PROCEEDINGS OF THE MEETING OF B.O.S. (PG) IN MICROBIOLOGY AND BIOTECHNOLOGY

The meeting of the B.O.S. (PG) in Microbiology and Biotechnology was held on **25th June, 2014** in the Department of Microbiology and Biotechnology, Bangalore University, Bangalore. At the outset, the Chairman welcomed the members and initiated the proceedings.

Agenda-1: The Choice Based Credit System (CBCS) for M.Sc. in Microbiology and Biotechnology, and the Syllabus (theory and practical) for I, II, III & IV Semesters were finalized and approved.

Agenda-2: The panel of examiners for PG Microbiology and Biotechnology (both external and internal) was modified and approved for the year 2014-15.

Agenda-3: The B.O.S. approved the panel of examiners for adjudication of Ph.D. thesis of the following candidates.

1. Mr. Divakara Y. G.
2. Ms. Chandrika R.
3. Ms. Vyshali P.
4. Ms. Sarvamangala
5. Mr. Sumantha M.G.
6. Ms. Sumalatha K. R.
7. Mr. Lakshmeesha T. R.
8. Mr. Mohammad Shafi Sofi
9. Ms. Vedashree S.
10. Ms. Soumya K.

The meeting concluded with the Chairman thanking all the members for their co-operation.

Members present:

1. Prof. M. Rajashekara
2. Prof. Ravishankar Rai
3. Prof. K. Manjunath
4. Prof. S. Chidananda Sharma
5. Dr. D. Manjulakumari
6. Dr. J. Savitha
7. Prof. S.K. Sarangi (Chairman)

25/6/14

25/6/14

M.Sc. BIOTECHNOLOGY (CBCS)
(Effective from the academic year 2014-2015)
SCHEME OF INSTRUCTIONS AND EXAMINATION
SEMESTER SCHEME

Paper No.	Title of the paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA	EA	Maximum Marks	Credits
I Semester		**Theory**						
BTH-101	Cell Biology	H Core	4	3	30	70	100	4
BTH- 102	Molecular Genetics	H Core	4	3	30	70	100	4
BTH -103	General Microbiology	H Core	4	3	30	70	100	4
BTH- 104	Biochemistry	H Core	4	3	30	70	100	4
BTS -105	Biostatistics	S Core	2	2	15	35	50	2
		Practical						
BTP- 106	Cell Biology and Molecular Genetics	Pract	4	4	30	70	100	4
BTP- 107	General Microbiology and Biochemistry	Pract	4	4	30	70	100	4
Total Marks and Credits							650	26

II Semester		**Theory**						
BTH- 201	Enzymology and Biochemical techniques	H Core	4	3	30	70	100	4
BTH- 202	Immunology and Immunotechnology	H Core	4	3	30	70	100	4
BTH- 203	Molecular Biology	H Core	4	3	30	70	100	4
BTH- 204	Environmental Biotechnology	H Core	4	3	30	70	100	4
BTS- 205	Bioinformatics	S Core	2	2	15	35	50	2
		Practical						
BTP- 206	Enzymology and Immunology	Pract	4	4	30	70	100	4
BTP- 207	Molecular Biology, Bioinformatics and Environmental Biotechnology	Pract	4	4	30	70	100	4
Total Marks and Credits							650	26

Paper No.	Title of the paper	Type of paper	Periods/ Week	Duration of Exam (Hours)	IA	EA	Maximum Marks	Credits
III Semester		**Theory**						
BTH- 301	Plant and Agricultural Biotechnology	H Core	4	3	30	70	100	4
BTH- 302	Animal Biotechnology	H Core	4	3	30	70	100	4
BTH- 303	Genetic Engineering	H Core	4	3	30	70	100	4
BTO- 304	Open Elective : Applied Biotechnology	O E	4	3	30	70	100	4
		Practical						
BTP- 305	Plant, Agricultural and Animal Biotechnology	Pract	4	4	30	70	100	4
BTP- 306	Genetic Engineering and Bioinformatics	Pract	4	4	30	70	100	4
BTP- 307	Industrial and Institutional Visit	Report					50	2
Total Marks and Credits							650	26

IV Semester		**Theory**						
BTH- 401	Bioprocess Engineering	H Core	4	3	30	70	100	4
BTH- 402	Medical Biotechnology	H Core	4	3	30	70	100	4
BTH- 403	Genomics and Proteomics	H Core	4	3	30	70	100	4
		Practical						
BTP- 404	Bioprocess Engineering, Medical Biotechnology	Pract	4	4	30	70	100	4
BTP- 405	Project Work/ Dissertation						100	4
	Project Viva						50	2
	Total Marks and Credits						550	22
						Grand total Marks and Credits	**2500**	**100**

Scheme of valuation:

1. Continuous evaluation in theory papers: 10 marks for test, 5 marks for assignment, 10 marks for seminar and 5 marks for attendance.
2. Practical examinations-each practical examination shall carry 70 marks, 10 marks shall be allotted for viva voce to be conducted during each practical examination.
3. Practical IA: 5 marks for Record, 15 marks for test and 10 marks for attendance.

PROJECT WORK

1. Proposed to carry out the project work individually or in group to a maximum of 3 or 4 students.
2. Project shall be allotted at the beginning of the III semester to facilitate students to carry out during semester break.
3. In house projects are encouraged.
4. Students may be allowed to carry out the project work in other research institutes.
5. Faculty members of the respective colleges/ university department must serve as guides
6. Co- guides from the other institutions may be allowed.
7. One copy of the dissertation to be submitted to the University for evaluation.
8. **Evaluation of dissertation** has to be done by the two external examiners appointed by the University for **100 marks.**
9. The **project viva voce examination** will be held at the University Department by the BOE for **50 marks** (25 marks for the presentation, 25 marks viva voce).

SCHEME OF THEORY EXAMINATION
(Hard Core)

Time 3 Hours Max. Marks 70

Section A
Write brief notes on **any five** of the following 5 x 3 =15
1-7 questions

Section B
Answer **any four** of the following 5 x 5 = 25
8-14 questions

Section C
Answer **any two** of the following 2 x 15 = 30
15-18 questions

SCHEME OF THEORY EXAMINATION
(Soft Core)

Time 2 Hours Max. Marks 35

Section A
Write brief notes on **any five** of the following 5 x 2 =10
1-7 questions

Section B
Answer **any two** of the following 2 x 5 = 10
8-11 questions

Section C
Answer **any one** of the following 1 x 15 = 15
12-14 questions

SCHEME OF PRACTICAL EXAMINATION

Question No.	Experiment	Marks
1	Major experiment/s	40
2	Minor experiment/s	20
3	Viva voce	10
	Max Marks	70

I SEMESTER (THEORY)

BTH- 101: CELL BIOLOGY

Course Objectives:

The course aims at: 1) Illustration of the basic characteristics of the cell and provide the students an understanding of the differences and similarities between prokaryotic and eukaryotic cells. 2) Explaining the constitution and components of a cell. 3) To emphasize on the importance of cell signaling and their pathways 4) To understand the structure and functions of specialized cells.

Total Hours: 52

Unit 1

Basic Characteristics of the Cell:

Structure, organization and composition of prokaryotic and eukaryotic cell. Plasma membrane- structure and functions, membrane models. Components of Blood & their functions (Plasma, RBC, WBC, Platelets). Extracellular matrix (collagen, proteoglycans, fibronectin, lamins).

8 Hours

Unit 2

Cytoskeleton:

Nature of cytoskeleton, Actin filaments, actin binding proteins, Intermediate filaments, Microtubules, MAPs, Structure and functions of cilia and flagella.

8 Hours

Unit 3

Membrane Transport:

Transport across membrane- passive diffusion, osmosis, active transport, Ion Channels, A B C transporters, Na^+ and K^+ pump, Ca^{2+} ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicular traffic.

8 Hours

Unit 4

Cell Signalling:

Cell to cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction- Tight and gap junctions, Desmosomes, plasmodesmata. General principles of cell signaling, signaling via G-protein coupled receptors, kinase receptors, role of secondary messengers.

