PUNJAB TECHNICAL UNIVERSITY KAPURTHALA

Scheme and Syllabus of B. Tech. Biotechnology (BT)

Batch 2011 onwards

By

Board of Studies Biotechnology / Biomedical Engineering

B. Tech. Biotechnology
Batch- 2011 onwards

Third Semester **Contact Hours: 31 Hrs.**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT301*	Mathematics	4	1	-	40	60	100	5
BTBT302	Foundations of Biotechnology	4	-	-	40	60	100	3
BTBT303	Microbiology	4	-	-	40	60	100	3
BTBT304	Biochemistry	4	-	-	40	60	100	3
BTBT305	Transport Phenomenon	4	1	-	40	60	100	5
BTBT 306	Biotech Lab –I	-	-	3	30	20	50	2
BTBT 307	Biotech Lab –II	-	-	3	30	20	50	2
BTBT308	Biotech Lab –III	-	-	3	30	20	50	2
BTBT309	Term Paper –I				50	-	50	1
BTCE-310	Training of 4 weeks duration after 2nd semester				60	40	100	1
	Total	**20**	**02**	**09**	**350**	**400**	**800**	**27**

*** This subject shall be taught by the faculty of Mathematics Department**

Fourth Semester **Contact Hours: 31 Hrs.**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT401	Biostatistics	4	1	-	40	60	100	5
BTBT402	Industrial Microbiology	4	-	-	40	60	100	3
BTBT403	Immunology and Immunotechnology –I	4	-	-	40	60	100	4
BTBT404	Cell & Molecular Biology	4	-	-	40	60	100	3
BTBT405	Intellectual Proprietary Rights Bioethics and Biosafety	4	-	-	40	60	100	5
BTBT 406	Biotech Lab –IV	-	-	3	30	20	50	2
BTBT 407	Biotech Lab –V	-	-	3	30	20	50	2
BTBT408	Biotech Lab –VI	-	-	3	30	20	50	2
BTBT409	Term Paper –II				50	-	50	2
BTBT-410	General Fitness				100	-	100	1
	Total	**20**	**01**	**09**	**440**	**360**	**800**	**28**

Fifth Semester **Contact Hours: 31 Hrs**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	**T**	**P**	**Internal**	**Externa**		
BTBT501	Chemical Engineering Principles	4	1	-	40	60	100	5
BTBT502	Immunology and Immunotechnology –II	4	-	-	40	60	100	4
BTBT503	Genetic Engineering	4	1	-	40	60	100	5
BTBT504	Animal Cell Culture & Biotechnology	4	-	-	40	60	100	4
BTBT505	Bioinformatics	4	-	-	40	60	100	4
BTBT 506	Biotech Lab –VII	-	-	3	30	20	50	2
BTBT 507	Biotech Lab –VIII	-	-	3	30	20	50	2
BTBT508	Biotech Lab –IX	-	-	3	30	20	50	2
BTBT509	Term Paper –III				50	-	50	2
BTBT-510	Training of 4weeks duration after 4th Semester				60	40	100	1
	Total	**20**	**02**	**09**	**400**	**400**	**800**	**31**

B. Tech. Biotechnology

Batch- 2011 onwards

Sixth Semester **Contact Hours: 31 Hrs**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT601	Fundamentals of Biochemical Engineering	4	1	-	40	60	100	5
BTBT602	Plant Biotechnology	4	-	-	40	60	100	4
BTBT603	Enzymology & Enzyme Technology	4	1	-	40	60	100	5
BTBT604	Computational Biology	3	1	-	40	60	100	4
BTBT605	Bioanalytical Techniques	3	1	-	40	60	100	4
BTBT606	Biotech Lab –X	-	-	3	30	20	50	2
BTBT607	Biotech Lab –XI	-	-	3	30	20	50	2
BTBT608	Biotech Lab –XII	-	-	3	30	20	50	2
BTBT609	Biotech Lab –XIII	-	-	3	30	20	50	2
BTBT610	General Fitness				100	-	100	1
Total		**18**	**04**	**12**	**420**	**380**	**800**	**31**

Seventh Semester **Contact Hours: 29 Hrs.**

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTBT701	Bioprocess Technology	4	1	-	40	60	100	5
BTBT702	Downstream Processing	4	1	-	40	60	100	5
BTBT703	Genomics & Proteomics	3	1	-	40	60	100	4
BTBT704	Food & Nutraceutical Biotechnology	3	-	-	40	60	100	3
BTBTXXX	Elective *	3	-	-	40	60	100	3
BTBT705	Biotech Lab – XIV	-	-	3	30	20	50	2
BTBT706	Biotech Lab – XV	-	-	3	30	20	50	2
BTBT707	Biotech Lab – XVI	-	-	3	30	20	50	2
BTBT708	Seminar				50	-	50	2
BTBT709	Training of 4 weeks duration after 6th Semester				60	40	100	1
Total		**17**	**03**	**09**	**400**	**400**	**800**	**29**

***Elective BTBTXXX**

BTBT901 Biophysics

BTBT902 Stem Cell Technology

BTBT903 Nanobiotechnology

BTBT904 Bioprocess Plant Design

BTBT905 Plant Molecular Farming

BTBT906 Molecular and Cellular Diagnostics

BTBT907 Environmental Biotechnology

Eight Semester **Contact Hours: 30 Hrs.**

Course Code	Course Name	Load Allocation	Marks Distribution				Total Marks	Credits
			Internal		External			
			Daily assessment	Attendance	Viva voce	Project Report		
BTBT801**	Industrial training / Project Dissertation	30 hrs/week	300	100	150	250	800	30

**It is compulsory to submit the certificate of completion of the said dissertation/training report issued by the organization where the student has done his/her work. The said organization will award internal marks and hand it over to the Parent institute in a sealed envelope along with the duly signed attendance record and the certificate of completion. The external marks will be awarded by the external examiner on the day of external evaluation in which student has to be present along with the certificate of completion and project report. The copy of the project report should be kept in the departmental library as well as Central library of the college.

Note: The college representative has to visit the organization where the student is doing his/her training twice in one semester.

Third Semester

BTBT 301 Mathematics

Objective: The knowledge of Mathematics is necessary for a better understanding of almost all the Engineering and Science subjects. Here our intention is to make the students acquainted with the concept of basic topics from Mathematics, which they need to pursue their Engineering degree in different disciplines.

Unit –I Algebra: Progressions (AP, GP, HP); Theory of Equations; Binomial Theorem; Logarithmic and Exponential Series.

Unit –II Trignometry: cos(a+b); Multiple, Sub-Multiple Angles; Trigonometric Equations.

Unit –III Co-ordinate Geometry: Straight lines; Circles; Conics (ellipse, parabola, hyperbola); Pair of Straight Lines; Canonical Forms.

Unit –IV Permutations & Combinations: Counting Principle, Permutations with Repetitions (like & dislikes), Circular Permutations, Permutations with r-particular things included/excluded.

Unit –V Probability Addition Theorem, Multiple Theorems, conditional Theorem, Baye's Theorem; Probability distributions, Binomial distributions, Poisson distributions, normal distribution.

Unit –VI Statistics Measure of central tendency, Measure of dispersion (Range, Q.D, M.D, S.D, C.V.) Quartiles, Percentiles, Deciles

Unit –VII Matrix and Determinants: Matrix operations; Adjoint of a matrix; Determinants (Properties and examples); Inverse of a matrix; Rank of a matrix; Inverse of a matrix by elementary operations; Solution of linear simultaneous equations; Eigen values and eigen vectors; Cayley Hamilton's theorem; Diagonalization of matrices; Orthogonal, Hermatian, Skew-Hermetian, Unitary matrices, quadratic forms.

Suggested Readings / Books:

• Differential Calculus by Shanti Narain
• Integral Calculus by Shanti Narain
• Differential Equation by A.R.Forsyth
• Higher Engineering Mathematics by H.K. Dass

BTBT 302 Foundations of Biotechnology

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

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 Reading and Books:

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

BTBT 303 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.

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

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

Unit –III Bacterial Nutrition & Growth: Physical growth requirements viz. temperature, pH, oxygen concentration, water activity, light, pressure. Chemical growth requirements viz. nutrients, nutrient uptake in bacteria: Passive and facilitated diffusion, active transport. Growth curve, growth rate and generation time. Growth kinetics, mathematical nature and expression of growth, measurement of growth by quantitating cell mass, cell number and a cell constituent, concept of geometric & arithmetic nature of growth, asynchronous and synchronous cultures, diauxic growth.

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

Unit –VFermentation Processes: Batch, fed-batch and continuous fermentations; solid state and submerged fermentations. Feed-stocks for industrial fermentation: Molasses, corn steep liquor, whey, malt, yeast extract and antifoams.

Unit –VI Isolation of industrially important microbial strains, strain improvement, maintenance and preservation of industrial microbes.

Unit –VII Agricultural & Environmental Microbial Biotechnology: Basic understanding and large-scale production of microbial inoculants for agriculture, mycorrhiza, microbial insecticides; treatment of urban (sewage) and industrial effluents.

