universities Press-IIM (2012)
- "Nano: The Essentials", T. Pradeep, Tata McGraw-Hill Publishing Company Ltd. (2007)
- "Bionanotechnology", D. S. Goodsell, John Wiley & Sons (2004)
- "Springer Handbook of Nanotechnology", Eds: Bhushan, 2nd edition.
- "Encyclopedia of Nanoscience and Nanotechnology", Eds: H. S. Nalwa, American Scientific Publishers (2004)

BTBT 508/18 Pharmaceutical Biotechnology

Unit -I

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

Unit-II

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

Unit-III

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, adversem effects of drugs and toxicology, Drug interactions.

Unit -IV

Pharmaceutical manufacturing: Drug dosage forms and their classification. Sterile dosage formsparenteral and biologics, novel dosage forms and targeted drug delivery systems. Current good manufacturing practices and issues. Packaging material and techniques. Quality control of pharmaceutical products as per pharmacopoeia. Microbial assays of vitamins and antibiotics. Stability studies, Method validation. Biotechnology derived pharmaceuticals. Production of pharmaceuticals by genetically engineered cells- hormones and vaccines. Regulatory issues in pharmaceutical products.

Suggested Readings/ Books

- Allen, L.V., Popovich, N.G. and Ansel, H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams and Wilkins (2005).
- Walsh, G., Biopharmaceuticals: Biochemistry and Biotechnology, Wiley (1998).
- Gennaro, A.R., Remington: The Science and Practice of Pharmacy. Lippincott Williams and Wilkins (2005).
- Tripathi, K.D., Essentials of Medical Pharmacology, Jaypee Brothers Medical Publishers (2008)

BTBT 509/18 Molecular Diagnostics

Unit-I

Historical introduction: Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples. Interpretation of results. Normal microbial flora of the human body. Nosocomial infections. Host-Parasite relationships.

Unit-II

Microbial Pathogenicity: Pathogenicity and diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium. Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis.Pathogen

Unit -III

Diagnostic techniques: Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Study ofhelminthic diseasesFasciola hepatica and Ascaris lumbricoides. Filariasis and Schistosomiasis.

Unit -IV

Medical Genetics: Human Genome Project, Identifying human disease genes. Human disorders Biochemical disorders, Immune disorders, chromosomal disorders, single cell disorders and complex traits. Chromosomal disorder diagnosis autosomal; sex chromosomal; karyotype analysis. G-banding, in situ hybridization (FISH and on-FISH), and comparative genomic hybridization (CGH). Cancer cytogenetics Spectral karyotyping Genes in pedigree. Genetic Counselling.

Suggested Readings / Books

- Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications, Maribeth L. Flaws Ph.d , Lela Buckingham Publisher: F A Davis Co
- Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory Wayne W. Grody, Robert M. Nakamura, Frederick L. Kiechle, Charles Strom, Publisher: Academic Press; ASIN: B003FQM2OI
- Medical Microbiology (1997), Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
- Parasitology (1997), Chatterjee K.D, Chatterjee Medical Publishers.
- Bailey & Scott's Diagnostic Microbiology (2002), Betty A. Forbes , Daniel F. Sahm,
- Alice S. Weissfel Ernest A. Trevino, Published by C.V. Mosby

BTBT504/18 Biotech Lab V

Section A (Any 04)

1. Bacterial transformation
2. Isolation of plasmid/bacteriophage DNA
3. Restriction analysis of DNA
4. Cloning in plasmid vectors
5. Different PCR techniques,
6. Gene expression in bacterial hosts and analysis of gene products

Section B (Any 04)

7. Laboratory Design & Instrumentation in ATC
8. Quality Assurance in Animal tissue culture facility
9. Preparation of animal cell culture media
10. Isolation and Culturing Peripheral Blood
11. Cryopreservation technique
12. Sub-culturing and maintenance of Cell line,
13. In vitro anticancer assay (MTT Assay),
14. Genomic DNA Isolation from Blood and Tissue.

BTBT 505/18 Biotech Lab VI

1. DNA and protein sequence and PDB file formats
2. Local and global sequence alignment of protein and DNA sequences
3. Needleman Wunsch and Smith-Waterman algorithm
4. BLAST
5. Multiple sequence alignment
6. Phylogenetic tree construction

Sixth Semester

Course Code	Course Title	Load Distribution			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT601/18	Fundamentals of Biochemical Engineering	3	1	-	40	60	100	4
BTBT602/18	Plant Biotechnology	3		-	40	60	100	3
BTBT603/18	Bioenergetics and Enzyme Technology	3	-	-	40	60	100	3
	Interdisciplinary Elective-II	3	-	-	40	60	100	3
	Elective-III	3			40	60	100	3
BTBT 604/18	Total Quality Management and Entrepreneurship	1	2		40	60	100	3
BTBT605/18	Biotech Lab –VII (PBT lab)	-	-	4	30	20	50	2
BTBT606/18	Biotech Lab –VIII (EET& BC lab)	-	-	4	30	20	50	2
	General Fitness				100		100	S/US
TOTAL		**16**	**03**	**08**	**400**	**400**	**800**	**23**