8 Hours

Unit 5

Cell Cycle:

Molecular events of cell division and cell cycle, regulation of cell cycle events- Cyclins, Cyclin dependent kinases, inhibitors. Apoptosis, necrosis

Unit 6 **Specialized Cells (Muscle & Nerve cells):** Structure & functions of muscles (Straited, nonstraited and cardiac). Molecular basis of muscle contraction. Structure of neuron, neuroglia. Mechanism of nerve transmission- Resting and action potential, electrical and chemical transmission, Neurotransmitters and their receptors.

Unit 7

Antioxidant defence system and Senescence:

Free radicals- ROS, RNS. Effect of free radicals on Proteins, Lipids and Nucleic acids. Mechanism of antioxidant defence system- enzymatic and non-enzymatic. Senescence-theories and concepts of aging.

6 Hours

References:

1. Matthews, C.A. (2003). Cellular physiology of nerve and muscle. 4th Edn. Blackwell publishers.
2. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., Watson, J.D. (1994). Molecular Biology of the Cell.
3. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
4. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
5. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
6. Garrett, R.H., Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
7. Holy Ahern (1992). Introduction to Experimental Cell Biology, Wm. C. Brown Publishers.
8. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
9. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.
10. Tobin and Morel (1997). Asking about "Cells" Saunders College Publisher.
11. Wolfe, S.L. (1991). Molecular and Cellular Biology, Wordsworth Pub.Co.
12. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.
13. Kanugo, M.S. (2002) Genes and aging. Cambridge University Press.

Course Learning Outcomes:

The students will be able to:

- Understand the Structure and function of organelles in a cell. Cellular transport and protein trafficking, Cell signaling and cancer pathways
- Understand the coordination and function of different cell organelles to develop a functional cellular structure
- Understand the process of membrane transport and its importance.
- Learn the concepts of cycle cycle regulation and able to analyze and apply its diverse roles in cancer cell research

BTH- 102: MOLECULAR GENETICS

Total Hours: 52 Hours

Course Objectives:

The course aims at:

- Illustration of the basics of genetics and inheritance and provide the students an understanding of the molecular basis of genetics and Mendel's fundamental work on genetics.
- Explaining the concepts of Mendelian genetics and its exceptions
- Making the student understand mutation, recombination and transposable elements
- Explaining the molecular basis of evolution
- Explaining population genetics and application of Hardy-Weinberg principle

Unit 1

Physical basis of Heredity

Introduction, concepts and theories of Mendelian genetics, chromosome theory of inheritance, Nucleus, nucleolus and extra chromosomal inheritance.

6 Hours

Unit 2

Chromosomes and Genes:

Structure and organization of eukaryotic chromosomes: Super coiled loops, domains and scaffolds in eukaryotic chromosome. Difference between interphase chromatin and mitotic chromosomes. Heterochromatin, euchromatin and telomeres. Nucleosomes- Organization of DNA in the nucleosome, histone octomer. Split genes and overlapping genes, gene interaction. Human chromosomal aberrations, karyotype analysis- normal and abnormal karoyotype.

10 Hours

Unit 3

Genetic Recombination:

Mechanism of recombination, Holliday, White house and Radding models, Enzymes involved in homologous and site specific recombination. Breakage and reunion of DNA at specific sites. Synapsis of homologous duplexes, role of RecA in recombination. Topological manipulation of DNA

Bacterial Recombination-Transformation, conjugation, transduction, plasmids and episomes- Application in genome mapping of *E. coli*.

10 Hours

Unit 4

Transposable Genetic Elements:

Transposons – Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposans, Tn3 elements, Ac and Ds elements, P elements, Retrotransposons and their significance. Transposable elements in human and their genetic and evolutionary significance.

8 Hours

Unit 5

Mutation:

Base pair and frame shift mutation, genetic suppression. Molecular basis of mutation – spontaneous and induced mutation and their role in evolution. Detection of mutation – Ame‟s test, Mutation in – yeast, neurospora and chlamydomonas. Mutation studies in drosophila and human disorders by mitochondrial genome mutation.

10 Hours

Unit 6

Sex Determination and Dosage Compensation:

Sex determination in Drosophila and mammals. Secondary sex determination in mammals. Dosage compensation in Drosophila and mammals.

4 Hours

Unit 7

Population Genetics:

Gene pools, allele frequencies, Hardy Weinberg equation, non random breeding, genetic drift,gene flow, selection, speciation. Protein and DNA sequence polymorphism, molecular basis of evolution in Homosapiens.

4 Hours

References:

1. David Freifelder. (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
2. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004). Molecular cell biology. Scientific American Books Inc., NY.
3. Gardner/Simmons/Snustad. (2006). Principal of Genetics. 8th Edn. John Wiley & sons.
4. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.
5. Dale, J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
6. Streips and Yasbin. (2001). Modern microbial Genetics. Niley Ltd.
7. John Ringo (2004). Fundamental Genetics. Cambridge University Press.

Course Learning Outcomes:

The students will be able to:

- Understand the genetic basis of heredity, Mendelian and non- Mendelian modes of inheritance.
- Understand basics of genetic recombination and transposons
- Explain the different types of sex determination system in different organisms
- Learn the concepts of gene and allele frequencies and able to analyze and apply the Hardy-Weinberg equilibrium for population genetics.

BTH-103: GENERAL MICROBIOLOGY

Total Hours: 52

Course Objectives:

This course aims at:

- Introducing the student to the world of microbes with the updated classification of viruses, bacteria, fungi, algae and protozoa.
- Elucidating the different methods used for the identification and characterization of microbes
- Elaborating the structural and functional features of different microbes.
- Explaining the growth characteristics and requirements of microbes

Unit 1

Microbial classification:

Three domain system of classification, Phylogenetic Relationships, Code for bacterial nomenclature and taxonomy, Criteria for microbial classification-morphological, staining techniques, biochemical methods, serological techniques, phage typing, fatty acid profiles, Flow cytometry, DNA base composition, DNA fingerprinting, rRNA sequence, Nucleic acid hybridization, Numerical Taxonomy, Chemotaxonomy, Classification of bacteria according to Bergey's Manual of Systematic Bacteriology, Dichotomous keys, Cladograms, dendrograms, universal phylogenetic tree.

12 Hours

Unit 2

Prokaryotic Microorganism- General properties, Structure, and Reproduction:

Domain Bacteria: Proteobacteria (Alpha, Beta, Gamma, Delta and Epsilon Proteobacteria), Cyanobacteria, Chlorobium, Firmicutes, Actinobacteria, Chlamydiae, Spirochaetes, Bacteroidetes, Fusobacteria. Domain Archea: Crenarchaeota, Euryarchaeota.

10 Hours

Unit 3

Eukaryotic Microorganisms- General characters, Structure and Reproduction:

Fungi (Saccharomyces), Algae (Spirulina), Protozoa (Plasmodium), Slime molds (Physarum)

8 Hours

Unit 4

Viruses, Virioids and Prions (Acellular entities)

General characters, Structure, Criteria for classification of Viruses, Viruses that affect humans, animals and plants, Isolation, cultivation and identification of Viruses (Growing in Bacteria, Living Animals, embryonated eggs, Cell Cultures). Viral Multiplication (Lytic and lysogenic life cycle), Virioids and Prions - General properties and diseases caused by virioids and prions.

10 Hours

Unit 5

Microbial Growth and Control

Physical parameters (Temperature, pH, Osmotic Pressure), Chemical parameters (Carbon, Nitrogen, Phosphorous, Sulphur, Trace elements, oxygen), Growth factors, Culture Media, Phases of Growth, Growth Measurements, Microbial growth control -Physical methods (Heat, Pasteurization, Filtration, Radiation, Dessication, Low Temperature, High Pressure, Osmotic Pressure) and Chemical Methods (Phenols, Halogens, Alcohols, quaternary ammonium compounds).

6 Hours

Unit 6

Microbiological methods:

Isolation and cultivation of microorganisms from Water, Soil, Air, Rhizoshere, Phyllosphere and Mycorrhiza, Biogeochemical cycle.