Suggested Readings / Books:

- ***Brock Biology of Microorganisms (12th Ed.)*** by Madigan MT, Martinko JM and Parker J, Pearson/Benjamin Cummings, 2009.
- ***Microbiology: An Introduction (9th Ed.)*** by Tortora GJ, Funke BR, and Case CL, Pearson Education, 2008.
- ***Prescott, Harley and Klein's Microbiology (7th Ed.)*** by Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education, 2008.
- ***Principles of Fermentation Technology (2nd Ed.)*** by Stanbury PF, Whitaker A and Hall SJ, Elsevier Science Ltd, 2006.
- ***Modern Industrial Microbiology & Biotechnology*** by N. Okafer, Scientific Publishers, Enfield, USA, 2007.
- ***Environmental Microbiology (2nd Ed.)*** by R. Mitchel, Wiley-Blackwell, 2009.
- ***Microbial Physiology (3rd Ed.)*** by Albert G. Moat and John W. Foster, John Wiley and Sons, 2002.
- ***Microbial Biotechnology: Fundamentals of Applied Microbiology*** by Glazer & Nikaido, W.H. Freeman and Co., New York, 1995.
- ***Biotechnology - Applying the Genetic Revolution*** by Clark DP and Pazdernik NJ. Academic Press, USA, 2009.
- ***Molecular Biotechnology (3rd Ed.)*** by Glick BR and Pasternak JJ, ASM Press, Washington D.C., 2003.
- ***General Microbiology,*** R.Y. Stanier, J.L. Ingraham, M.L.Wheelis and P.R. Painter, Macmillian
- ***Microbiology VI Edition,*** M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill Microbiology by Prescott.
- ***The microbes – An Introduction to their Nature and Importance,*** P.V. Vandenmark and B.L. Batzing, Benjamin Cummings.

BTBT 304 Biochemistry –I

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

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

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

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

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

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

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

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

Suggested Readings / Books:

- ***L. Stryer: Biochemistry,*** W.H. Freeman and Company, New York (2006)
- ***A.L. Lehninger: Principles of Biochemistry,*** Worth Publishers, New York (2007)
- ***B.D. Hames et al: Instant Notes in Biochemistry***, BIOS Sci. Pub. Ltd. U.K. (2001)
- ***G. Zubay: Biochemistry,*** W.C. Brown Publishers, Oxford, England (2002).

BTBT 305 Transport Phenomenon

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

Unit –I Molecular Transport Phenomena: Molecular transport of momentum, heat and mass, laws of molecular transport: Newton's law of viscosity, Fourier's law of conduction and Fick's law of diffusion. Transport coefficients – viscosity, thermal conductivity and mass diffusivity and their analogous behaviour. Estimation of transport coefficients and temperature/pressure dependence.

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:

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

BTBT 306 Biotech Lab –I

1. Microscopic Examination of Microorganisms

- ***Staining methods:***
  - Simple staining of bacteria
  - Gram staining of bacteria
  - Endospore Staining
  - Capsule staining

2. Measurement of cell concentration of bacteria by counting chamber/Haemocytometer.

3. Preparation and Sterilization of Culture Media :

- Preparation of basic liquid media (broth) for the routine cultivation of bacteria
- Preparation of basic solid media, agar slants and agar deeps for the routine cultivation of bacteria
- Preparation of selective and differential media

4. Isolation and Maintenance of Microorganisms :

- Pour plate method
- Spread plate method
- Streak plate method
- Sub culturing techniques
- Preparation of glycerol stock

Suggested Reading and Books:

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

BTBT 307 Biotech Lab –II

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 through permanent slides.
4. To study the structure of DNA through models.
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 study the various haematological parameters :

a. Clotting time
b. Bleeding time
c. Total Leucocyte Count (TLC)
d. Differential Leucocyte Count (DLC)

8. To demonstrate the activity of enzyme salivary 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. Dissolved Oxygen
d. Conductivity

BTBT 308 Biotech Lab –III

1. Qualitative test for carbohydrates, proteins, amino acids and lipids
2. Detection of normal & abnormal constituents of urine.
3. To test salivary amylase activity.
4. Quantitative estimation of proteins by lowery method.
5. Estimation of carbohydrates by anthrone method.
6. Estimation of blood glucose by Folin- wu method.
7. Estimation of amino acid by ninhydrin method.
8. Determination of saponification value and Iodine number of fats.
9. Titration curve for amino acids and determination of pK value.
10. Preparation of standard buffers & determination of pH.
11. Separation of amino acids & sugars using paper & thin layer chromatography
12. RBCs, WBCs count, Hb estimation, Blood group determination.

BTBT 309 Term Paper

Methodology

A term (or research) paper is primarily a record of intelligent reading in several sources on a particular subject. The students will choose the topic at the beginning of the session in consultation with the faculty assigned. The progress of the paper will be monitored regularly by the faculty. At the end of the semester the detailed paper on the topic will be submitted to the faculty assigned. The evaluation will be done by Board of examiners comprising of the faculties.

Guidelines for Term Paper

The procedure for writing a term paper may consists of the following steps:

1. Choosing a subject
2. Finding sources of materials
3. Collecting the notes
4. Outlining the paper
5. Writing the first draft
6. Editing & preparing the final paper

- **Choosing a Subject**

  The subject chosen should not be too general.

- **Finding Sources of materials**

  Material sources should be not more than 10 years old unless the nature of the paper is such that it involves examining older writings from a historical point of view.

  Begin by making a list of subject-headings under which you might expect the subject to be listed.

  The sources could be books and magazines articles, news stories, periodicals, scientific journals etc.

- **Collecting the notes**

  Skim through sources, locating the useful material, then make good notes of it, including quotes and information for footnotes.

  - Get facts, not just opinions. Compare the facts with author's conclusion.
  - In research studies, notice the methods and procedures, results & conclusions. Check cross references.

- **Outlining the paper**

  Review notes to find main sub-divisions of the subject.

  Sort the collected material again under each main division to find sub-sections for outline so that it begins to look more coherent and takes on a definite structure. If it does not, try going back and sorting again for main divisions, to see if another general pattern is possible.

- **Writing the first draft**

  Write the paper around the outline, being sure that you indicate in the first part of the paper what its purpose is. You may follow the following:

  - statement of purpose

- main body of the paper
- statement of summary and conclusion

Avoid short, bumpy sentences and long straggling sentences with more than one main ideas.

- **Editing & Preparing the final Paper**
  - Before writing a term paper, you should ensure you have a question which you attempt to answer in your paper.
  - This question should be kept in mind throughout the paper. Include only information/ details/ analyses of relevance to the question at hand. Sometimes, the relevance of a particular section may be clear to you but not to your readers. To avoid this, ensure you briefly explain the relevance of every section.
  - Read the paper to ensure that the language is not awkward, and that it "flows" properly.
  - Check for proper spelling, phrasing and sentence construction.
  - Check for proper form on footnotes, quotes, and punctuation.

Check to see that quotations serve one of the following purposes:

- Show evidence of what an author has said.
- Avoid misrepresentation through restatement.
- Save unnecessary writing when ideas have been well expressed by the original author.
- Check for proper form on tables and graphs. Be certain that any table or graph is self-explanatory.

Term papers should be composed of the following sections:

1) Title page
2) Table of contents
3) Introduction
4) Review
5) Discussion & Conclusion
6) References
7) Appendix

Generally, the introduction, discussion, conclusion and bibliography part should account for a third of the paper and review part should be two thirds of the paper.

Discussion

The discussion section either follows the results or may alternatively be integrated in the results section. The section should consist of a discussion of the results of the study focusing on the question posed in the research paper.

Conclusion

The conclusion is often thought of as the easiest part of the paper but should by no means be disregarded. There are a number of key components which should not be omitted.

These include:

- summary of question posed
- summary of findings
- summary of main limitations of the study at hand
- details of possibilities for related future research

References From the very beginning of a research project, you should be careful to note all details of articles gathered. The bibliography should contain ALL references included in the paper. References not included in the text in any form should NOT be included in the bibliography.

The key to a good bibliography is consistency. Choose a particular convention and stick to this.

Evaluation: Based on the organization of the paper, objectives /problem profile/ issue outlining, comprehensiveness of the research, flow of the idea/ ideas, relevance of material used/ presented, outcomes vs. objectives, presentation/ viva etc.

Fourth Semester

BTBT 401 Biostatistics

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

Unit – I Introduction: types of biological data (data on ratio scale, interval scale, ordinal scale, nominal scale, continuous and discrete data), frequency distribution and graphical representations (bar graph, histogram and frequency polygon), cumulative frequency distribution, populations, samples, random sampling, parameters and statistics (5)

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

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

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

Unit – V Statistical hypothesis testing: Statistical testing, errors, one-tailed and two-tailed testing, t-test, Fisher exact test, chi square test, two sample hypothesis (testing difference between two means), Non parametric tests (Mann-Whitney test) (9)

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

- Zar, JH, Biostatistical Analysis, Pearson-Prentice Hall (2007).
- Rao K Visweswara, Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition & Anthropology, Jaypee Brothers Publishers (2007)
- Pagano, M. and Gauvreau, K., Principles of Biostatistics, Thomson Learning (2005)
- Mahajan BK, Methods in Biostatistics, Jaypee Brothers Publishers (2002)

BTBT 402 Industrial Microbiology

Objective/s and Expected Outcome: The course is designed to develop the student's ability to apply the techniques used in the different phases of industrial microbiology: discovery, production (including fermentation and scale-up), bioprocessing and cell banking. It includes the principles and practices in the main applications of micro-organisms to the industrial production of foods, pure chemicals, proteins and other useful products, including the use of genetically modified organisms. This course aims to enable graduates to enter

industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product.