Interdisciplinary Elective-II:

BTBT 607/18 Introduction to Food Technology
BTBT 608/18 Bioterrorism and National Security
BTBT 609/18 Biomaterials

Elective-III:

BTBT 610/18 Biosimilars Technology
BTBT 611/18 Waste Management & Upcycling
BTBT 612/18 Gene Expression and Transgenics

BTBT601/18 Fundamentals of Biochemical Engineering

Unit I – Mass and energy balance in biological processes. 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, oxygen consumption and heat evolution in aerobic cultures, oxygen uptake rate, thermodynamic efficiency of growth

Unit II – **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, thermal death kinetics of cells and spores. Ideal reactors for kinetics measurement: chemostat, turbidostat, batch, fed batch and continuous cultivation

Unit III – Sterilization and Scale-up in Bioreactors: sterilization of air, medium, bioreactor, kinetics of death, theory of depth filters, design of depth filters, design of batch sterilization and continuous sterilization process. Overview of typical 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, mass transfer correlation, experimental determination of K_La values, factors affecting K_La value, fluid rheology, scale- up principles and its difficulties, scale down

Unit IV – Instrumentation and control of bioprocesses: Methods of measuring process variables, online and offline analytical methods, control systems

Suggested Readings / Books

1. Principles of Fermentation Technology by P.R. Stanbury, A. Whitakar, and S.J. Hall, Aditya Books Private Limited
2. Biochemical Engineering by S. Aiba, A. E. Humphry and N.F. Millis, Publisher: University of Tokyo Press
3. Bioprocess Engineering Basic Concepts, by M.L. Shuler and F. Kargi, Prentice Hall
4. Bioprocess Engineering Principles by P. M. Doran Publisher- Academic Press
5. Bioprocess Engineering Principles by J. Nielson and J. Villadsen, Publisher Plenum Press
6. Chemical Engineering by J.M. Coulson and J.F. Richardson, Publisher Butterworth Heinemann

BTBT602/18 Plant Biotechnology

Unit – I Crop Improvement: The need of crop improvement. Conventional methods of crop improvement, selection, mutation, polyploidy and clonal selection. Green revolution in India. Introduction to marker assisted breeding and selection.

Unit -II Plant tissue culture: History of plant tissue culture, plasticity and totipotency. Laboratory setup for a typical plant tissue culture facility. Sterilization methods used in plant tissue culture. Types of nutrient media and plant growth regulators in plant regeneration. Pathways for in vitro regeneration: organogenesis, somatic and gametic embryogenesis; protoplast isolation, culture and regeneration; culture of other explants, somatic hybridization; Haploid and triploid production and their applications. Genetic fidelity of plants raised through tissue culture. Applications of micro-propagation, meristem culture, embryo rescue, somaclonal and androclonal variations. Application of tissue culture for crop improvement. Methods for Plant Conservation, Cryopreservation, synseed production. Production of bio active secondary metabolites by plant tissue culture.

Unit -III Principles and methods of genetic transformation: Introduction to Agrobacterium biology and biotechnology. Mechanism of T-DNA transfer to plants and Agro infection. A. rhizogenes and its application. Transplastomics and its utility. Methods for direct gene transfer, Marker and reporter genes; Promoters used in plant vectors. Plant viral vectors. Molecular techniques for analysis of transgenics (copy number, transgene stability, silencing; segregation). Marker-free transgenics and environmental, social and legal issues associated with transgenic plants. Case studies for genetic engineering in plants for traits of agronomic value, biotic, abiotic stresses and herbicide tolerance.

Unit -IV Molecular Farming: Transgenic crops for production of antibodies, viral antigens and peptide hormones in plants, Edible vaccines and Nutraceuticals. Plant Biotechnology for biofuels.

Suggested Readings / Books

- Principles of Plant Genetics and Breeding by George Acquaah 2007. Blackwell Publishing.
- An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.
- Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
- Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2002.

BTBT603/18 Bioenergetics and Enzymology

UNIT-I

Introduction to Bioenergetics: Laws of Thermodynamics. Enthalpy, entropy, Gibb's Free Energy and their mathematical relationship, Standard free energy change. Equilibrium constant, Coupled reactions, phosphorylation potential, phosphoryl group transfers. Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP. Redox reactions, standard redox potentials and Nernst equation.

UNIT-II

Basics of enzymology, enzyme properties and kinetics: Nature of enzymes, Cofactor and prosthetic group, apo-and holo-enzymes. Enzyme classification & nomenclature (IUB). Fischer's lock & key and Koshland's induced fit hypothesis. Enzyme specificity, active site, transition state complex and activation energy. Kinetics of single substrate reactions: Michaelis-Menten equation, Lineweaver-Burk plot. Determination of Km, Vmax, Kcat. Enzyme inhibitions – concept and kinetics of competitive, non-competitive & uncompetitive. Irreversible inhibition. multi-substrate reactions.