6 Hours

References:

1. Microbiology by MJ Pelczar Jr, ECS Chan, NR Krieg 5th Edition, Pub: Tata Mcgra-Hill Publishing Co Ltd.
2. Introductory Microbiology by Heritage Pub Heritage
3. General Microbiology by Stainer Pub; Ingraham and Wheeler (McMillan)
4. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc.N.Y.
5. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2nd Edition, Milan Publishing Co.
6. Brock T.D. and Madigan M.T (1992) Biology of Microorganisms 6th Edn. Prentice Hall, Eagle wood cliffs N.j.
7. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T (1994) Bergey‟s Manual of Systemic Bacteriology 9th Edn. William and Wilkins, Baltimore.
8. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers

Course learning outcomes:

At the end of this course the student should:

- Have a basic understanding of the basis of and the latest method of microbial classification including the techniques used
- Be able to broadly classify microbes based on their structural and functional characteristics of microbes
- Be familiar with general microbiological methods and techniques used to study the growth and control of microbes in air, water, soil and other environments

BTH- 104 BIOCHEMISTRY

Total Hours: 52

Course Objectives:

This course aims at:

- Introducing the student to the four major classes of biomolecules including carbohydrates, lipids, proteins and nucleic acids
- Elaborating the structural and functional characters of different biomolecules
- Elucidating the different metabolic pathways for carbohydrate and lipid metabolism
- Explaining the energy generated from the catabolism of various biomolecules

Unit-1

Principles of Bioenergetics:

Introduction, Laws of thermodynamics, Gibbs free energy, Relationship of Standard free energy to enthalpy, entropy and equilibrium constant, High energy compounds, ATP as universal currency of free energy, Oxidation-Reduction Reactions, Electromotive force, Half reactions, Redox potentials, Relationship of standard redox potential and standard free energy change. Standard redox potentials of some biologically important Half reactions.

6 Hours

Unit-2

Oxidative phosphorylation:

Electron transport chain, Electron transfer reactions in mitochondria, Electron carriers, Ubiquinone, Cytochromes, Iron sulfur centers, Methods to determine sequence of electron carriers, Fractionation of Multi enzyme complexes I, II, III, IV of Mitochondria and their inhibitors, Oxidative phosphorylation, ATP synthesis, Chemiosmotic model, Proton gradient, Structure of ATP synthetase, Mechanism of ATP synthesis, Brown fat, Regulation of Oxidative phosphorylation.

8 Hours

Unit-3

Carbohydrates:

Classification, structure and Properties of mono, oligo and polysacharides. Chirality and optical activity, stereoisomerism, cyclic structure of monosaccharide, (pyranoses and furanoses) , structures of glucose. absolute and relative configuration (D & L and R & S nomenclature). Derived sugars- Sugar acids (Aldonic, Aldaric and Saccharic acids), Amino sugars. Disaccharides-structures of Maltose, Lactose, Sucrose, Trehalose, Raffinose. Polysaccharides- structure and properties of homo and hetero polysaccharides. Storage polysaccharides. (Starch, Glycogen, cellulose, chitin) Glycosamino glycans and glycoproteins.

Carbohydrate metabolism: Glycogenolysis, Glycogenesis, Coordinated regulation of Glycogen metabolism. Glycolysis-Energetics and Regulation, Fermentation reactions (Lactic

acid and alcoholic fermentation), Gluconeogenesis, Reciprocal regulation of Glycolysis and Gluconeogenesis, Citric acid cycle- Energetics and regulation, Glyoxylate cycle. Pentose phosphate pathway.

12 Hours

Unit- 4

Amino acids and proteins:

Classification, structure and properties of amino acids, reactions of amino acids, peptide bond. Classification of proteins- Structural organisations of proteins (primary, secondary, tertiary and quarternary), conformational analysis, Ramachandran's plot. Thermodynamic aspects of protein folding.

General aspects of amino acid metabolism: Transamination, Deamination, Decarboxylation, basic glutamine and glutamic acid pathways, urea cycle and its regulation, formation of uric acid.

10 Hours

Unit-5

Lipids:

Classification- Structure, properties, reactions and biological functions of lipids. Phospholipids, Sphingo and glyco lipids, Steroids-cholesterol-bile salts, steroid hormones.

Metabolism of Lipids: Beta oxidation of Fatty acids-activation, transport to mitochondria, Beta oxidation reactions. Oxidation of unsaturated fatty acids. Alpha and omega oxidation. Biosynthesis of saturated and unsaturated fatty acids and cholesterol. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).

10 Hours

Unit-6

Nucleic acids:

Structure and properties- Bases, Nucleosides, Nucleotides, Polynucleotides.

Nucleic acid metabolism: Biosynthesis of purines and pyrimidines, Denovo and Salvage pathways, biodegradation of purines and pyrimidines.

6 Hours

References:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
3. Mathews, Van Holde and Ahern, Biochemistry by 3rd edition, Pub Pearson education
4. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
8. Zubey, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

9. Edwards and Hassall. Biochemistry and Physiology of the cell 2nd Edn. McGraw Hill Co. UK. Ltd.

Course learning outcomes:

At the end of this course, the student should be able to:

- Draw the molecular structures of simple and complex carbohydrates lipids, proteins and nucleic acids
- Have a comprehensive understanding of the three dimensional structure of biomolecules
- Relate structure with the general and special functions of biomolecules
- Explain the different metabolic pathways and their importance

BTS-105 BIOSTATISTICS
(Soft core)

Course Objectives:

The course aims at:

- Introducing some fundamental concepts mean, mode, median and percentiles.
- Providing understanding of the basic concepts of Probability and Probability Distribution
- Understanding of Statistical Quality Control, Correlation and regression analysis,Testing Hypothesis and Analysis of variance.
- Exploring the connection between basics as well the advance tools of the subject to demonstrate the link between theory and its real world applications

Total Hours: 26

Unit 1:

Introduction to Bio-statistics, basic concepts, data types. Need for statistical techniques for biological applications, replicable data, Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations.
Frequency distribution, Arithmetic mean, mode, median and percentiles. Measures of Variability: Range, mean deviation. standard deviation and co-efficient of variation.

Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis and their various measures, percentiles Simple linear correlation and regression analysis. Analysis of variance.
Population and sample: Random sample, use of table of random numbers, parameter and statistics, sampling distribution of sample means, Standard error; confidence intervals.

14 Hours

Unit 2:

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions and a few simple problems. Statistical Inference- Estimation, standard error, confidence interval for means and proportion. Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square and F distributions, interpretation of „p" value.
Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical programme.

12 Hours

References:

1. Daniel (1999). Biostatistics (3rd edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
8. Wiley and Sons, Inc. NY.

Course Learning Outcomes:

The students will be able to:

- Understand the basics of mean, median, mode and percentiles.
- Remember and understand the Probability and Probability Distribution.
- Understand the Statistical Quality Control, Correlation and regression analysis.
- Learn to understand, analyze, and apply The Testing of Hypothesis and Analysis of variance in SPSS software.

I SEMESTER (PRATICAL)

BTP-106: CELL BIOLOGY AND MOLECULAR GENETICS

Total Units: 16

Course objective:

This course aims at:

- Preparing students to learn mounting and staining of polytene chromosomes, Barr bodies
- Visualise chromosomes by karyotyping
- Performing genetic studies, solving theoretical problems
- Isolation and determination of organelles and their functions in terms of enzyme activity

1. Mounting of polytene chromosomes
2. Mounting of Barr bodies
3. Study of Karyotyping in onion, humans (normal and abnormal)
4. Study of mutation in E.coli by UV light
5. Demonstration of multiple allele by blood group in humans
6. Mounting of imaginal discs of drosophila
7. Study of Drosophila mutant type
8. Problems on (a) law of segregation (b) Independent assortment (c) Sex linked inheritance (d) population genetics
9. Study of mitosis by using onion root tips
10. Study of meiosis
11. Isolation of nucleus and determination of its purity
12. Isolation of mitochondria and determination of purity
13. Isolation of chloroplast by sucrose density gradient and determination of its purity
14. Determination of the rate of active transport of glucose across the intestinal membrane
15. Determination of muscle ATPase activity
16. Determination of acetylcholine esterase activity in the rat brain

Course outcome:

- Students will be able to visualize polytene chromosomes, Barr bodies and know their general characteristics
- They can study the morphology of chromosomes
- Learn both theoretical and practical approach of solving genetic problems
- Visualise organelles and know their functions through enzyme activity

BTP- 107: GENERAL MICROBIOLOGY AND BIOCHEMISTRY

Total Units: 16

Course Objective:

1) To make students prepare the various nutrient media, sugar media and media for culturing and biochemical tests. 2) To make the students perform the various staining such as endospores staining, nuclear material staining, capsule staining. 3) To make the students perform the various techniques of isolation, biochemical characterization and enumeration of microorganisms. 4) To make students perform estimation of biomolecules such as sugars, aminoacids, proteins.5) To make students determine lipid characteristics.