Unit-I: Introduction: aim and scope. Industrially important microbes, Strategies involved in the isolation of desired microbes from the environment.

Unit-II: Strain improvement techniques and preservation of microbes

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

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 , Bioplastics : brief introduction , production and biochemical attributes, Biosensors: role of various biomolecules their sources and applications, production and applications of biofertilizers, production and application of bioinsecticides.

Suggested Readings / Books:

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

BTBT 403 Immunology and Immunotechnology-I

Objectives and Expected Outcome: The objective of this course is to provide students with a comprehensive overview of the immune system and its function as well as to introduce students to clinical situations in which the immune system plays an essential role. Remember, immunology started in 1796 as a case study when Edward Jenner injected the son of his neighbor with cowpox virus and found that he was later protected against smallpox. In its 200 year history the science of immunology has been closely linked to the clinic where it has shed tremendous light on the pathogenesis of disease. At the end of this course, students should be able to synthesize key concepts in immunology, understand the way in which different components of the immune system interact in a coordinated manner to fight infection and discuss the way the immune system reacts to various kinds of infectious agents.

Unit-I: Introduction

Introduction to Immunology, Brief historical perspectives, Aims and Scope; Organization of the immune system, Structure and Functions of important immune cells- T cell, B cell, Macrophage, Neutrophil, NK cell, Dendritic cell, Stem cells; Immune organs- Bone marrow, Spleen, Thymus, Lymph node, GALT.

Unit-II: Concepts of Innate & Adaptive Immunity; Active and Passive Immunity

Unit-III: Antigens and Antibodies

Characteristics of an antigen (foreignness, molecular size and heterogeneity), haptens, epitopes, adjuvants. Structure, types, properties and functions of antibodies; VDJ rearrangements, complement

Unit-IV: Major Histocompatibility Complex

Organization of MHC locus (mice & human); Structure and functions of MHC I and II molecules

Unit-V: Generation of Immune response

Antigen processing and presentation. Primary and Secondary Immune response; Generation of Humoral Immune Response; Generation of cell mediated Immune response (T cell activation, co-stimulatory signals); Killing mechanisms by CTL and NK cells

Unit-VI: Immunological Techniques

Bases of antigen antibody interactions; Affinity and Avidity; Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western Blotting, Immunofluorescence, Flow cytometry and Immunoelectron Microscopy

Unit-VII: Immunotechnology

Hybridoma & Monoclinal antibodies, chimeric antibodies, single chain antibodies, diagnostic kits, therapeutic antibodies and Immuno-toxins, Vaccines (conventional and recombinant: subunit vaccines, conjugate vaccines, DNA vaccines, Adenovirus-vector based vaccines), Recombinant Interferons

Suggested Readings / Books:

- Kuby's Immunology (6th Ed.) by Goldsby RA, Kindt TJ, Osborne BA.), W.H. Freeman and Company, New York, (2007).
- Janeway's Immunobiology (7th Ed.) by Murphy K, Travers P, Walport M. Garland Science Publishers, New York, (2008).
- Cellular and Molecular Immunology (6th Ed.) by Abbas AK, Lichtman AH, Pillai S.,Saunders Publication, Philadelphia, (2007).
- Immunology (6th Ed.) by Richard C and Geiffrey S. Wiley Blackwell Publication, (2009).

- Roitt's Essential Immunology (11th Ed.) by Delves P, Martin S, Burton D, Roitt IM. Wiley-Blackwell Scientific Publication, Oxford. (2006).
- Biotechnology - Applying the Genetic Revolution by Clark DP and Pazdernik NJ. Academic Press, USA, 2009.
- Molecular Biotechnology (3rd Ed.) by Glick BR and Pasternak JJ, ASM Press, Washington D.C., 2003.

BTBT 404 Cell & Molecular Biology

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

Unit-I Cell - Structural & functional unit of life, prokaryotic & eukaryotic. Cell organelles – Structure & functions

Unit-II Cell organelles – Binary fission, Mitosis & Meiosis, cell cycle & its regulation Cytoskeleton & ECM

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

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

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

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

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

Suggested Readings / Books:

- **Molecular Biology of the Cell**, Fifth Edition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, December 2007
- **Cell and Molecular Biology,** Sixth Edition, Gerald Karp

BTBT 405 Intellectual Property Rights, Bioethics & Biosafety

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

Unit-VIII Social and ethical implications of biological weapons.

Unit-IX Good safety practices, GLP standards, lab contaminants.

BTBT406 Biotech Lab IV

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.

BTBT407 Biotech Lab –V

1. To perform Immunodiffusion (Ouchterlony)

2. To perform Immunoelectrophoresis
3. To study Quantitative precipitation assay
4. To perform Latex Agglutination test
5. To perform Dot- ELISA
6. Hapten conjugation and quantization
7. To perform Plate ELISA
8. To perform Western Blotting

BTBT 408 Biotech Lab –VI

1. Microscopic study of shape and size of bacterial, fungal and plant cells
2. Microscopic study of dividing cells in different phases of mitosis
3. Genomic DNA isolation of *E coli*
4. Preparation of *E coli* competent cells and their transformation using plasmid offering antibiotic resistance to the host cells
5. Qualitative and quantitative analysis of DNA by spectrophotometry
6. Isolation and quantification of RNA from bacterial cells
7. Isolation and quantification of total proteins of the cells
8. Isolation and quantification of carbohydrates and lipids from different biological sources
9. Demonstration of inducible expression of genes in bacteria

BTBT 409 Term Paper –II

Methodology

A term (or research) paper is primarily a record of intelligent reading in several sources on a particular subject. The students will choose the topic at the beginning of the session in consultation with the faculty assigned. The progress of the paper will be monitored regularly by the faculty. At the end of the semester the detailed paper on the topic will be submitted to the faculty assigned. The evaluation will be done by Board of examiners comprising of the faculties.

Guidelines for Term Paper

The procedure for writing a term paper may consists of the following steps:

7. Choosing a subject
8. Finding sources of materials
9. Collecting the notes
10. Outlining the paper

11. Writing the first draft

12. Editing & preparing the final paper

- **Choosing a Subject**

  The subject chosen should not be too general.

- **Finding Sources of materials**

  Material sources should be not more than 10 years old unless the nature of the paper is such that it involves examining older writings from a historical point of view.

  Begin by making a list of subject-headings under which you might expect the subject to be listed.

  The sources could be books and magazines articles, news stories, periodicals, scientific journals etc.

- **Collecting the notes**

  Skim through sources, locating the useful material, then make good notes of it, including quotes and information for footnotes.

  - Get facts, not just opinions. Compare the facts with author's conclusion.
  - In research studies, notice the methods and procedures, results & conclusions. Check cross references.

- **Outlining the paper**

  Review notes to find main sub-divisions of the subject.

  Sort the collected material again under each main division to find sub-sections for outline so that it begins to look more coherent and takes on a definite structure. If it does not, try going back and sorting again for main divisions, to see if another general pattern is possible.

- **Writing the first draft**

  Write the paper around the outline, being sure that you indicate in the first part of the paper what its purpose is. You may follow the following:

  - statement of purpose
  - main body of the paper
  - statement of summary and conclusion

  Avoid short, bumpy sentences and long straggling sentences with more than one main ideas.

- **Editing & Preparing the final Paper**

  - Before writing a term paper, you should ensure you have a question which you attempt to answer in your paper.

- This question should be kept in mind throughout the paper. Include only information/ details/ analyses of relevance to the question at hand. Sometimes, the relevance of a particular section may be clear to you but not to your readers. To avoid this, ensure you briefly explain the relevance of every section.
- Read the paper to ensure that the language is not awkward, and that it "flows" properly.
- Check for proper spelling, phrasing and sentence construction.
- Check for proper form on footnotes, quotes, and punctuation.

Check to see that quotations serve one of the following purposes:

- Show evidence of what an author has said.
- Avoid misrepresentation through restatement.
- Save unnecessary writing when ideas have been well expressed by the original author.
- Check for proper form on tables and graphs. Be certain that any table or graph is self-explanatory.

Term papers should be composed of the following sections:

8) Title page
9) Table of contents
10) Introduction
11) Review
12) Discussion & Conclusion
13) References
14) Appendix

Generally, the introduction, discussion, conclusion and bibliography part should account for a third of the paper and review part should be two thirds of the paper.

Discussion

The discussion section either follows the results or may alternatively be integrated in the results section. The section should consist of a discussion of the results of the study focusing on the question posed in the research paper.

Conclusion

The conclusion is often thought of as the easiest part of the paper but should by no means be disregarded. There are a number of key components which should not be omitted.

These include:

- summary of question posed
- summary of findings

- summary of main limitations of the study at hand
- details of possibilities for related future research

References From the very beginning of a research project, you should be careful to note all details of articles gathered. The bibliography should contain ALL references included in the paper. References not included in the text in any form should NOT be included in the bibliography.