UNIT-III

Mechanism of enzyme action: Features of enzyme catalysis, General mechanisms of enzyme action: Acid-base and covalent catalysis (chymotrypsin, lysozyme), Metal activated enzymes and metalloenzymes, Factors affecting enzyme activity; Regulation of enzyme action: allosteric regulation of enzymes, Feedback inhibition (ATCase), Reversible covalent modification (glycogen phosphorylase). zymogens. Multienzyme complexes, Coenzymes. Mechanism based inhibitors.

Unit –IV

Enzyme technology: extraction, isolation and purification of enzymes by various methods. Immobilized enzymes - principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulase, artificial enzymes, industrial applications, fermentation, enzyme modification, immobilized enzymes in industrial processes. Industrial utilization of enzymes. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase), isoenzymes, Enzyme therapy (Streptokinase).

Suggested Readings / Books

- Enzymes (2007) 2nd edition T Palmer P L Bonner Woodhead Publishing **ISBN:** 9781904275275
- Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
- Enzymes, Dixon & Webb. M.Sc. Biotechnology: Syllabus (CBCS) 32
- Principles of Biochemistry, AL. Lehninger, D.L. Nelson and M. M. Cox. 1993. Worth Publishers, New York.

BTBT 604/18 Total Quality Management and Entrepreneurship

Unit-I Total Quality Management: Introduction, concept, role and importance of TQM, contributions of management thinkers in quality management, cost and economics of quality, competitive benchmarking.

Unit -II Tools and Techniques of TQM: Techniques for analyzing quality process, statistical process control, problem solving tools, six-sigma.

Unit -III Entrepreneurship: The characteristics of entrepreneurs, business vs. Enterprise, types of enterprises, different forms of ownership, social entrepreneurship, woman entrepreneurship

Unit -IV Start Ups: Ideation, feasibility study- technical and financial feasibility, business plan and DPR preparation, registering a start up with GoI, Govt. platforms that support start ups.

Suggested Readings / Books

- The Startup Owner's Manual: The Stepby-Step Guide for Building a Great Company Steve Blank and Bob Dorf K & S Ranch ISBN – 978- 0984999392
- The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses Eric Ries Penguin UK ISBN – 978- 0670921607
- Demand: Creating What People Love Before They Know They Want It Adrian J. Slywotzky with Karl Weber Headline Book Publishing ISBN – 978- 0755388974
- The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business Clayton M. Christensen Harvard business ISBN: 978- 142219602

BTBT 605/ 18 Biotech Lab VII

1. Preparation and sterilization of standard tissue culture media.
2. Sterilization of explants and generation of undifferentiated mass of cells. Regeneration of plants from undifferentiated cells.
3. Preparation of competent cells, transformation and colony PCR for confirmation of transformation in Agrobacterium tumefaciens.
4. Agrobacterium mediated transformation of plants.
5. Selection and screening of transgenic plants.
6. Evaluation of a transgenic phenotype (viz., Herbicide resistance) under contained conditions.
7. Analysis of crude extracts from medicinal plants using HPLC.
8. Use of microsatellite markers for DNA fingerprinting

BTBT 606/ 18 Biotech Lab VIII

1. Isolation of amylase from bacteria
2. Isolation of protease from pulses
3. Isolation of cellulase from fungi
4. Partial purification of isolated enzyme by ammonium sulphate fractionation
5. Assay of enzymes and specific activity of amylase, cellulose & protease
6. Enzyme Kinetics: Effect of varying substrate concentration on enzyme activity, determination of Michaelis-Menten constant (Km) and Maximum Velocity (Vmax.) using Lineweaver-Burk plot.
7. Effect of temperature and pH on enzyme activity
8. Immobilisation of enzymes

BTBT 607/18 Introduction to Food Technology

Unit-I Introduction to food technology: Importance and scope of food technology. Introduction to food processing, food engineering and food analytics.

Unit -II Food Processing: High temperature processing, low temperature processing, dehydration. Techniques of food preservation. Food spoilage-chemical and biological, and its prevention, food poisoning and food infections.

Unit -III Food Engineering: Concept of material and energy balance, modes of heat transfer, Fluids-types of fluids and fluid flow behaviour, psychrometry, Unit operations- evaporation, drying, size reduction, centrifugation.

Unit -IV Food Analytics: Spectrometry-UV-Vis, Spectroscopy-NMR, Chromatography- HPLC and HP-TLC, X-ray diffraction and RT-PCR (for detection of genetically modified foods).

Suggested Readings / Books

- Potter, Norman. M. Food Science, 5th Ed. Springer US
- Manay, S.; Shadakshara Swamy, M., (2004). Foods: Facts and Principles, 4 th Ed.
- New Age Publishers.
- B. Srilakshmi., (2002) Food Science, New Age Publishers.
- Meyer, (2004). Food Chemistry. New Age
- Deman JM. (1990) Principles of Food Chemistry. 2 nd Ed. Van Nostrand Reinhold, NY
- Ramaswamy H and Marcott M. Food Processing Principles and Applications. CRC Press

BTBT 608/18 Bioterrorism and National Security

Unit -I Terrorism and Bioterrorism Definition-Traditional Terrorists-New Terrorists-Nuclear, chemical, and radiological weapons-The psychology of Bioterrorism-Historical perspective. Microbes and Immune System Primary classes of Microbes-bacteria, virus, and other Agents Immune system Interaction between microbes and the immune system. Interdisciplinary

Unit -II Bioterrorism Weapons and Techniques Characteristics of microbes and the reasons for their Use-Symptoms-Pathogenicity Epidemiology-natural and targeted release-The biological, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and VHF.