1. Determination of pI of amino acid by titration method
2. Estimation of glucose by Hagerdon and Jensen method
3. Estimation of total sugar by Anthrone method
4. Estimation of amino acid by Ninhydrin method
5. Estimation of protein by Lowry‟s method
6. Estimation of inorganic phosphate by Fiske-Subbarow method
7. Determination of (a) Iodine number and (b) Acetyl number of a lipid
8. Separation of amino acids by paper chromatography and TLC
9. Microbes culture in broth and solid media, Colony characteristics and Counting of colony (serial dilution method)
10. Bacterial growth assessment by turbidometry
11. Staining techniques (a) Simple staining (b) Gram staining (c) Endospore staining (d) Capsule staining (e) AFB staining (f) negative staining
12. Biochemical tests (a) Indole test (b) Methyl red test (c) Voges Proskaeur test (d) Citrate utilization test (e) Triple sugar vion agar test (f) Starch hydrolysis test (g) Gelatin hydrolysis test (h) Catalase test (i) Oxidase test
13. Soil Microbiology Isolation microflora of (a) rhizosphere (b) phylloplane (c) actinomycetes (d) Rhizobium from legume of root nodules (e) Sporocarp by sieve method (f) identification of Rhizobium and agrobacterium
14. Air Microbiology Isolation of air microflora (a) exposure plate method (b) rotorod sampler method.
15. Water Microbiology: Testing of quality of water (coliform test), H2S strip method.
16. Estimation of lactate/ Citrate from bacterial culture media

Course outcome:

1) Students would be able to prepare the various nutrient media, sugar media and media for Biochemical tests. 2) Students would be able to perform the staining of endospores, nuclear material and capsule of bacteria. 3) Students will be able to perform the various techniques of isolation, biochemical characterization and enumeration of microorganisms. 4) Students will be able to perform estimation of biomolecules. 5) Students will be able to determine lipid characteristics.

II SEMESTER (THEORY)

BTH-201: BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY

Total Hours: 52

Course outline:
This course aims at:

- Introducing various techniques used in the separation and structural characterization of molecules
- Elucidating the classification, properties and requirements of enzymes
- Elaborating the importance of coenzymes and cofactors for enzyme reactions

Unit 1

Physical Techniques:
Principles and applications of Rayleigh scattering, viscometry. Absorption, adsorption, crystallization, x-ray crystallography spectrophotometry, fluorimetry, flame photometry, mass spectroscopy.
Distillation, liquid - liquid extraction
Centrifugation, differential, gradient, ultra centrifugation, salt fractionation and dialysis.

10 Hours

Unit 2

Chromatographic Techniques
Principles and applications of gel filtration- ion exchange chromatography-thin layer chromatography-affinity chromatography- gas chromatography, high performance liquid chromatography (HPLC).

8 Hours

Unit 3

Electrophoresis
Principles and applications of moving boundary electrophoresis, zone electrophoresis, gel electrophoresis-PAGE and SDS PAGE agarose gel electrophoresis, isoelectric focusing and 2D Gel electrophoresis. Pulsed field electrophoresis.

6 Hours

Unit 4

Enzyme catalysis
Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, activation energy, factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Types of enzyme specificity, units of enzyme activity. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. Enzyme single and multi substrate reactions. Ping-pong mechanism, sequential mechanism (ordered and random), enzyme models - host guest complexation chemistry.

8 Hour

Unit 5

Enzyme Kinetics and Mechanism of Enzyme catalysis

Chemical kinetics, rate of reaction, order of reaction, zero order and first order. Derivation of michaelis-menton equation, km value and its significance, lineweaver-burk plot. Velocity maximum. Mechanism of enzyme action, lock and key model, induced fit hypothesis, substrate strain theory (with lysozyme as a typical example). Mechanism of enzyme catalysis - Acid-Base catalysis, Covalent catalysis, metal ion catalysis and entropy effect. Enzyme inhibition-reversible and irreversible, competitive, uncompetitive, non competitive. Regulation of enzyme activity – Covalent modulation, Allosteric regulation, ligand interactions, scatchard plot, co-operative interactions, feedback regulation. Isozymes.

12 Hours

Unit 6

Coenzymes

Structure and mechanism of action of some important co-enzymes NAD+, FAD, FMN, TPP, pyridoxal phosphate, lipoic acid, CoASH and vitamin B12

8 Hours

References:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4th edition Pub WH Freeman Co.
2. Daniel, L, Purich, Melvin, I. Simon, John, N., Abelson. (2000). Contemporary enzyme kinetics and mechanism.
3. Plowman. (1972). Enzyme kinetics. McGraw hill.
4. Jack kite. (1995). Mechanisms in protein chemistry, Garland publishers.
5. Gerhartz, W. (1990). Enzymes in industry: Production and applications. VCH publishers, NY.
6. Chaplin, M.F., Bucke, C. (1990). Enzyme technology. Cambridge university press, Cambridge.
7. Belter, P.A.,Cussier, E. (1985) Wiley Bio separations .
8. Asenjo, J. Dekker, M. (1993) Separation processes in biotechnology.
9. Upadhyay and Nath (2003). Biophysical chemistry, principles and techniques, Himalaya publishing house.

Course learning outcomes:

At the end of this course the student should:

- Be familiar with the principle and uses of important techniques for the separation of biomolecules
- Know the analytical techniques used in the structural characterization of biomolecules
- Understand the nomenclature and classification of enzymes
- Understand the different mechanisms of enzyme catalysis and regulation
- Appreciate the role of vitamins as coenzymes and metal ions as cofactors in enzyme catalysis

BTH-202: MOLECULAR BIOLOGY

Total Hours: 52

Course outline:
This course aims at:

- Familiarising the student with the structural and functional properties of DNA and RNA
- Elucidating the replication of DNA and repair mechanisms for damaged DNA
- Describing the steps involved in and regulation of transcription of DNA to RNA and the translation of mRNA to protein
- Relating protein sequence to organellar location

Unit 1

Structure and Properties of DNA and RNA:

Information flow in biological systems: Central dogma. Biochemical evidences for DNA as genetic material. Watson and Crick model of DNA, different forms of DNA (A, B, Z, C and D). Properties and types of DNA. UV absorption, Denaturation and renaturation, thermodynamics of melting of the double helix, kinetics of unwinding of the double helix, Interaction with small ions. Structure and functions of different types of RNA.

6 Hours

Unit 2

Replication:

Characteristics and functions of bacterial DNA polymerases, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication, Nearest neighbor frequency analysis. Eukaryotic DNA polymerases and mechanism of replication. Telomere synthesis-telomerases. Replication of viral DNA, rolling circle model. Inhibitors of replication

8 Hours

Unit 3

Transcription:

Characteristics and function of bacterial RNA polymerases, mechanism of transcription and regulation. Eukaryotic RNA polymerases- transcription factors, mechanism of transcription and regulation. Stringent response. Post transcriptional modifications of mRNA (5‟CAP formation, poly adenylation, mechanism of splicing, Group I, II and III, spliciosome assembly, splicing editing, Group IV splicing), stablility. Processing of tRNA and rRNA. Inhibitors of transcription. Ribozyme technology: mechanism of action and applications.