The key to a good bibliography is consistency. Choose a particular convention and stick to this.

Evaluation: Based on the organization of the paper, objectives /problem profile/ issue outlining, comprehensiveness of the research, flow of the idea/ ideas, relevance of material used/ presented, outcomes vs. objectives, presentation/ viva etc.

Fifth Semester

BTBT501 Chemical Engineering Principles

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

***Unit I*- Material and Energy Balance**: Units and dimensions, Dimensional analysis, simple problems on material balance, calculations involving unit process and reactive systems, available electron balances

***Unit II*- Chemical reaction engineering**: Kinetics of homogenous reaction, concepts of reaction rate, order of reaction and molecularity, Factors affecting reaction kinetics, Searching for a mechanism, Prediction of Reaction Rate from Theory.

***Unit III*- Interpretation of Batch Reactor Data:** Analysis of batch reactors for kinetic interpretation of the data, Constant-volume Batch Reactor, Varying-volume Batch Reactor, Search for a Rate Equation

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

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

***Unit VI*- Instrumentation:** Principles of measurement: error, accuracy and sensitivity, measurement of flow, pressure, temperature level, pH, viscosity and chemical composition

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

Suggested Readings / Books

1. Basic principles and calculation of Chemical Engineering by D.M. Himmelblau Publisher: Prentic Hall
2. Basic Principles of Chemical Engineering by E.I. Shaheen Publishers: Houghton Miffin
3. Chemical Process Control, an introduction to theory and practice by G. Stephanopoulos. Publisher: Prentice Hall Inc.
4. Chemical reaction engineering by O. Levenspiel. Publisher: John Wiley and sonc Inc.
5. Coulson's and Richardson's Chemical Engineering by J.F. Richardson and D.G. Peacock, Publisher: Asian books

6. Elementary Principles of Chemical Processes by R. M. Felder and R. W. Rousseau Publisher: John Wiley and sons Inc.

7. Fundamentals of Chemical Reaction Engineering by C.D. Holland and R.G. Anthony , Publishers, Prentice Hall Inc.

BTBT502 Immunology and Immunotechnology-II

Objectives: The overall learning goals for the course are to acquire a fundamental knowledge of the basic principles of immunology, to understand the process of immune function; and to develop the ability to solve problems in clinical immunology.

Unit-I: T Cell Receptor, T Cell Development, Activation & Differentiation; B Cell Development, Activation & Differentiation

Unit-II: Cytokines; Complement system

Unit-III: Cell mediated effector response; Leukocyte migration and inflammation

Unit-IV: Hypersensitive Reactions; Immune response to infectious diseases

Unit-V: AIDS and other immunodeficiencies

Unit-VI: Autoimmunity; Cancer and immune system

Unit-VII: Transplant immunology

Suggested Readings / Books:

1. Kuby's Immunology (6^{th} Ed.) by Thomas J. Kindt, Richard A. Goldsby, Barbara Anne Osborne, W.H. Freeman and Company,New York (2007)
2. Roitt's Essential Immunology (11^{th} Ed.) by Delves P, Martin S, Burton D, Roitt IM. Wiley-Blackwell Scientific Publication, Oxford (2006)
3. Immunology (6^{th} Ed) by Richard C, Geiffrey S. Wiley- Blackwell Scientific Publication, Oxford (2009)
4. Cellular and Molecular Immunology (6^{th} Ed.) by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Saunders Publication, Philadelphia, (2007)
5. Biotechnology- Applying the genetic Revolution by Clark DP and Pazdernik NJ. Academic Press, USA, (2009)
6. Immunobiology, (4th Edition) by Janeway et al. (1999) Current Biology Publications

BTBT503 Genetic Engineering

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

Unit-I Introduction, Milestones in Genetic Engineering

Unit-II Molecular tools and their applications: DNA & RNA modifying enzymes: Restriction enzymes and other endonucleases, Exonucleases, Polymerases, Kinases, Methylases and Ligases.

Unit-III Molecular Techniques: Restriction analysis of DNA, Restriction map, electrophoretic techniques for nucleic acid protein analyses, DNA sequencing, Chemical synthesis of oligonucleotides, Southern, Northern and Western blotting techniques.

Unit-IV Different vectors for molecular cloning: Plasmids, Bacteriophages, Phagemids, Cosmids; YAC and BAC, Transformation Techniques

Unit-V Construction of genomic and cDNA libraries; Gene specific probes; Screening strategies for isolation of genes.

Unit-VI Alternative strategies of gene cloning: PCR techniques and their applications, introduction to two and three hybrid systems, nucleic acids microarrays.

Unit-VII Random and site-directed mutagenesis, Expression strategies for heterologous genes: Expression of recombinant proteins in Bacteria, Yeast, Insect cells, Mammalian and Plant cells, in vitro transcription and translation;

Suggested Readings / Books:

1. Principles of Gene Manipulation and Genomics (7^{th} edition), by S.B. Promorose and R. M. Twyman, Blackwell Publishing (2006)
2. Gene Cloning and DNA Analysis: An Introduction (6^{th} edition), by T A Brown, Wiley – Blackwell Publications.
3. Recombinant DNA by Watson.J.D. et al, 1993, Scientific American Books, New York.
4. Biotechnology, U. Satyanarayana, Books and Allied (P) Ltd., Kolkata (2005)

BTBT504 Animal Cell Culture and Biotechnology

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

Unit-I **Introduction to Animal Tissue culture:** Background, Advantages, Limitations, Application, culture Environment, Cell Adhesion, Cell Proliferation, Differentiation.

Unit-II **Design, Layout and Equipment:** Planning, Construction Layout, Essential Equipments, Aseptic Technique, Sterile Handling, Safety, Risk Assessment, biohazards

Unit-III **Media:** Physicochemical Properties, Balanced salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media

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

Unit-V **Scale up of Cell Culture:** Principles and Procedure, Roller bottles, Reactors and Fomenters and various adaptations; Factors affecting scale up; Growth monitoring during scale up.

Unit-VI Contamination**:** Sources of contamination, Cross contamination, Type of microbial contamination, Eradication and Cryopreservation

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

Suggested Readings / Books:

1. Culture of animal cells: A manual of Basic Technique, by Freshney R. Ian, Willey-Liss Publisher, 5th edition (2005).
2. Textbook of Biotechnology by H.K. Das, Wiley India, 4th edition, (2010).
3. Animal Cell Biotechnology: Methods and Protocol by Jenkins N, ed. Humana Press (1999).
4. Mammalian Cell Biotechnology- A Practical Approach, by Butler, M, IRL Oxford University Press (1991)

BTBT505 Bioinformatics

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

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

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

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

Unit-IV **Predictive methods using nucleotide sequence:** Annotation of DNA and protein sequences, Codon bias detection, Detecting functional site in DNA, ESTs, Polymorphism, finding RNA genes.

Unit-V **Predictive methods using protein sequence:** protein identity based on composition, physical properties based on sequence, secondary structure, specialized structures or features, tertiary and quaternary structures.

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

Unit-VII ***Applications Of Bioinformatics In Biotechnology*****:** gene prediction in prokaryotes, eukaryotes; other applications in the areas of health, food and medicine.

Suggested Readings / Books:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, By Andreas D, Baxevanis, B.F, Francis O, Wiley –Interscience , 3rd Edition, 2004.
2. Textbook of Biotechnology, H K Das, Wiley- India (P) Ltd., New Delhi (2005).
3. Sequence and genome analysis dy D.W.Mount-Cold Spring Harbour Lab., 1st edition, 2004.
4. Bioinformatics and the genome projects by Smith DW, Academic Press, 1993.
5. Bioinformatics: A Biological Guide to computing and the Internet by Stuart M and Brown NYU, Mecical Centre, NY USA, 2000.

BTBT506 Practical Lab. VII (Genetic Engg. and Immunotechnology Lab)

1. Extraction and purification of genomic DNA from prokaryotes and eukaryotes
2. Plasmid DNA isolation
3. RNA isolation
4. Restriction analysis
5. Basic molecular cloning technique
6. PCR technique
7. Screening of clones by blue-white selection (i.e. α-complementation)
8. Qualitative and quantitative analysis of isolated nucleic acids
9. Preparation of competent cells and genetic transformation of bacteria
10. To perform ELISA- Dot and Plate
11. To perform Western Blotting

BTBT508 Practical Lab. IX (Bioinformatics)

1. Computer basic
2. Search, retrieval of biological database (PUBMED)
3. Sequence retrieval of Nucleotide and protein databases
4. Interconversion of different file formats
5. Database homology with query sequences using BLAST and FASTA analysis
6. Pairwise comparison of sequences
7. Multiple sequence analysis and phylogenetic analysis using CLUSTAL W
8. HMM for sequence analysis (expand HMM)
9. Sequence analysis packages: EMBOSS, NCBI Tool Kit
10. Protein databank retrieval & visualization of Secondary 3D structures

BTBT507 Practical Lab VIII (Animal cell Culture and Biotechnology)

1. Separation of serum and plasma
2. Media preparation and sterilization, Testing of complete and incomplete media
3. Sterilization of media and instruments for animal cell culture
4. Culturing and subculturing of adherent and suspension cell
5. Isolation of Lymphocytes
6. Lymphocyte Proliferation assay
7. Toxicity evaluation using tumor cell lines
8. Cell counting and viability by Trypan Blue dye exclusion test
9. Cryo-preservation of cells
10. Thawing of cryo-preserved cells

Sixth Semester

BTBT601 Fundamentals of Biochemical Engineering

Objective: The objective of this course is to impart knowledge of mass and energy balance in biological system, cultivation, growth kinetics of microorganism and scale up in bioreactor, bioreactor design and process control in biochemical engineering system.