Unit -III Prevention and Control of Bioterrorism Surveillance and detection- Detection equipment and sensors –Diagnosis-Treatment Vaccinations-Supplies- Effectiveness-Liability-Public Resistance-Response-First Responders-Infectious Control-Hospital-Prevention-Protection-Decontamination Notification-Role of Law Enforcement-Economic impact.

Unit -IV Bioterrorism Management Ethical issues: personal, national, the need to inform the public without creating fear, cost-benefit Rations-Information Management-Government control and industry Support-Microbial forensics.

Suggested Readings/ Books:

- Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, American Medical Association, 1st Edition, 2002.
- Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua (Editor), MIT Press ,1999.
- Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005.
- The Demon in the Freezer: A True Story, Preston, Richard, Fawcett Books, 2003.
- The Anthrax Letters: A Medical Detective Story, Cole, Leonard A., Joseph Henry Press, 2003.
- Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.
- http://www.centerforhealthsecurity.org/ourwork/pubs_archive/pubspdfs/2012/sloan_book/Preparing%20for%20Bioterrorism_Gigi%20Kwik%20Gronvall_December%202012.pdf

BTBT 609/18 Biomaterials

Unit-I Introduction to Materials, General structure, and properties. Classification of common materials and applications. Chemical Bonding, Crystalline, Amorphous. Melting, Solidification, Nucleation, Phase diagrams.

Unit -II Metal and alloys in Medical application: Stainless steel, cobalt based alloys, titanium-based alloys (including shape memory alloys). Ceramics and glasses-bio ceramics: Type of Ceramics and their classification, Calcinations, Annealing, Sintering, Nearly inert ceramics, bio-reactive glasses and glass ceramics, Calcium phosphate ceramics.

Unit -III Introductions to polymers: Definition, classification, Polymerization. Rubber, plastics, fibres and resins and structure-properties relationship. Biodegradable polymers; Natural polymers, Composites, Pyrolytic carbon, Carbon nanotubes. Bulk Proper, Surface properties and modification of surface properties.

Unit -IV Basic principles of engineering manufacturing, methods and applications of common manufacturing processes, milling, grinding, finishing, rolling, forging, Concept of biomimetic synthesis, Preparation of fibre and wire, Fabrication of Porous Materials, Direct molding Technique, Different advanced fabrication technique.

Suggested Readings/ Books

- Biomaterials Science - An Introduction to Materials in Medicine, Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons, ISBN: 9780080470368, Academic Press, Published Date: 18th August 2004.
- Biomaterials: An Introduction- J. Bo. Park.
- Materials Science and Engineering- Callister.
- Materials for Medical Engineering- Euromat 99 vol-2.

BTBT 610/18 Biosimilars Technology

Unit -I Introduction to Biopharma Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars, The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

Unit -II Types of biosimilar drugs Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid-based therapies (DNA, RNA, etc), Cell based therapies (including stem cells)

Unit -III Characterization methods
Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination

Unit -IV Bioequivalence Studies
Immunogenicity & allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalence (average, population, individual), experimental designs & statistical considerations for bioequivalence studies (Non-replicated designs – General Linear Model, Replicated crossover designs), introduction to "ORANGE BOOK" & "PURPLE BOOK".

Suggested Readings/ Books

- Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.
- Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.
- https://www.drugs.com/medical-answers/many-biosimilars-approved-unitedstates-3463281/

BTBT 611/18 Waste Management & Upcycling

Unit I

Waste management: The definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and permitting regime for the delivery of waste management solutions Liquid waste collection, treatment and disposal systems: Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system. Air Pollution management and treatment: Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions;

Unit II

Technologies for Waste treatment technologies: waste incineration and energy from waste, pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes, managing biomedical waste.

Unit III

Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added value products; Landfill engineering and the management of landfill leachate and the mining of old landfills.

Unit IV

Interface of waste and resource management and civil engineering in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and lifecycle analysis, as appropriate.

Suggested Readings/ Books:

- O.P. Gupta, “Elements of Solid & Hazardous Waste Management”, Khanna Publishing House, New Delhi, 2019.
- George Tchobanoglous et.al., “Integrated Solid Waste Management”, McGraw-Hill Publishers, 1993.
- B.Bilitewski, G.HardHe, K.Marek, A.Weissbach, and H.Boeddicker, “Waste Management”, Springer, 1994.

BTBT 612/18 Gene Expression and Transgenics

Unit -I Overview of expression vectors and promoters: Vectors with tags such as Poly-Histidine, GST, MBP, GFP. Cleavable tag and non-cleavable tags, Affinity purification of recombinant protein. Vectors for tag free protein expressions. Over-expression of integral membrane proteins, Challenges in overexpression such as inclusion body formations.