.

8 Hours

Unit 4

Translation:

Genetic code, Wobble hypothesis. Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and posttranslational modifications of proteins. Control of translation in eukaryotes (Antisense RNA, Heme and interferon).

8 Hours

Unit 5

Regulation of Gene expression:

Gene regulation, Operon model-Inducible and repressible systems, lac, gal, trp, his and arabinose operon; Attenuation, positive and negative regulation, role of cAMP and CRP in the expression of lac genes, catabolite repression, regulation of eukaryotic gene expression transcriptional control, cis control elements, promoters, enhancers, transacting factors, homeobox in the control of developments in insects and vertebrates. DNA binding motifs of transcription factors, posttranscriptional control.

10 Hours

Unit 6

Protein localization and Targeting:

Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxysomes and membrane.

5 Hours

Unit 7

DNA damage and Repair:

DNA damage- alkylation, deamination, oxidation, UV radiation. Repair mechanisms- photo-reactivation, excision repair, post replication repair, mismatch repair and SOS repair.

5 Hours

Unit 8

Gene Silencing:

Definition, types –transcriptional and post transcriptional gene silencing, RNAi pathway (si RNA and mi RNA).

2 Hours

References:

1. Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 1993.
2. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition
   Pub WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition,
   Pub. Oxford.
4. Mathews, Van Holde, Ahern, Biochemistry by 3rd edition, Pub Pearson education.
5. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
6. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
7. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
8. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
9. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.

10. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.

Course learning outcomes:

At the end of this course the student should:

- Know the structure and function of various types of DNA and RNA
- Understand the possible damage to DNA and mechanisms to repair the same
- Understand the process of transcription and the and importance of post-transcriptional modifications of mRNA
- Understand the process of translation and the importance of post translational modification
- Appreciate the mechanism of protein localization with respect to cellular structure

BTH-203: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Total Hours: 52

Course outline:
This course aims at:

- Giving the student a broad overview of the human immune system
- Elucidating the various cellular and soluble factors involved in the immune response
- Elaborating the importance of cell surface antigens in tissue compatibility
- Familiarising the student with relevant immunological techniques used for research, diagnostics and vaccine development

Unit 1: Immune system and Immune Response: Innate and acquired immunity, structure and functions of immune cells- T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophils, Neutrophils, Mast cells. Organs of immune system- Primary and secondary lymphoid organs. Primary and secondary immune response, Clonal selection theory.

10 Hours

Unit 2: Antigens and Antibodies: Structure and properties of antigens –Iso and alloantigens-antigen specificity, Haptens and adjuvants- structure and properties. Immunoglobulins-Structure and properties, types and subtypes. Generation of immunological diversity. Complement system- component, properties and functions. Complement pathways and biological significance.

8 Hours

Unit 3: Major Histocompatibility Complex and Transplantation: Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation- Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy.

6 Hours

Unit 4: Hypersensitivity Reactions: Allergy, Hypersensitivity reactions- types (I, II, III, and IV), symptoms, immunodiagnosis.
Lymphokines and cytokines : Interleukins and Interferons- Production, biological functions and assay methods. Immunological tolerance.

8 Hours

Unit 5: Autoimmunity and Immunomodulation: Autoimmunity- Autoimmune diseases- Hashimoto‟s disease, Systemic lupus erythematosus, Multiple sclerosis, Myasthenia gravis and their treatment. Immunomodulation(immunosuppression & immunostimulation), Immunotherapy, lymphocyte migration, homing and trafickking, antigen-induced lymphocyte proliferation, Granulysin mediated anti-microbial activity of T cells.

8 Hours

Unit 6: Immunological Techniques: Agglutination, precipitation, immune-fluorescence, immunoelectrophoresis, immunoblotting, ELISA, RIA, Flow cytometry. Production and purification of antibodies, determination of antibody titre by RID and EID, production of hybridoma.

T- cell cloning:Mechanism of antigen recognition by T and B -lymphocytes, Importance of antigen and MHC class II molecules in T-cell cloning. Antigen specific and alloreactive T-cell cloning - immunologically relevant antigens and T cell subtypes. Applications in vaccine development.

8 Hours

Unit 7: Immunization: Vaccines- conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies, Immune stimulatory complexes. Common immunization programmes- BCG, small pox, DPT, polia, measles, Hepatitis-B.

4 Hours

References:

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ.NY.
3. Borrebacc, C.A.K. (1995). Antibody Engineering, 2nd eidtion. Oxford University Press.
4. Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd.Oxfird.
5. Hyde, R.M. (1992). Immunology, 2nd edition, Williams and Wilkins, Baltimore.
6. Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
7. Klaus D. Elgert (1996). Immunology. ELBS, Blackwell Scientific Publishers, London.
8. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers, London.
9. Richard A., Goldsby, Thomas, J., Kindt, Barbara, A., Osborne (2000). Kuby Immunology, 4th edition. W.H. Freeman and Company, NY.
10. Tizard I.R.(1995). Immunology, 4th edition, Saunder College Pub.
11. William E Paul (1989). Fundamentals in Immunology, Raven Press. NY.

Course learning outcomes:

At the end of this course, the student shall:

- Be familiar with the cells of the immune system including T & B cells and antigen presenting cells
- Be able to relate the role of humoral factors such as antibodies and cytokines in mounting of an immune response
- Understand the adverse effects of an overactive immune system in allergies and autoimmune disorders
- Appreciate the importance of antigens in tissue compatibility and graft rejection
- Be thorough with important techniques such as ELISAs, flow cytometry, hybridoma technology and should be able to apply these in vaccine development

BTH-204: ENVIRONMENTAL BIOTECHNOLOGY

Total Hours: 52

Course outline:

This course aims at:

- Giving the student an overview of environmental pollution and the use of biological techniques to alleviate its effects
- Elucidating the steps involved in the treatment of biowaste, waste water and ways to reduce greenhouse gases and acid rain
- Explaining the pros and cons of the use of biological sources of fuels, recovery of metals and removal of toxic waste
- Instilling the importance of conservation of environment and biodiversity

Unit 1

Environment and monitoring: Introduction, renewable and non-renewable sources of energy; Enviromental pollution- water pollution, soil pollution and air pollution-sources. Xenobiotic compounds and their sources, Biomagnification, Bioindicators.

Biomonitoring: Biosensors and biochips.

8 Hours

Unit 2

Water Management and waste water treatment: Water as a scarce natural resource, water management including rain water harvesting. Waste water characteristics, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors. Reverse osmosis and ultrafiltration. Treatment of industrial effluents.

12 Hours

Unit 3

Biomining and Biodiesel: Bioleaching of ores to retrieve scarce metals, Bio-mining;. Biodiesel production from Jatropa, Pongamia and Castor.

4 Hours

Unit 4

Bioremediation: Concept and principles, Bioremidiation using microbes, *In situ* and *ex situ* bioremediation, biosorption and bioaccumulation of heavy metals; Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastic). Bioremedidation of soil and water contaminated with hydrocarbons and surfactants, biofilms.

8 Hours

Unit 5

Biowaste treatment: Microorganisms involved in the degradation of plant fibre, cell wall, lignin, fungal de-lignification and pulping of wood. Pitch problems in pulp and paper processes and solving by enzymes or fungi. Hemicellulases in pulp bleaching. Solving slime problem in the pulp and paper industry. Reduction of organochlorine compounds in bleach plant effluents.

Solid wastes: Sources and management, waste as a source of energy. Production of oils and fuels from solid waste, composting, vermiculture, Biogas production, methanol production from organic wastes, byproducts of sugar industries.

12 Hours

Unit 6

Global environmental problems: Global warming, ozone depletion, UV-B, green house effect and acid rain, their impact and management. Biodiversity and its conservation, status of biodiversity, hotspots, Red data book.