Unit I – Mass and Energy Balance: Mass and energy balance in biological processes

Unit II – Stoichiometry of Microbial Growth and Product Formation and energetic: 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 III – 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

Unit IV – Cell Cultivation and Growth Kinetics in Bioreactor: Ideal reactors for kinetics measurement: chemostat, turbidostat, batch, fed batch and continuous cultivation, chemostat with recycle

Unit V – Sterilization: Introduction, sterilization of air, medium, bioreactor, kinetics of death, theory of depth filters, design of depth filters, design of batch sterilization and continuous sterilization process

Unit VI – Scale-up in Bioreactors: Overview of reactor, types of bioreactor, their parts and functions, aeration and agitation of bioreactor, mass transfer, molecular diffusion, diffusion theory, film theory, gas-liquid mass transfer, oxygen transfer from gas bubble to cell, oxygen uptake rate, 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 VII – 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 Michael L. Shuler and Fikret Kargi, Pearson 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 Plant Biotechnology

Objective: One of the major challenges of human civilization today is to improve crop productivity on a sustainable basis. The course contents are designed in such a way that a student can learn various aspects of modern plant biotechnology in a step-wise manner. This course includes the following features: plant tissue culture techniques, architecture of plant genomes, structural attributes of plant genes, cloning and manipulation of useful genes, techniques involved in plant genetic transformation, and generation of genetically modified plants with desirable phenotypic traits

Unit I – Introduction and scope of plant biotechnology,. introduction to plant tissue culture, plasticity and totipotency, various media formulations, plant growth regulators, callus and suspension cultures

Unit II – Micropropagation, organogenesis and somatic embryogenesis, haploid plants and homozygous lines, embryo culture and rescue

Unit III – Protoplast isolation, culture and fusion, selection of hybrid cells, regeneration of hybrid plants, bioresource conservation

Unit IV – Architecture of plant nuclear, chloroplast and mitochondrial genomes, structural aspects of plant genes, regulation of gene expression, transposons, cytoplasmic male sterility, molecular markers

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

Unit VI – Control mechanisms and manipulation of biosynthetic pathways of the aromatic amino acids tryptophan, tyrosine and phenylalanine in plants; introduction to secondary metabolites, plant cell culture techniques for production of secondary metabolites & other important compounds; underlying principles and genetic manipulations involved in the production of commercially important enzymes, therapeutic proteins, edible vaccines, bioplastics, and other novel compounds

Unit VII – Plant transgenics: issues and concerns, biosafety, societal and ethical aspects of genetically modified foods and crops

Suggested Readings / Books:

1. Plant Biotechnology by Slater, A., Scott, N.W., and Fowler, M.R., Oxford Univ Press (2008)

2. Principles of Gene Manipulation and Genomics by Primrose, S.B., Twyman, R.M., 7th Edition, Blackwell Publishing (2006)

3. Concepts in Biotechnology by Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., and Jayaraman, K., Revised Edition,COSTED-IBN, Universities Press (2007)

4. Biotechnology by Satyanarayana, U., Books and Allied (P) Ltd, (2005)

5. Introduction to Plant Tissue Culture by Razdan, M.K., Oxford & IBH Publishing Co. (2003)

BTBT603 Enzymology & Enzyme Technology

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

Unit I – Introduction to Enzyme: Introduction, scope, nomenclature, mechanism of catalysis, monomeric and oligomeric enzyme, industrial applications

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

Unit III – Enzyme Kinetics: Method used for investigating the kinetics of enzyme-catalysed reactions: initial velocity studies, rapid-reaction techniques , single substrate steady state kinetics: Henri and Michaelis-Menten equation, Briggs-Haldane modification of the Michaelis-Menten equation, significance of M-M equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot, Haldane relationship for reversible reactions, inhibitors and activators, reversible and irreversible enzyme inhibition kinetics, multi-substrate systems, effect of pH and temperature on enzyme kinetics, allosteric enzymes

Units IV – Immobilisation of Enzymes: Advantages, carriers, adsorption, covalent coupling, cross linking and entrapments, micro-environmental effects

Unit V – Enzyme Reactors: Reactors for batch/continuous enzymatic processing, choice of reactor type, idealized enzyme reactor systems

Unit VI – Mass Transfer Effect in Immobilized Enzyme: Mass transfer in enzyme reactors, steady state analysis of mass transfer

Units VII – Challenges and Future trends: Enzyme catalysis in organic media, catalytic antibodies, non-protein biomolecules as catalysts, biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria

Suggested Readings / Books

1. Biotechnological Innovations in Chemical Synthesis by R.C. B. Currell, V. D. Mieras, Biotol Partners Staff Publisher: Butterworth Heinenmann

2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer and Philip L. Bonner, East-West Press Private Limited

3. Industrial Enzymes and their Application by H. Uhlig. Publisher: John Wiley and Sons Inc

4. Enzyme kinetics: Behavior and Analysis of Rapid Equilibrium and Steady –State Enzyme Systems by I.H. Segel Publisher: Wiley-Interscience

5. Enzyme Technology by M. F. Chaplin and C. Bucke. Publisher: Cambridge University Press

6. Principles of Biochemistry by Lehninger, A.L., Worth Publishers, New York (2007)

BTBT604 Computational Biology

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

Unit I – Biomolecular Structure Dynamics

Computational methods for pathways and systems biology, databases of metabolic pathways, Kyoto Encyclopedia of Genes and Genomes (KEGG), analysis of pathways, Glycolysis, signaling pathways, genetic pathways

Unit II– Gene Prediction

Computational gene mapping and gene hunting, genetic mapping, physical mapping, sequencing similarity search, gene prediction, mutational analysis, introduction to restriction mapping and map assembly, gene prediction methods, gene prediction tools, gene expression

Unit III – Gene Mapping

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

Unit IV – Computer Aided Drug Design

Computer aided drug design, methods of computer aided drug design, ligand design methods, docking algorithms and programs, drug design approaches, absorption, distribution, metabolism, and excretion (ADME) property prediction, computer based tools for drug design

Unit V – Soft Computation

Markov Model and Hidden Markov Model, Neural networks, machine learning, support vector machines, fuzzy logic, Evolutionary computing and genetic algorithms –application to data mining and bioinformatics

Unit VI – Structure Databases

PDB and MMDB, structure file formats, visualizing information, advance structure modeling, Internal and external co-ordinate system and cylindrical polar co-ordinate system, potential energy calculations using semiempirical potential energy function, Electrostatic energy surface

generation, three dimensional structure using dynamic programming methods, Molecular mechanics and dynamics

Unit VII – RNA Secondary Structure and Perl Language

RNA secondary structure – combinatories, minimum free –energy structures, consensus folding, Unusual DNA structures, Perl language and Perl Programming

Suggested Readings / Books

1. Introduction to Computational Biology, Map, sequences and genomes, Michael S. Waterman, Chapman & Hall Publisher
2. Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology by D. Gusfield Publisher Cambidge University Press
3. Bioinfomatics: Sequence and Genome Analysis by D.W. Mount Publisher Cold Spring Harbor Laboratory Press
4. Computaional Molecular Biology: An Algorithm approach by P.A. Pevzner Publisher MIT Press
5. Computational Modelig of Genetic and Biochemical Networks by J.M. Bower and H. Bolouri Publisher: MIT Press
6. Essentials of Genomics and Bioinfomatics by C.W. Sensen Publisher John Wiley and Sons Inc.
7. Bioinformatics Methods and Application - Genomics, proteomics, and drug discovery, S. C. *Rastogi*, N. Mendiratta, and P. *Rastogi*, Prentice Hall of India

BTBT605 Bioanalytical Techniques

Objective: Biotechnology is a multi-disciplinary applied approach towards biological systems. Research in the field of biotechnology and its applications in development of technologies involves various kind of unique techniques. Though these techniques are purely based on the principles of physics and chemistry yet they are specialized for biological applications. The course is aimed to impart conceptual as well as descriptive knowledge about such techniques to the bachelor students pursuing education in the field of biotechnology. The course covers broad areas of chromatography, electrophoresis, centrifugation, microscopy, radioactivity and spectroscopy.

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

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

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

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

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

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

Unit VII – Radioisotope Techniques: Atomic stability and radiation, types of decay, rate of radioactive decay and half life, units of radioactivity, specific activity, detection methods based on ionization (Geiger-Muller monitor), excitation (solid and liquid scintillation counting), Cerenkov counting, autoradiography, safety aspects of handling radioactive material and radiations, units of exposure such as gray and sievert, precautions associated with radioactivity handling

Suggested Readings / Books

1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K. and Walker J., Cambridge University Press (2005) 6th ed.