Unit -II Organisms for recombinant protein expression: Overexpression in *E. coli*, *B. subtilis*, *Corynebacterium*, *Pseudomonas fluorescens*, yeasts like *S. cerevisiae* and *Pichia pastoris*, insect cell lines like Sf21, Sf9 and BTI-TN-5B1-4, Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell. Chloroplast transformation and protein expression in chloroplasts.

Unit -III Cell free protein Expression-Cell free extracts from *E. coli*, rabbit, wheat germ, insects. Purification of tagged and tag-free proteins. GMP and GLP requirements, Applications of recombinant proteins

Unit -IV Use of transgenic animals: Safety and ethics of transgenic animals. Methods for creation of transgenic animals-DNA microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer. Use transgenic animals in medical research, in toxicology, in mammalian developmental genetics, in molecular biology in the pharmaceutical industry, in biotechnology, in aquaculture and in xenografting. Humanised animal models

Suggested Readings / Books

- Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006) 7th ed. ISBN 1-4051-3544-1
- Gene Expression Systems, Using Nature for the Art of Expression. Edited by Joseph M. Fernandez and James P. Hoeffler.
- Regulation of Gene Expression, By Perdew, Gary H., Vanden Heuvel, Jack P., Peters, Jeffrey M. Springer.
- Prokaryotic Gene Expression. Edited by Simon Baumberg. Oxford Press
- Transgenic Animal Technology,3rd Edition, A Laboratory Handbook By Carl Pinkert. Elsevier.
- Ethical Use of Transgenic Animals (English, Paperback, Shah Krunal V). Lambert
- Transgenic Animals as Model Systems for Human Diseases. Edited E. F. Wagner F. Theuring. Springer.

BTBT 701/18 FOOD BIOTECHNOLOGY

Course objectives: This course will provide a foundation about use of biotechnology in food processing applications, with emphasis on methods. It will give the student a real time understanding of foods used in our daily lives, thereby invoking inquisitiveness.

Learning outcomes: Upon completion of the course, the student will understand the concepts of food biotechnology, the understanding of different kind of foods, such that the student may be enthused into foodpreneurship. Food engineering concepts will be best understood for designing equipment for the food industry.

UNIT 1: INTRODUCTION TO FOOD BIOTECHNOLOGY
Introduction and scope of food biotechnology: food biochemistry and food microbiology. Food infection and food intoxication. Food adulterations and food analytics.

UNIT 2: METHODS IN FOOD BIOTECHNOLOGY
Biotechnological methods for the production of microbial enzymes, flavours and vitamins. Probiotics, fermented foods and beverages (bread, cheese, dosa, sauerkraut, wine and beer). Food emulsions: concepts and products (milk, butter, mayonnaise, ice cream).

UNIT 3: FOOD ENGINEERING
Fundamentals of mass transfer and heat transfer; types of fluids (Newtonian and non-Newtonian) and fluid flow (laminar, transitional and turbulent); modes of heat transfer (conduction, convection, radiation); fundamentals of evaporation and dehydration, types of evaporators and dryers used in the food industry.

UNIT 4: GENETICALLY MODIFIED FOODS and FOOD REGULATIONS
GM Foods: methods, risks and regulatory control; ethical issues concerning GM foods; testing of GM Foods. Food regulatory authorities: FDA, Codex Alimentarius, FSSAI. Future and applications of food biotechnology in India.

Suggested Readings / Books

1. Potter, Norman. M. Food Science, 5th Ed. Springer US
2. Manay, S.; Shadakshara Swamy, M., (2004). Foods: Facts and Principles, 4 th Ed. New Age Publishers.
3. B. Srilakshmi., (2002) Food Science, New Age Publishers.
4. Meyer, (2004). Food Chemistry. New Age
5. Deman JM. (1990) Principles of Food Chemistry. 2 nd Ed. Van Nostrand Reinhold
6. Ramaswamy H and Marcott M. Food Processing Principles and Applications. CRC Press

7. Food Biotechnology by Stahl, Ulf, Donalies, Ute E.B., Nevoigt, Elke (Eds.), Springer publications, 2008.
8. Fundamentals of Food Biotechnology, Byong H Lee, Wiley publications, 2014.
9. Genetically Modified Foods-basics, applications and controversy by Salah Mahgoub, CRC Press, 2015.

BTBT702/18 INSTRUMENTATION AND PROCESS CONTROL

UNIT 1 TEMPERATURE MEASUREMENTS

Thermoelectric temperature measurement: thermoelectricity, industrial thermocouples, thermocouple lead wires, thermal wells, industrial potentiometers. Resistance thermometers: thermal coefficient of resistance, industrial resistance-thermometer bulbs, null-bridge resistance thermometers, deflect ional resistance thermometer. Radiation temperature measurement: radiation receiving elements, radiation pyrometers, photoelectric pyrometers, optical pyrometers.

UNIT 2 COMPOSITION ANALYSIS

Spectroscopic analysis, adsorption spectroscopy, emission spectroscopy, mass spectroscopy. Analysis of solids by Xray diffraction, color measurement by spectrometers, gas analysis by thermal conductivity, psychomotor method for moisture in gases, hygrometer method for moisture in gases, dew-point method, measurement of moisture in paper, textiles and lumber, pH ion concentration measurement.