8 Hours

References:

1. Allsopp D and K.J Seal., Introduction to Biodeterioration-ELBS/Edward Arnold. 1999
2. Christon, J. Harst Manual of Environment Microbiology, ASM Press, Washington DC.1997.
3. Ericksson Ed., Biotechnology in the pulp and paper industry, Springer –Verleg.1997
4. Hurst CJ et al. eds., Environmental Microbiology, ASM Press, Washington, D.C. 1997
5. Larry Anderson and David A. Tilman., Fuels from waste, Academic Press. 1997.
6. Whitaker J R and S.Philip. Biocatalysis in agricultural Biotechnology, Washington ACS.1989
7. Jordening H.J and Josef Winter Environmental biotechnology: concepts and applications (2nd Ed.) Wiley & Sons Publishers.UK.2005
8. Daniel Vallero., Environmental Biotechnology: A Biosystems Approach (1st Ed.) Academic press. New York.2010
9. Wang LK. Handbook of Environmental Engineering (1st Ed.) Springer Publishers.2010
10. Evans G G and Judy Furlong., Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers. 2011
11. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering (1st Ed.) Springer Publishers
12. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.

Course learning outcomes:

At the end of this course the student is expected to:

- Be thorough with the types of pollutants in water, air and soil
- Have a working knowledge of the various biological means of treatment of polluted environments
- Be familiar with environmentally friendly means of recovery of metals and degradation of xenobiotics
- Translate the learned knowledge into environment protection and biodiversity conservation

BTS-205 BIOINFORMATICS (Soft core)

Total Hours: 26

Course Objectives: 1) To give the students the basic knowledge about computers, operating system, internet resources. 2) To acquaint the students with the various important tools and techniques of information technology, Metabolimics and Phylogenetic analysis . 3) To make the students understand the basics of biological databases, Methods of sequence alignment, Genomics & Proteomics, Protein structure prediction & drug designing.

Unit 1

Introduction to Computer: Computer softwares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS).

2 Hours

Unit 2

Computer Network and Programming Languages: Structure, architecture, Advantages, types (LAN, MAN & WAN), Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. C Programming and PERL- Algorithm and flowchart, Structure of C program, Header file, Global declaration, Main function, variable declarations, Control statement-conditional and
unconditional - sub functions. Introduction to PERL, Application of Bioperl.

6 Hours

Unit 2

Databases: Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.

3 Hours

Unit 3

Biological Databases: Datamining and applications, accessing bibliographic databases-Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB). Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Sequence alignment - Global and Local alignment, scoring matrices. Restriction mapping - NEB CUTTER, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids
and protein sequences, Identification of ORFs, Identification of motifs.

10 Hours

Unit 4

Protein Structure and Molecular Interaction: Introduction to protein structure - secondary structure prediction, tertiary structure prediction, protein modelling- principles of homology and comparative modelling. Threading, structure evaluation and validation and *ab intio* Modelling, Applications - Molecular docking - Autodoc .

5 Hours

References:

1. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
2. Jan (2001). Nucleic acid research, Genome Database issue
3. Higgins & Taylor (2000). Bioinformatics, OUP.
4. Baxavanis (1998). Bioinformatics.
5. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
6. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, John

Course Outcomes:

1) Students will acquire the knowledge of computers, operating system, internet resources

2) Students will get introduced with tools and techniques of information technology, Metabolomics and Phylogenetic analysis .

3) Students will acquire the knowledge of biological databases, Methods of sequence alignment, Genomics and Proteomics

4) Students will get introduced with basic of 'C' language and structured query language.

II SEMESTER (PRACTICAL)

BTP-206: ENZYMOLOGY AND IMMUNOLOGY

Total Units: 16

Course outline:
This course aims at:

- Familiarising students with the measurement and analysis of enzyme activity
- Demonstrating antibody-antigen interactions and antibody purification and immunoelectrophoresis
- Introducing students to microscopic techniques to study various cells of the immune system

1. Isolation and assay of alpha-amylase activity from saliva
2. Isolation and assay of urease from horse gram or kidney gram
3. Isolation and assay of acid phosphatase from sweet potato
4. Determination of Km and V max
5. Effect of pH and temperature on enzyme activity
6. Determination of specific activity of an enzyme
7. Molecular weight determination of a protein by gel electrophoresis
8. Immobilization of enzyme (Urease/Amylase)
9. Partial purification of IgG by ammonium sulphate fractionation and Dialysis
10. Purification of IgG by column chromatography
11. Serum separation and serological reactions (a) agglutination (b) precipitation
12. Enzyme linked immunosorbant assay
13. Isolation of lymphocytes from peripheral blood
14. Ouchterlony double diffusion
15. Single radial immunodiffusion
16. Rocket immunoelectrophoresis

Course learning outcomes:

At the end of this course students should be able to:

1. Determine the activity of enzymes and calculate the kinetic parameters

2. Identify different types of immune cells and antibody-antigen interactions

BTP-207 MOLECULAR BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

Total Units: 16

Course outline:
This course aims at:

- Familiarising the students with the use of spectrophotometric methods for the estimation of nucleic acids
- Demonstrating the extraction and gel electrophoresis of genomic and plasmid DNA
- Demonstrating the modes of DNA transfer in E.coli
- Familiarising students with the basic tests involved in the analysis of waste water

1. Estimation of DNA by diphenyl amine method
2. Estimation of RNA by orcinol method
3. Isolation of Genomic DNA and agarose gel electrophoresis
4. Isolation of Plasmid DNA and agarose gel electrophoresis
5. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency
6. Study of conjugation in E.coli
7. Study of transduction in E.coli
8. Searching bibliographic databases for relevant information. Sequence retrieval from nucleic acid and protein databases
9. Determination of total dissolved solids, BOD and COD of water sample
10. Estimation of Chromium in Industrial effluent by colorimetry
11. Estimation of Calcium in water sample by titration method
12. Isolation of bacteriophages from sewage
13. Sludge analysis (a) Organic matter, (b) Nitrogen (c) Phosphorous (d) Potassium
14. Biodegradation of industrial aromatic compounds
15. Determination of Phosphate and nitrate from sewage samples
16. Microbial analysis of water-MPN

Course learning outcomes:

At the end of this course students should be familiar with:

- Basic techniques in molecular biology such as nucleic acid estimation, agarose gel electrophoresis
- The processes of conjugation, transformation and transduction
- Tests involved in the analysis of waste water

III SEMESTER (THEORY)

BTH- 301: PLANT AND AGRICULTURAL BIOTECHNOLOGY

Total Hours 52

Course outline:

This course aims at:

- Giving the students a broad overview of tissue culture and its use in the development of new and improved varieties of plants
- Familiarising students with the use of in vitro cultures for the industrial production of chemicals and secondary metabolites in plants
- Elucidating the processes involved in generating recombinant and genetically modified plants and their uses and abuses
- Elaborating on the efficacy of biotechnology in improving crop yield, disease resistance and post-harvest preservation

Unit 1

Plant tissue culture: Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintaiinance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

8 Hours

Unit 2

Plant transformation techniques: Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript IIKs, pBin19, pGreen vectors, Transgene stability and gene silencing.

10 Hours

Unit 3

Metabolic engineering of plants: Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.

Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

10 Hours

Unit 4

Plant Development: Plant growth regulators, auxin, gibberlins, cytokinins, abscicic acid, acetylene. Biological nitrogen fixation, importance and mechanism.

Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorhiza, Actinorhiza Vermicomposting technology. Biopesticides.

6 Hours

Unit 5

GM Technology: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato.

Stratagies for engineering stress tolerance. transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds

10 Hours

Unit 6

Post-harvest technology: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses.