2. Biochemical Method-A Concise guide for students and researchers, Pingoud A., Urbanke C., Hoggett J. and Jeltsch A. Wiley-VCH Publishers

3. Bioseparations: Science and Engineering, Harrison, R.G., Todd, P., Rudge, S.R. and Petrides, B.B. Oxford University Press (2006).

4. Molecular Spectroscopy, McHale, J.L., Prentice Hall (1998).

5. Microscopy and Microtechniques. Marimuthu, R., MJP Publishers (2008).

6. Instrument Methods of Analysis, Willard H.W., Merritt L.L., Dean J.A. & Settle F.A. 6th ed. East West Publishers,

BTBT606 Biotech Lab-X (Plant Biotechnology Lab)

1. Preparation of plant tissue culture media
2. Collection and surface sterilization of different explants and establishment of plant germplasm under *in vitro* condition
3. Callus induction, regeneration and morphogenesis
4. Meristem culture for virus free plants
5. Protoplast isolation techniques
6. Micropropagation, hardening and acclimatization
7. Isolation and purification of plant DNA and RNA & its restriction analysis
8. Demonstration on molecular cloning of plant genes
9. *Agrobacterium*-mediated transformation of plants
10. Direct DNA transfer to plants (visit to some lab)
11. Molecular characterization of a transgenic plant

BTBT607 Biotech Lab –XI (Enzymology & Enzyme Technology Lab)

1. Isolation of amylase from bacteria/ protease from pulse/ cellulase from fungi
2. Partial purification of enzyme by ammonium sulphate fractionation
3. Assay of enzymes and specific activity of amylase, cellulose & protease
4. Substrate specificity of enzymes
5. Kinetics of enzyme catalaysed reactions: Effect of varying substrate concentration on enzyme activity, determination of Michaelis-Menten constant (K_m) and Maximum Velocity ($V_{max.}$) using Lineweaver-Burk plot
6. Effect of temperature and pH on enzyme activity
7. Immobilisation of enzymes
8. Microenvironmental effects on immobilised enzymes

BTBT608 Biotech Lab –XII (Computational Biology Lab)

1. Write a sequence assembly program
2. HMM for sequence analysis
3. Develop a simple gene finder program for identifying introns and exons
4. Motif and pattern searching in biomolecules
5. Energy minimization and simulated annealing
6. Docking small molecules/peptides in active site of protein. Use of automated docking procedures, free energy calculation
7. Identifying palindromes and DNA sequence
8. DNA and RNA structure prediction
9. Structure superimposition tools for proteins/enzymes

BTBT609 Biotech Lab-XIII (Bioanalytical Techniques Lab)

1. 2D-TLC analysis of amino acids
2. Column chromatographic analysis of chlorophyll
3. GC & HPLC (demonstration)
4. Microscopy (staining & size measurement)
5. UV – spectrophotometric analysis of DNA and protein samples
6. Determine λ_{max} of DNA, protein, bromophenol blue solutions by wavelength scan
7. Comparison of Coomassie brilliant blue and silver staining methods for visualizing protein bands in SDS-PAGE
8. Comparison of ethidium bromide and silver staining methods for visualisation of small DNA fragments analyzed by native PAGE
9. Compare the centrifugation of bacterial culture and ethanol precipitated DNA and calculate relative centrifugal force for the two centrifugations

Seventh Semester

BTBT701 Bioprocess Technology

Objective: The objective of the course is to apply the principles of biochemical engineering in large scale production of industrially important products. The students will be able to develop a flow sheet for production of primary, secondary and mixed metabolites. They will get exposure of product case studies.

Unit I – Introduction to Bioprocess Technology: Bioprocess vs chemical processing, advantages, disadvantages, substrates for bioconversion process

Unit II – Media Design: Cell culture techniques: Isolation methods, media design and sterilization, Inoculum development and aseptic transfers, Criteria for inoculums transfer, Aseptic inoculation, Different types of pumps, valves, and line materials, Piping conventions etc. used in biochemical Process

Unit III – Production of Primary Metabolites: Process technology for production of primary metabolites: Baker's yeast: baker's and distiller yeast production using various raw materials, "bios" factors for growth, Crabtree effect, harvesting, different forms and uses, Acetone Butanol

Ethanol: production by batch, continuous and cell recycle adopted by various technologies practiced in Indian distilleries using molasses and grains, computation of fermentation efficiency, distillation efficiency and overall efficiency of ethanol production, recovery, uses, glucose effect, power alcohol – definition, uses, merits and demerits of various technologies for its production, acetone-butanol, citric acid, amino acids, polysaccharides and plastics

Unit IV – Production of Secondary Metabolites: Production of secondary metabolites; Penicillin, Cephalosporins, Streptomycin, metabolites from plant and animal cell culture Citric acid.

Unit V – Microbial Enzymes and Amino Acids: Microbial production of industrial enzymes: Glucose isomerase, cellulase, amylase, protease. Amino Acid: Control of metabolic pathways-underlying principles, Lysine**:** Indirect and direct fermentation – mechanism of pH and metabolic block in accumulation of L- lysine by inhibition and repression mechanism, Glutamate acid

Unit VI – Biomass, Biofertilizers & Biopesticides: Production from agro and microbial sources

Unit VII – Case Studies: Case studies on production of lactic acid, glutamic acid, penicillin, microbial lipase and protease, recombinant insulin, case studies on strain improvement, medium designs, process optimization

Suggested Readings / Books

1. Biochemical Engineering by S Aiba, A E Humphery and N F Millis, University of Tokyo Press
2. Bioprocess Engineering Basic Concepts by M.L. Shuler and F. Kargi, Prentice Hall
3. Bioprocess Engineering by B.K. Lydersen, K.L. Nelson, B.K. Lyderson and N. D'Elia, John Wiley and Sons Inc.
4. Bioprocess Engineering Principles by P Doran, Academic Press
5. Biotechnology. A Textbook of Industrial Microbiology by W. Crueger and a. Crueger, Sinauer Associates.
6. Principles of Fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press
7. Process Engineering in Biotechnolgy by A T Jackson, Prentice Hall

BTBT702 Downstream Processing

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

Unit I – Introduction to Downstream Processing: Characterization of biomolecules and fermentation broth. Guidelines for recombinant protein purification

Unit II – Cell Disruption: Mechanical methods – Homogenization, sonication, chemical methods-enzymes & detergents, factors affecting disruption, Dynomill and French press-principle, batch and continuous operations

Unit III – Mechanical Methods of Separation: Flocculation and conditioning of broth, sedimentation, filtration and centrifugation- principle, instrumentation, types and applications

Unit IV – Solid Liquid Separation: Protein precipitation and its separation, aqueous two phase extraction-principle, Instrumentation and application, Adsorption-desorption processes.

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

Unit VI – Chromatography: Chromatographic methods of separation based on size, charge, hydrophobic interactions, biological affinity method and crystallization

Unit VII – Case Studies: Case studies on purification of lactic acid, penicillin, microbial lipase and protease, recombinant insulin

Suggested Readings / Books

1. Bioseparations: Downstream Processing for Biotechnology by P.A. Belter et. al. Publisher: John Wiley and Sons Inc
2. Bioseparation by P.A. Belter, E. L. Cussler and W.S. Hu, Publisher John Wiley and Sons Inc
3. Biochemical Engineering Fundamental by J.E. Bailey and D.F. Ollis, Publisher: McGraw-Hill
4. Biotreatment, Downstream Processing and Modelling (Advances in Biochemical Engineering/Biotechnology, Vol 56) by T. Scheper et. al. Publisher: Springer Verlag.
5. Downstream Processing by J.P. Hamel, J.B. Hunter and S.K. Sikdar. Publisher Amercian Chemical Society.

6. Protein Purification by M.R. Ladisch, R. C. Wilson, C.C. Painton and S.,E. Builder, Publisher: American Chemical Society

7. Bioseparatioins, P.A. Belter, E.L. Cussler and W.S. Hu, John Wiley and Sons Inc. Bioseparations: Downstream Processing for Biotechnology, P.A. Belter et al, John Wiley and Sons Inc.