UNIT 3 BASIC CONCEPTS OF PROCESS CONTROL

Laplace transform of simple functions, transforms of derivatives, solution of differential equations, inversion by partial fractions: partial fractions. Response of first-order systems, physical examples of first-order systems, response of first-order systems in series, higher order systems: second order, and transportation lag.

UNIT 4 LINEAR CLOSED LOOP SYSTEMS

Control system, controllers and final control elements, block diagram of a chemical reactor control system, closed loop transfer functions, transient response of simple control systems, Root locus.

Suggested Readings / Books

- Donald P. Eckman, “Industrial Instrumentation”, Wiley Eastern Limited, 1993.
- Coughanour D.R., “Process system Analysis & Control”, 2nd Edn., McGraw Hill, Singapore, 1991.
- Peter Harriott, “Process Control” McGraw Hill, New York, 1972.
- Sharma B.K., “Instrumental Methods of Chemical Analysis”, 7th Edn.,Goel Publishing, Meerut, 1985-86.
- Galen W. Ewing, “Instrumental Methods of Chemical Analysis”, 5th Edn., McGraw Hill, New York, 1985.

BTBT703/18 FERMENTATION TECHNOLOGY

UNIT 1 FERMENTATION DESIGN

Basic components of media, natural and synthetic media, basic designs of fermenter, types of fermenters, fermentation facility, equipment and space requirements, design of large fermenters (based on aeration), statistical methods for fermentation optimization, downstream processing and product recovery.

UNIT 2 PILOT PLANT FERMENTATION

Microbial fermentation (cheese fermentation), vaccine production (Polio or Rabies), alcohol fermentation, mammalian cell culture system, plant cell tissue and organ cultures (Single cell protein).

UNIT 3 ENVIRONMENTAL CONCERNS ABOUT FERMENTATION

Environmental regulations and technology, laws and regulations, Technology (waste water), Waste water treatment strategy, Air (emissions of concerns), Selecting a Control Technology, Inorganics, and volatile Organic Compound Emission Control.

UNIT 4 ANAEROBIC DIGESTERS

An overview of aerobic and anaerobic fermentation. Substrates, products and biogas, operational conditions, types of anaerobic digesters.

Suggested Readings/ Books

- Principles of Fermentation Technology, Peter Stanbury Allan Whitaker Stephen J. Hall, 3rd Edition, **2016,** Butterworth-Heinemann Ltd, ISBN No. 978-0080361314
- Essentials in Fermentation Technology, Aydin Berenjian, 2019, Springer, ISBN No. 978-3030162290
- Fermentation and biochemical engineering handbook byHenry C. Ogal, 2nd edition, **1996,** Noyes Publications, ISBN No. 978-0815514077
- The Microbiology of anaerobic digesters by Michael H. Gerardi, **2003,** A John Wiley & Sons, Inc., Publication, ISBN No. 978-0471206934

BTBT704/18 BIOTECH LAB- IX

1. Isolation of food borne bacteria (*Campylobacter, Salmonella, Yersinia, E. coli*) from various food sources using differential media.
2. Confirmation of food borne isolates by biotechnological tools.
3. Isolation and characterization of food borne viruses (rotavirus, hepatitis virus, polio virus, enterovirus) using biotechnological tools.

BTBT705/18 BIOTECH LAB- X

1. To prepare Sauerkraut
2. To study the design of fermenter and its working.
3. To study the production of a. Citric Acid b. Ethanol c. Amylase d. Protease
4. Effect of pH, Temperature, Substrates, Inhibitor on enzyme activity
5. Laboratory scale fermentation of antibiotics, immobilization of cells and enzymes
6. Fermentation in the production secondary metabolites (antibiotics)
7. Solid state fermentation for production of enzymes
8. Shake flask fermentation (Study of effect of agitation)

Suggested Readings/ Books

- Mansi & CFA. Bryce. Fermentation Microbiology & Biotechnology Taylor & Francis Ltd. (2004).
- Stanbury, P.F., A. Whitaker & S.J. Hall. Principles of fermentation technology Oxford. (1997).

BTBT706/18 INTRODUCTION TO GENOMICS AND PROTEOMICS

Course Objectives: This course will provide a foundation about the structure and organization of various genome, gene identification, expression and application of genomic analysis, application of Human genome Project and introduction to epigenetics. Proteomics, its analysis and applications.

Learning Outcomes: After the course is finished, the learner will understand basics of genome organization, applications of Human Genome Project, Proteomics its applications and analysis which might inspire him into diagnostics and applied research.

UNIT1 : INTRODUCTION TO GENOMICS AND EPIGENETICS
Introduction and organization of Genomes. Genome size. Genome in viruses, prokaryotes and eukaryotes, Pyrosequencing, Genome sequencing, DNA finger printing. DNA methylation, DNA methyl transferases, CpG island methylation, transcriptional repression by methylation, bisulfite PCR.

UNIT 2: GENOME ANALYSIS
Impact and applications of Human Genome Project, physical mapping, cytogenetic map, STS map, EST map, genome sequencing methods. Next generation sequencing, Single nucleotide polymorphisms (SNPs) and their types, RFLP, Allele specific PCR.