8 Hours

References:

1. Chrispeels M.J.et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
2. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.1998
3. Hammound J, P McGravey & Yusibov.V. Plant Biotechnology, Springer verlag.2000
4. Heldt. Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt.Ltd. Delhi. 1997
5. Lydiane Kyte and John Kleyn. Plants from test tubes. An introduction to Micropropagation (3rd Ed.). Timber Press, Portland. 1996
6. Murray D.R. Advanced methods in plant breeding and biotechnology.Panima Publishing Corporation.1996
7. Nickoloff J.A.Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana press incorp, USA. 1995.
8. Sawahel W.A. Plant genetic transformation technology. Daya Publishing House, Delhi.1997
9. Gistou, P and Klu, H.Hand book of Plant Biotechnology (Vol. I & II).John Publication.2004
10. Slatu A et al.The genetic manipulation of plant. Oxford University Press.2003
11. Kirakosyan A and Kaufman P.B.Recent Advances in Plant Biotechnology (1st Ed.).Springer Publishers.2009
12. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiely Publishers.2006

Course learning outcomes:

At the end of this course, the student should:

- Be familiar with the techniques used in plant tissue culture and the generation of genetically modified plants
- Be familiar with the procedures involved in the industrial production of important plant intermediates, enzymes and proteins
- Be familiar with the development of genetically modified crops to fight diseases, drought and pest
- Be aware of the ethical issues involving the use of such GMOs
- Understand the uses of biopesticides and biofertilisers

BTH-302: ANIMAL BIOTECHNOLOGY

Total Hours: 52

Course outline:

This course aims at:

- Introducing the student to techniques and uses of animal cell culture
- Familiarising students with the isolation and use of stem cells
- Elucidating the protocols for the generation of transgenic animals and their use
- Making students aware of the ethical issues involved in the genetic manipulation of animals and the precautions to be taken

Unit 1

Animal Cell Culture: Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO2, Serum, supplements, growth factors (EGF, PDGF,NGF, Gap-43). Serum and protein free defined media.

Culture and maintenance of primary and established cell lines. Biology of cultured cells- culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.

15 Hours

Unit 2

Stem cells and Tissue Engineering: Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences.

Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.

7 Hours

Unit 3

Transgenic Animals and Animal cloning: Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases.

Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for livestock and humans.

10 Hours

Unit 4

Applications of Animal Biotechnology: Improvement of biomass, disease resistant, recombinant vaccines for poultry, live stock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines.

8 Hours

Unit 5

Bioethics: Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries. Ethical issues associated with consumptions of genetically modified foods. Ethical implication of human genome project, international ethical and legal issues connected with human genome diversity research. Genetic studies of ethnic races.

Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation.

6 Hours

Unit 6

Biosafety: The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science, GM crops,. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). Use of genetically modified organisms (crippling organisms) and their release to environment.

6 Hours

References:

1. Ballinic C.A., Philips J.P and Moo Young M.Animal Biotechnology. Pergamon press, New York. 1989.
2. Watson J.D.et al. Molecular Biology of Gene (6^{th} Ed.) Publisher Benjamin Cummings.2007.
3. Berger S. L. and A.R. Kimmel.Methods in enzymology guide to molecular cloning techniques (Vol 152). Academic Press Inc. San Diego.1996
4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC.2003.
5. Jenni,P, Mather and David Barnes, Methods in Cell Biology (Vol 57) Academic Press.2001
6. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001
7. Watson J.D et al. Molecular Biology of the Gene(6^{th} Ed), The Benjamin Cummings Pub.Co.Inc.USA.2008
8. Shantharam, D., Jane F Montgomery. Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for Sustainable development. 1999
9. Jan Freshney. R .Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6^{th} Ed.) Wiley & Sons. 2010
10. John Davis., Animal Cell Culture: Essential Methods (1^{st} Ed.) Wiley-Blackwell and Sons publisher. 2011
11. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology.WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003

Course learning outcomes:

At the end of this course the student should:

- Be familiar with the media, conditions and precautions to be followed during animal cell culture
- Be conversant with stem cell isolation, identification and uses in tissue engineering
- Be aware of the protocols and ethical issues for the generation of transgenic animals

BTH-303 GENETIC ENGINEERING

Total Hours: 52

Course outline:

This course aims at:

- Introducing the student to the basic concepts of cloning and recombinant DNA technology
- Elucidating the step-by-step protocols for cloning and expression of genes, construction of gene libraries, screening and selection of recombinants
- Explaining associated techniques of sequencing, labeling and chemical synthesis of oligonucleotides

UNIT 1

Introduction to Genetic Engineering: Scope and importance of Genetic Engineering

2 Hours

UNIT 2

Tools of Gentic Engineering: Enzymes; Non-specific endo & exo nucleases, DNase, RNase. Restriction modification; restriction endonucleases- types, nomenclature, recongnition sequences and mechansism of action. Methylation, RNA modification. Role of Kinases, phosphotases, polynucleotide phosphorylase, polynucleotide kinases. Ligases- types and mechanism of action.

Vectors: General characteristics of vectors, Brief account of naturally occurring plasmids. Promoter, MCS, Ori, and marker genes-lac Z. Construction of pBR 322, pBR325, pUC 18 and 19 vectors and expression vectors. E.coli promoters, lac promoter, trp promoter, lambda pL promoter, hybrid tac promoter, ribosome binding site, codon selection. M 13 derived vectors, Lambda based vectors, cosmids, phagemids, minichromosomes, BAC‟s, YAC‟s,
Shuttle vectors, Ti plasmids, vectors for animals-SV40 and Bovine papilloma virus.

14 Hours

UNIT 3

Gene Cloning Strategies and Construction of Gene Libraries: Cloning from mRNA: Isolation and purification of RNA, synthesis of cDNA, Isolation of plasmids, cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors. cDNA libray.

Cloning of genomic DNA: Isolation and purification of DNA, preparation of DNA fragments and cloning. Construction of genomic libraries (Using λ gt 10 and 11 vector). *In vitro* packaging of λ phage and amplification of libraries.

Advanced cloning strategies-synthesis and cloning of cDNA, PCR amplified DNA, use of adaptors and linkers, homopolymer tailing in cDNA cloning, expression of cloned DNA molecules,

Selection, screening and analysis of recombinants: Genetic selection, insertional inactivation, chromogenic substrates, complementation of defined mutations, nucleic acid hybridization, screening methods for cloned libraries, PCR screening protocols, immunological screening, restriction mapping of cloned gene, blotting techniques, sequencing methods. Purification strategies of expressed His- tagged proteins.

14 Hours

UNIT 4

Transformation Techniques: Purification of vector DNA, restriction digestion, end modification, cloning of foreign genes, (from mRNA, genomic DNA, synthetic DNA) transformation screening, selection, expression and preservation.Transformation and transfection techniques, preparation of competent cells of bacteria, chemical methods- calcium phosphate precipitation method, liposome mediated method, physical methods- Electroporation, gene gun method. Method of DNA transfer to yeast, mammalian and plant cells, transformation and transfection efficiency.

8 Hours

UNIT 5

Labelling and Detection Techniques: Labeling of DNA, RNA and Proteins by
radioactive isotopes, non-radioactive labeling, in vivo labeling, autoradiography and autofluorography. DNA sequencing by enzymatic and chemical methods, Agarose gel
electrophoresis, PAGE, PFGE. Methods of nucleic acid hybridization; Southern, Northern and Western Blotting techniques.

8 Hours

UNIT 6

Chemical Synthesis of Genes and PCR: Phosphodiester, phosphotriester and Phosphite ester methods, principles and strategies. Oligonucleotide syntesis and application, synthesis of complete gene.
PCR, methodology, essential features of PCR, primers, Taq polymerases, reverse transcriptase-PCR, types of PCR-Nested, inverse, RAPD-PCR, RT-PCR (real time PCR), Applications of PCR.