BTBT703 Genomics and Proteomics

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

Unit I – Genome Mapping: Sequence tags, STS, EST, RFLP, SNP, RAPD, AFLP, radiation hybrid mapping, HAPPY mapping

Unit II – Genome Sequencing: Sequencing genomes-high throughput sequencing, clone-by-clone approach, whole genome shot gun approach, the quality of genome sequence, annotation of genomes, human genome project and its significance in modern biology

Unit III – Comparative Genomics: Comparative genomics of bacteria, eukaryotes, organelles and their applications

Unit IV – Analysis of Transcriptomes: Introduction to transcriptomics, differential gene expression, SAGE, various DNA microarrays and their applications in functional genomics

Unit V – Proteomics: Introduction to proteomics, protein arrays, protein chips and their applications, 2D gel electrophoresis and its application, multi-dimensional liquid chromatography, mass spectrometry and protein identification, role of bioinformatics in proteomics, proteomics databases

Unit VI – Structural Proteomics: High throughput solving of protein structures- X-ray crystallography, NMR, homology modelling and protein structure prediction methods, applications of structural proteomics

Unit VII – Protein-Protein Interactions: Concepts, techniques –Yeast two hybrid system, rosetta stone method, multiple sequence alignment, phage display and databases of protein-protein interactions

Suggested Readings / Books

1. Principles of gene manipulation and genomics by Primrose, S.B. and Twyman, R.M., Blackwell Publishing (2006)

2. Introduction to Genomics by Lesk AM, Oxford University Press (2008)

3. Proteomics: from protein sequence to function by Pennington, S.R. and Dunn, M. J., Viva Books (2001)

4. Bioinformatics: Sequence and Genome Analysis by Mount, D.W., Cold Spring Harbor Laboratory Press (2001)

BTBT704 Food & Nutraceutical Biotechnology

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

Unit I – Introduction: Current status of food processing industry, food spoilage and its prevention, role of microbes in food processing operations and production. Nutraceuticals- Historical perspectives, definition, nature, nutraceutical compounds and their classification based on their biochemical nature, scope and future prospects

Unit II – Food as Remedies: Nutraceuticals bridging the gap between food and drug, protein foods, single cell protein, mushroom, yeast/algal proteins, probiotics, nutraceuticals in chemoprevention

Unit III – Oxidants and Antioxidants: Concepts of free radicals and antioxidants, food antioxidants as nutraceuticals and their role in food preservation

Unit IV – Fermentation: Fermented foods- yoghurt, sauerkraut, bread, pickles and alcoholic beverages. Fermentation as a method of preparing and preserving foods

Unit V – Additives: Food additives like colours, flavours and vitamins. Organisms and their use in production of colours and flavours

Unit VI – Production methods: Mechanism of enzyme function and reactions in processing techniques-starch and sugar conversion process, baking analysis, beer mashing and chill proofing, cheese making by protease and various other enzyme catalytic actions in food process waste- whey, molasses, starch substrates and other food waste for bioconversion to useful products

Unit VII – Introduction to Gene-Diet Interactions: Nutrigenomics: scope and its importance in human health and food industry, transporter gene polymorphisms - interaction with micronutrients in humans, nutrigenomic approaches in unraveling physiological effects of complex foods, role of intestinal microbiota in nutrigenomics

Suggested Readings / Books:

1. Understanding Pathophysiology by Huether, S.E., Kathryn, R.N., Elsevier 5th Edition.
2. Nutraceuticals Food Is Medicine Dietary Supplements of Plant Origin-Wildman by Rapport, L., Lockwood, B., Cousion, P.J., Maffei, M., Routledge Publishers
3. Functional Foods: Handbook of Nutraceuticals and Functional Foods by Mazza, Robert E.C.

4. Food Microbiology by Frazier, W.C. and Westhofff, D.C., Tata McGraw Hill.

5. Food – The Chemistry of its Components by Coultate, T.P., 2nd Edn. Royal Society, London, 1992.

6. Molecular Nutrition Research—The Modern Way Of Performing Nutritional Science, *Journal Nutrients 2012, 4, 1898-1944*

7. Nutrigenetics and Metabolic Disease: Current Status and Implications for Personalized Nutrition *Journal Nutrients 2013, 5, 32-57*

BTBT901 Biophysics

Objective: This course aims to make students to understand the theories of physics and apply them to study biological phenomena. Additionally course will help students to understand the physics of instruments and techniques applied in biotechnology.

Unit I – Interactions in Biological Systems: Intra- and intermolecular forces, electrostatic interactions and hydrogen bonding interactions, disulfide bridges, hydrophobic and hydrophilic molecules and forces, water and weak interactions

Unit II – Protein Structure and Conformation: Configuration and conformation, non bonded and dipolar interaction, protein and polypeptides - secondary and tertiary structures and protein folding, conformational analysis, Ramachandran plot, hydration of proteins

Unit III – Stability of Protein Structure: Laws of thermodynamics, heat, energy and work, chemical equilibrium flexibility, reversible folding and unfolding, pH titration, chemical denaturation, thermal denaturation, solvent perturbation and chemical modification, prediction of protein structures using circular dichroism, NMR methods, structure-function relationship

Unit IV –Structure and Conformation of Nucleic Acids : Base-pairing and base stacking, backbone torsional angle, sugar confirmation, A, B and Z form of DNA, DNA supercoiling, DNA and RNA conformational structures, RNA secondary structure, unusual structures of DNA such as bending, kinking, bulges, breathing, hairpin and cruciform structures

Unit V – Functions and Properties of Nucleic Acids: Thermal denaturation of DNA, re-association kinetics, $C_0t_{1/2}$ curve and DNA sequence complexity, Techniques involved in DNA protein interactions

Unit VI – Biological Membranes: Membrane structure and models, Lipid structure and their organization, phase transitions in lipids, polysaccharides, molecular shapes and the conformation, physical properties of membrane, diffusion and permeability

Unit VII – Membrane Transport: Cell membrane transport system- active transport, passive and facilitated diffusion, co-transport across membrane, concentration gradient, membrane potential, electrochemical gradient, carrier transport, ion transport, ion pumps, water transport, use of liposomes for membrane models and drug delivery systems

Suggested Readings / Books:

1. Molecular Biophysics by Daune, M, Oxford University Press (1999).
2. Biophysics by Glaser, R, Springer (2004).
3. Lehninger's Principles of Biochemistry by Nelson, D.L., Cox, M.M., McMillan Publishers (2008) 4th ed.

BTBT902 STEM CELL TECHNOLOGY

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

Unit I – Introduction to Stem Cells: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells

Unit II – Stem Cell Niche: Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues

Unit III – Cell Cycle and Development: Cell cycle regulators and checkpoints, cell fusion, differentiation of stem cells and their role in self renewal

Unit IV - Epigenetic Control: DNA-methylation and histone modifications, genomic imprinting, telomerase regulation, X-chromosome inactivation, reprogramming of cells, induced pluripotent stem cells and their therapeutic applications

Unit V – 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

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

Unit VII – Applications: Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns

Suggested Readings / Books:

1. Hematopietic 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

BTBT903 Nanobiotechnology

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

Unit I – Basics of Quantum Mechanics and Atomic Structure: Duality of light, de Broglie wave, electrons in potential well, structure of hydrogen atom, classic atomic bonding, LCAO theory, band theory, energy bands for metals, semi conductors and insulators

Unit II – Surface Science of Nanomaterials: crystal structure, close packed structures – FCC, HCP and BCC, surface structure for close-packed surfaces, surface reconfiguration (surface relaxation & surface reconstruction) adsorption, wetting, surface area in nanomaterials

Unit III – Introduction to Nanostructures: Carbon nanotubes (CNT), fullerene ('C**60**'), quantum dots and semiconductor nanoparticles, metal-based nanostructures, nanowires, polymer-based nanostructures, gold nanostructures

Unit IV – Nanomaterial Characterization: X-ray diffraction, electron microscopy, interaction between electron beam and solids, TEM, SEM, SPM (STM & AFM), AES, XPS, SIMS

Unit V – Nanobiomaterials: Biomimetic nanotechnology, protein-based nanostructures, nanomotors, bacterial (*E. coli*) and mammalian (Myosin family), DNA nanotechnology, nanostructures in cells study, microarray platforms, nanoprinting of DNA, RNA, and proteins biochips applications in nano scale detection, lab-on-a-chip devices (LOC), tissue engineering

Unit VI – Nanotechnology in Biomedical Application: micro- and nano electromechanical devices in drug delivery, other applications in drug delivery, photodynamic therapy in targeted drug administration, Nanobiosensors, applications of quantum dots in biotechnology, DNA based nanomaterials as biosensors

Unit VII – Health and Environmental Impacts of Nanotechnology: Engineered nanomaterial of relevance to human health, routes of entry into the body, toxic effects on health, plants and microbes are nanofactories

Suggested Readings / Books:

1. Fundamentals and applications of nanomaterials by Guo Z and Tan L, Artech house (2009)
2. Nanobiotechnology by Balaji S, MJP Publishers (2010)
3. Nanobiotechnology: concepts, applications and perspectives by Niemeyer CM and Mirkin CA, Wiley-VCH (2004)
4. Introduction to Nanoscience by Lindsay SM, Oxford University Press (2010)

BTBT904 Bioprocess Plant Design

Objective: The students will understand the fundamentals of bioprocess design and regulations governing the design and operation of bioprocess plant. They will have knowledge of individual unit operations and learn the skills required in bioprocess design using industrially relevant case studies.