UNIT3: Gene Expression
Introduction to gene expression, methods and analysis of gene expression. RT-PCR, SAGE, overview of comparative genomics. Analysis of RNA expression. Application of Microarrays Micro array techniques

UNIT 4 : INTRODUCTION TO PROTEOMICS AND ITS ANALYSIS
Introduction to proteomics, and proteomes,2d PAGE, SDS PAGE, mass spectroscopy methods for protein identification, Mining proteomes, Bridging Genomics and Proteomics. Proteomics and new biology.

Suggested Readings/ Books

- Brown T.A. 2017 Genomes 4. Garland Science Publishing, New York
- Liebler, D.C . 2002. Introduction to Proteomics. Humana Press
- Lewin,'s Genes XII 2017 Johns and Barlett Publisherrs
- Campbell & Reece 2018 Biology: A Global Approach . Pearson
- Sadva et al, 2018 Life: The Science of Biology
- Watson,J.D et al 2018 Molecular Biology of the Gene. Pearson
- Thangadurai ,D .Sangeetha ,J. 2021. Genomics and Proteomics. CRC Press

BTBT 707/18 GOOD MANUFACTURING AND LABORATORY PRACTICE

UNIT -I INTRODUCTION

Introduction to Good Manufacturing and Laboratory Practice, Requirement of GLP and GMP compliance for regulatory approval, Ethics in manufacturing and control

UNIT -II QUALITY BY DESIGN

Principles of quality by design (QBD) Introduction to the concept of Design of Experiment (DOE) Application of QBD principles in Biotech product development. Case studies: Example of QBD and DOE in Process Development, Example of DOE in analytical development

UNIT -III REGULATORY GUIDELINES

Introduction to ICH guidelines and their usage, National and international regulatory authorities and their function, Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies

UNIT IV PROCESS DESIGN AND MANAGEMENT

Good Manufacturing Practices, Formulation Production Management, Authorization and marketing of drugs. Computer simulation on process design.

Suggested Readings/ Books

- cGMP starter guide: Principles in Good Manufacturing Practices for Beginners, Emmet P. Tobin, Createspace Independent Publishing Platform, April 2016.
- Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, B Cooper, Createspace Independent Publishing Platform, July 2017.
- Sarwar Beg and Md Saquib Hasnain, Pharmaceutical Quality by design: Principles and application, Academic press, March 2019.
- Ron S. Kenett, Shelemyahu Zacks, Daniele Amberti, Modern Industrial Statistics: with applications in R, MINITAB and JMP, 2nd Edition, Wiley, January 2014.
- N Politis S, Colombo P, Colombo G, M Rekkas D.Design of experiments (DoE) in pharmaceutical development, Drug Dev Ind Pharm. 2017 Jun;43(6):889-901. doi: 10.1080/03639045.2017.1291672.
- Andrew Teasdale, David Elder, Raymond W. Nims, ICH quality guidelines- An implementation guide, Dec 2017.
- Gajendra Singh, Gaurav Agarwal an Vipul Gupta, Drug regulatory affairs, CBS publication, 2005.
- Marc P. Mathieu, New Drug Development: A regulatory overview, Nov 2000.
- ICH guidelines available in the official website “https://www.ich.org”.

BTBT 708/18 SYNTHETIC BIOLOGY

UNIT 1: INTRODUCTION TO SYNTHETIC BIOLOGY
Introduction to Synthetic Biology, Historical overview of Synthetic Biology, Jacob and Monod Model of Gene Regulation based on Regulatory Circuit of lac Operon, Synthesis of gene by Har Gobind Khorana, Synthetic Genomics work by Venter Craig. Definition of Synthetic Biology, Current Status and Scope of Synthetic Biology, Ethical and Biosafety related issues.

UNIT 2: DNA BASED CIRCUITS
Central dogma, Transcriptional Regulation Mechanisms (Defining gene and its parts – Coding region, Promoters, Terminators, Enhancers, Inducers, Repressors, Transcription Factors, Co-factors), Post-transcriptional Regulation, Post-translational Modifications), RNA based Regulation, Protein-protein Interactions, Artificial Gene Circuits.

UNIT 3: GENETIC ENGINEERING BASED APPLCIATIONS OF SYNTHETIC BIOLOGY
DNA Sequencing, Molecular Cloning and Amplification of Insert DNA, PCR, Oligonucleotide Synthesis, Site-directed Mutagenesis and Directed Evolution, Synthetic Genes, Genome Sequencing and Genome, Editing, CRISPR/Cas9, Metabolic Engineering Techniques and Applications.

UNIT 4: OTHER APPLICATIONS OF SYNTHETIC BIOLOGY
Designed Proteins, Biosensors, Synthetic Cells, In vitro/cell-free systems, Biological computers.

Suggested Readings/ Books

- Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC (2006).
- Eric Davidson, The Regulatory Genome: Gene Regulatory Networks In Development And Evolution, Academic Press (2006).
- Hamid Bolouri, Computational Modeling of Gene Regulatory Networks - A Primer, Imperial College Press (1st edition) (2008).
- Freemont, P.S and Kitney, R.I. (2012). Synthetic Biology – a Primer. World Scientific Publishing Co pte Ltd
- Singh, V and P.K. Dhar. (2015). Systems and Synthetic Biology. Springer publishing, Netherlands
- Fu, P and Panke, S (2009). Systems Biology and Synthetic Biology. Wiley Publishing.
- Covert, M.W. (2014). Fundamentals of Systems Biology: from Synthetic Circuits to Whole Cell Models. CRC Press
- Church, G and Regis, E. (2012). Regenesis: How Synthetic Biology will Reinvent Nature and Ourselves. Basic Books.
- Synthetic and Systems Biology for Microbial production of Commodity Chemicals - http://www.nature.com/articles/npjsba20169.
- Biotechnology and Synthetic Biology Approaches for Metabolic Engineering of Bioenergy Crops - https://www.ncbi.nlm.nih.gov/pubmed/27030440.

BTBT 709 BREWING SCIENCE AND PRACTICE

UNIT 1 OUTLINE OF BREWING
Introduction – Malts – Brewing liquors – Milling and Mashing- Processing of Beer – types of beer – malting – water, effluents, and wastes.

UNIT 2 SCIENCE OF MASHING
Introduction – Mashing schedules – Altering Mashing Conditions – Mashing Biochemistry – Mashing and Beer flavour – Spent Grains – Preparation of grists – Mashing technology.

UNIT 3 WORT BOILING AND FERMENTATION
Introduction – Chemistry of wort boiling – Clarification, Cooling and Aeration. Basic principles – Bottom and top Fermentation Systems – Continuous Fermentation – Fermentation Control Systems, Beer Maturation– flavour and aroma changes - Stabilization against non-biological haze – Carbonation – Clarification
and filtration – Special beer treatments.

UNIT 4 CHEMICAL AND PHYSICAL PROPERTIES OF BEER
Chemical Composition – Nutritive value – Colour – Haze – Viscosity – foam Characteristics – gurting flavour – Semors analysis – Packaging.

Suggested Readings/ Books

- Brewing – Science and Practice by Dennis E. Briggs, Chris A. Boulton, Peter A. Brookers and Roger Sterens, Wood head Publishing Limited, 2004.
- Brewing Science: A Multidisciplinary Approach by Mosher, Michael, Trantham, Kenneth, Springer, 2017
- Handbook of Brewing, Stewart G G, Taylor & Francis Exclusive(CBS), 2017

BTBT 710 NUTRITION IN HEALTH AND DISEASE

UNIT 1 Food as a source of nutrients. Classification, source, requirement, deficiencies, and nutritional role of proteins, fats, carbohydrates, minerals, vitamins, water, and roughages. Study of importance, composition, and nutritive value of different foods (cereal grains, millets, pulses, nuts and oil seeds, fruits and vegetables), milk and milk products, meat, egg, poultry, fish, spices and condiments.

UNIT 2 Utilization of Food: Digestion, absorption and metabolism of proteins, fat and carbohydrates. Basal metabolism and factors affecting basal metabolism. Methods of measurement of Basal Metabolic Rate (BMR). Total energy requirement and factors affecting requirement. Body composition- Definition, importance, classification, methods of assessment of body composition. Energy value of food. Determination of Energy value of food.

UNIT 3 Introduction to therapeutic diets. Basic concepts, principles, involved in adoption of normal diet for formulating therapeutic diet, factors considered, classification, use of food exchange groups. Diets during pregnancy, lactation, infancy, school age, adolescent, adulthood and old age.

UNIT 4 Planning therapeutic diets and dietary management in case of fever, typhoid, influenza, rheumatic fever, nephritis, peptic ulcer, hypertension, atherosclerosis, liver cirrhosis and hepatitis. Diet in diseases (metabolic disorders -Obesity and Diabetes, febrile conditions, surgical & other stress conditions) - causes, symptoms, physiological changes and dietary management.

Suggested Readings/ Books

- Joshi S. A. ‘Nutrition and Dietetics’, New Delhi, Tata Mc Graw Hill Publishing Co. Ltd.
- Robinson ‘Normal and Therapeutic Nutrition’ New Delhi, Tata Mc Graw – Hill Publishing Co. Ltd.
- Crampton E.W. and L. E. Lloyd (1915), ‘Fundamentals of Nutrition’, San Francisco W. H. Freeman
- Davidson S.R, Passmore and J.F. Brock (1986), ‘Human Nutrition and Dietetics’ London Churchill, Livingstone
- Antia F.P (1986), ‘Clinical Dietetics and Nutrition’, Bombay, 3rd edition, Oxford University Press.

BTBT 711/18 STEM-CELL TECHNOLOGY

UNIT -1 INTRODUCTION TO STEM CELLS
Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells. Stem Cell Niche: Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues.

UNIT-2 CELL CYCLE AND DEVELOPMENT AND EPIGENETIC CONTROL
Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self-renewal. DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications.

UNIT -3 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 and their applications.

UNIT-4 APPLICATIONS
Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns, Organ farming.

Suggested Readings/ Books

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