Unit I – Introduction to Plant Design : Introduction of Bioprocess Plant Design, Process Design Development: technical feasibility survey, design procedures, design information and flow diagrams, material and energy balances for steady and unsteady state system, comparison of different process and design specifications Optimization techniques and strategies

Unit II – General Design Considerations: Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, govt. regulations Health and safety hazards, Environment protection, plant location and plant layout, plant operation and control

Unit III – Economics Evaluation: Capital cost of a project; Interest calculations, nominal and effective interest rates; basic concepts in tax and depreciation; Measures of economic performance, rate of return, payout time; Cash flow diagrams; Cost accounting-balance sheet and profit loss account; Break even and minimum cost analysis

Unit IV – Basic Design Problems: Design examples on continuous fermentation, aeration, and agitation, design calculation of filter for air sterilization, design of batch and continuous sterilizers

Unit V – Sterilization of Bioreactor and Materials: Sterilization of liquids, gase**s,** batch and continuous sterilizers, calculations for immobilized enzyme kinetics, kinetics of death

Unit VI – Construction Material and Equipment Design: Materials of construction for bioprocess plants, mechanical design of process equipment, process flow sheet, piping and instrumentation, vessels for biotechnology application, design considerations for maintaining sterility of process streams processing equipment, selection and specification of equipment for handling fluids and solids, selection, specification, design of heat and mass transfer equipment used in bioprocess industries, design of facilities for cleaning of process equipment used in biochemical industries, Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries, design exercise on trickle flow fermentor, problems associated with design equations

Unit VII – Process Economics: Utilities for biotechnology production plants, process economics, bioprocess validation, safety considerations, case studies, bio-products regulations, economic analysis of bioprocess, capital, overhead and manufacturing costs estimation, case

studies of antibiotics, recombinant products, single cell protein, anaerobic processes and other fine chemicals

Suggested Readings / Books:

1. Plant Design and Economics for Chemical Engineers by M. Peters and K. Timmerhaus, McGraw-Hill
2. Applied Process Design for Chemical and Petrochemical Plants by E.E. Ludwig, Butterworth-Heinemann Publisher
3. Chemical Engineering by R.K. Sinnott, J.M. Coulson and J.F. Richardsons, Butterworth-Heinemann Publisher
4. Chemical Engineers Handbook by R.H. Perry and D.W. Green, McGraw-Hill
5. Manufacturing Facilities Design and Material Handling by F.E. Meyers and M.P. Stephens, Prentice Hall
6. Plant Design and Economics for Chemical Engineers by M. Peters and K. Timmerhaus, McGraw-Hill
7. Process Plant Layout and Piping Design by E. Bausbacher and R. Hunt, Prentice Hall PTR.

BTBT905 Plant Molecular Farming

Objective: Students will be able to identify the likely targets for molecular farming including carbohydrates, fats, proteins as well as various secondary products. They will be exposed to various case studies so as to acquaint them to large scale production and processing.

Unit I – Introduction: Definition, common perception and the milestones of plant molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance and advantages of plant-based molecular farming

Unit II – Plant Transformation Techniques: Advantages of various strategies for genetic transformation of plants-stable nuclear and plastid transformation, plant cell-suspension cultures, introduction to transient expression systems

Unit III – Factors Affecting Transgene Expression: Limitations and optimization of plant production systems-choice of suitable host plants, optimizing expression and stability of recombinant proteins, glycosylation aspects, downstream processing of the plant-derived products

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

Unit V – Commercially Useful Products-I: Genetically engineered plants as protein factories: Enzymes for industrial and agricultural uses, plantibodies and subunit vaccines

Unit VI – Commercially Useful Products-II: The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes

Unit VII – Social and Ethical Concerns: Critical evaluation of various case studies on molecular farming and their future prospects; Economic and regulatory considerations of plant molecular farming

Suggested Readings / Books:

1. Plant Biotechnology by Slater, A., Scott, N.W., and Fowler, M.R., Second Edition, Oxford University Press (2008).
2. Principles of Gene Manipulation and Genomics by Primrose, S.B. and Twyman, R.M., Seventh Edition, Blackwell Publishing (2006).
3. Biotechnology by Satyanarayana, U., Books and Allied (P) Ltd. (2005).
4. Biotechnology-an Introduction by Barnum, S.R., Thompson Brooks/Cole (2007).
5. Molecular Biotechnology by Primrose, S.B., Second Edition, Panima Publishing Corporation (2001)

BTBT906 Molecular and Cellular Diagnostics

Objective: The students will learn various kinds of diseases and disorders and the techniques used for their diagnosis. The students will also be acquainted with general rules of working in diagnostic laboratory.

Unit I – General Clinical Laboratory Techniques & Procedure: Chemical & related substrates used in clinical laboratories, volumetric analysis, balancing & weighing, concept of solute & solvent, units of measurement, specimen collection (blood, urine, spinal fluid, saliva synovial fluid, amniotic fluid), preservation, transportation, sensitivity and specificity, receiver operator characteristics, interpretation of tests

Unit II – Quality Management: Fundamentals of total quality management, element of QAP, external quality assessment and proficiency testing programme, GMP, GLP and records

Unit III – Disorders: Biochemical disorders, immune disorders, infectious diseases, parasitic diseases, genetic disorders chromosomal disorders, complex traits, chromosomal disorders: autosomal; sex chromosomal, haemoglobinopathies, neuro-developmental disorders, neuro-degenerative disorders

Unit IV – Product Development: Assay development, evaluation, and validation, reagent formulations and shelf life evaluation, data analysis, documentation, registration and diagnostics start-ups

Unit V – Clinical Enzymology: Principle of diagnostic enzymology, liver, cardiac and skeletal enzyme, digestive enzyme, miscellaneous enzyme, liver function test, cardiac function test, renal function test, thyroid function test, reproductive endocrime function test

Unit VI – Immunodiagnostics and DNA based Diagnostics: Introduction, antigen-antibody reactions, conjugation techniques, antibody production, enzymes and signal amplification systems, separation and solid-phase systems, case studies related to bacterial, viral and parasitic infections, PCR, ligation chain reaction, southern blot diagnostics, array-based diagnostics, DNA sequencing, genetic profiling, single nucleotide polymorphism, RFLP, SSCP, microarrays, FISH, in situ hybridization, DNA diagnostics related to bacterial, viral and parasitic infections

Unit VII – Cell based Diagnostics and Biosensors: Karyotype analysis, G-banding, FISH, cancer cytogenetics (spectral karyotyping), antibody markers, CD markers, FACS, HLA typing, bioassays, biosensors for personal diabetes management, non-invasive biosensors in clinical analysis, introduction to biochips and their application in modern sciences, nanobiosensors

Suggested Readings / Books:

1. Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R. Ashwood, Harcourt Brace & Company Aisa Pvt. Ltd.
2. Commercial Biosensors: Graham Ramsay, John Wiley & Son, INC. (1998).
3. Essentials of Diagnostic Microbiology, Lisa Anne Shimeld.
4. Tietz Text book of Clinical Biochemistry, Burtis & Ashwood.
5. The Science of Laboratory Diagnosis, Crocker Burnett.

BTBT907 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.

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 Readings/ 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

BTBT705 Biotech Lab – XIV (Bioprocess Technology Lab)

1. Isolation of industrially important microorganisms for microbial processes
2. Determination of thermal death point and thermal death time of microorganisms for design of a sterilizer.
3. Determination of growth curve of a supplied microorganism and also determine substrate degradation profile and to compute specific rate and growth yield from the data obtained.
4. Estimation of Monod parameters
5. Cultivation of microorganism in batch and continuous process
6. Comparative studies of ethanol production using different substrates
7. Microbial production of antibiotics (Penicillin)
8. Production and estimation of alkaline protease
9. SauerKraut fermentation
10. Use of alginate for cell immobilsation

BTBT706 Biotech Lab – XV (Downstream Processing Lab)

1. Conventional filtration
2. Protein precipitation and recovery
3. Aqueous two phase separation
4. Ion exchange chromatography
5. Gel filtration
6. Membrane based filtration i.e. microfiltration and cross filtration in cross flow modules

BTBT707 Biotech Lab – XVI (Genomics and Proteomics Lab)

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

BTBT708 Seminar

Guidelines for presenting a seminar

1. The tentative list of topics for Seminar shall be notified in the previous semester.
2. The students are advised to discuss with the concerned mentors, and get it approved by the HOD. The entire process should be completed within 5 days of notification on website. The students can as well suggest a topic not included in the list.
3. During the semester break / vacation, students are expected to work on the Seminars individually.
4. Students are advised to contact the mentors, as and when required, for discussion regarding the seminars. Consultation session with the mentors should be arranged as per mutual convenience.
5. The students shall be required to submit the rough draft of the seminar outputs within one month of reopening of college (following the semester exams) to their respective mentor.
6. Mentor shall make suggestions for modification in the rough draft. The final draft shall be presented by the student thereafter.
7. Presentation schedules will be prepared by the Department in line with the academic calendar.

The Seminars shall be evaluated as follows:

The student should collect information from various sources on the topic and collate them in a systematic manner. He/ She may take the help of the concerned mentors on mutually agreed time and place in this regard. The report should be typed in "MS-Word" file with "Times New Roman" fonts, with font size of 20 for main heading, 14 for sub-headings and 12 for the body text. The contents should also be arranged in Power Point Presentation with relevant diagrams, pictures and illustrations. It should normally contain 20 to 30 slides consisting of the followings:

1. Topic, name of the student & mentor	1 Slide
2. List of contents	1 Slide
3. Introduction	1-3 Slides
4. Descriptions of the topic (point-wise)	7-12 Slides
5. Images, circuits etc.	6-10 Slides
6. Conclusion	1-2 Slides
7. References, Bibliography	1 Slide

Note: Duration of the presentation should be 20 – 25min

Soft and hard copy of the seminar presentation should be sent by email to the concerned mentor, with a copy to the HOD within 7 days after presentation.

Evaluation of the presentation shall be done by a team comprising of the mentor, HOD and/or his nominees.