6 Hours

References:

1. Nicholl D.S.T. Introduction to Genetic Engineering Cambridge (3rd Ed.) University press.UK. 2008
2. Old R.W., Primrose S.B. Principles of gene manipulation - An introduction to genetic engineering (5th Ed.), Blackwell Scientific Publications, UK. 1996.
3. David S L. Genetics to Gene Therapy – the molecular pathology of human disease (1st Ed.) BIOS scientific publishers, 1994.
4. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
5. Benjamin Lewis, Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.2004
6. Robert Williamson.Genetic Engineering (1st Ed.) Academic Press.1981.USA
7. Rodriguez. R.L (Author), Denhardt D.T. Vectors: A Survey of Molecular Cloning Vectors and Their Uses (1st Ed.) Butterworth-Heinemann publisher.UK. 1987
8. Ansubel F.M., Brent R., Kingston R.E., Moore D.D. et al. Short protocols in molecular biology(4th Ed), Wiley publishers. India. 1999.
9. Sambrook J et al. Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA. (1989, 2000)

10. Terence A Brown. Genomes, (2nd Ed.) BioScientific Publishers.UK.2002
11. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. 1999
12. S. B. Primrose, Richard M. Twyman.Principles of gene manipulation and genomics (7th Ed.) John Wiley & Sons publishers.2006

Course learning outcomes:

At the end of this course the student should:

- Be familiar with the tools and techniques of genetic engineering including cloning and expression vectors, restriction enzymes, host strains and selection media
- Be aware of the strategies to clone prokaryotic and eukaryotic genes including construction of genome and expression libraries, transformation techniques and selection criteria
- Be comfortable with the protocols of separation, labeling, sequencing and identification of DNA

OPEN ELECTIVE
BTO-304: APPLIED BIOTECHNOLOGY

Total Hours: 52

Course objectives:

This course aims at:

- Giving an overview of the utility of biotechnology and its processes to students from non-biology backgrounds
- To give a brief introduction to biotechnological approaches to crop And livestock improvement and the industrial production of important Enzymes and antibiotics and related ethical issues
- Emphasising the role of biotechnology in the preservation and conservation Of the environment

Unit-1

Bioprocess Engineering

Introduction: Scope and importance of bioprocess engineering technology, Bioreactors: Typical structure of Bioreactor and their working mechanism; Fermentation media and Fermentation Process: Natural and synthetic media. Types of fermentation processs- Industrially important products: Ethanol, citric acid, penicillin, riboflavin, amylase, protease, biodegradable plastic: Fermented foods

8 Hours

Unit -2

Plant and Agricultural Biotechnology

Plant tissue culture, micropropagation, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, production of enzymes, biodegradable plastics, therapeutic proteins, edible vaccines.

8 Hours

Unit-3

Animal Biotechnology

Animal cell culture, stem cells and tissue engineering, transgenic animals, IVF technology for livestock improvement, biofarming, pharmaceutical products, plasminogen activator, blood clotting factors, interleukins, vaccines.

8 Hours

Unit-4

Medical Biotechnology

Microbial diseases of humans: AIDS, Hepatitis B, Rabies, Typhoid, STDs, Tb, plague, malaria, amoebiosis, tumors, treatment of cancer, diabetes, anemia, gene therapy

8 Hours

Unit-5

Environmental Biotechnology

Pollution : Air, water, soil , Bio-indicators, waste water management, treatment, bioremediation, biodegradation, biowaste treatment, global warming, ozone depletion, acid rain

8 Hours

Unit-6

Nanobiotechnology

Introduction, types, DNA, protein based applications, nanobiosensors, drug and gene delivary, risk potential of nanomolecules

6 Hours

Unit-7

IPR, patenting of biotech products, examples: turmeric, basmathi rice, neem, Bioethiccs, ethical issues related to consumption of GM crops, ethical implication of Human Genome Project

6 Hours

References:

1. Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
2. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers, London.
3. Gistou, P and Klu, H.Hand book of Plant Biotechnology (Vol. I & II).John Publication.2004
4. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiely Publishers.2006
5. Ballinic C.A., Philips J.P and Moo Young M.Animal Biotechnology. Pergamon press, New York. 1989.
6. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings.2007.
7. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001
8. David S L. Genetics to Gene Therapy – the molecular pathology of human disease (1st Ed.) BIOS scientific publishers, 1994.
9. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
10. Santaniello V, Evenson RE, Zilberman D and Carlson GA, Agriculture and Interllectual property rights: Economic, Institutional and Implementation Issues in Biotechnology, University Press. 2003
11. S N Jogdand Medical Biotechnology 2nd Edition Himalaya publishers 2008
12. Niemeyer C.M. and Mirkin C.A, Introduction to Nanobiotechnology, Wiley VCH publishers 2003

Course learning outcomes:

At the end of this course, students are expected to:

- Be familiar with the use of biotechnology in the industrial production of various useful products such as enzymes, antibiotics and vaccines
- Have a basic idea about plant and animal cell culture and their uses
- Learn the advances in medicine and treatment of diseases
- Appreciate the importance of environment conservation
- Be aware of the ethical issues in the use of recombinant DNA technology

III SEMESTER (PRACTICAL)

BTP- 305: PLANT, AGRICULTURAL AND ANIMAL BIOTECHNOLOGY

Total Units: 16

Course outline:
This course aims at:

- Familiarising the students with the basic techniques of plant and animal tissue culture
- Demonstrating the importance of tests to determine viability of in vitro cultures
- Introducing the students to the effect of biopesticides and biofertilisers on plant growth

1. Preparation of plant tissue culture media and Organ culture (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration.
3. Anther culture for the production of haploids.
4. Isolation, culture and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. Agrobacterium culture, selection of transformants
7. Suspension culture and production, separation and estimation of secondary metabolites β-carotene from carrot and anthocyanin from beetroot
8. Study of VAM, isolation of spores, arbuscles and vesicles from roots
9. VAM culture
10. Organic pharming and Mushroom Cultivation
11. Study and culture of biocontrol agents (*Trichoderma viridae, Trichoderma harzianum, Aspergillus awamori*)
12. Animal cell culture: Preparation of (serum and non serum supplemented) media, cell culture, assessment of viability and counting using trypan blue exclusion method
13. Primary culture of fibroblast cells/liver cells/testis-leydig cells
14. Determination of GST enzyme activity in cytotoxicity induced cells
15. Estimation of lipid peroxides (Malondialdehyde) in cytotoxicity induced cells
16. MTT assay for cell viability and growth

Course learning outcomes:

At the end of this course students should be:

- Capable of generating plant calluses
- Familiar with the basic techniques of genetic manipulation in plants
- Able to identify and implement the use of biopesticides and biofertilisers
- Conversant with basic techniques of animal cell culture including determination of viability

BTP- 306: GENETIC ENGINEERING AND BIOINFORMATICS

Total Units: 16

Course outline:

This course aims at:

- Familiarising students with basic techniques in molecular biology and recombinant DNA technology
- Getting the students to have hands-on experience in cloning and overexpression of genes
- Demonstrating DNA-DNA and DNA-RNA hybridization techniques
- Introducing students to various bioinformatics tools and interpretation of the results obtained from their use

1. Electrophoresis of restriction digested plasmid DNA, Restriction mapping and determination of molecular weight of digested DNA fragment
2. Ligation of DNA and analysis by electrophoresis
3. DNA amplification by PCR and RAPD
4. Preparation of competent cells and transformation by $CaCl_2$ method and Selection of Transformed colony by X-Gal method
5. Determination of molecular weight of proteins by SDS PAGE and analysis by Western blotting
6. Analysis of DNA by Southern blotting
7. Labelling of proteins by dinitroflurobenzene and analysis
8. Isolation of total RNA and analysis by formaldehyde gel electrophoresis
9. Restriction mapping, Sequence (FASTA and BLAST) searches.
10. Pair wise comparison of sequences, multiple alignments of sequences.
11. Evolutionary studies / Phylogenetic analysis.
12. Identification of genes in Genomes and Primer Design
13. Protein databank retrieval and visualization Ras Mol
14. Ramachandran plot-secondary structure prediction of proteins.
15. Introduction to Auto doc
16. Calculation of SD, Variance and plotting the graph by using MS Excel

Course learning outcomes:

At the end of this course, students should be able to:

- Clone and overexpress genes in bacteria
- Identify and characterize recombinant proteins
- Use bioinformatics tools to compare genomes and build phylogenetic trees
- Use software to study and predict protein structure and function

IV SEMESTER (THEORY)
BTH-401: BIOPROCESS ENGINEERING

Total Hours: 52

Course Objectives:

This course aims at:

- Giving an overview of the design of fermentors, types of fermentors , equipments, instruments used,
  sterilization processes, fermentation media, inoculum preparation, Scale up processes.
- To give a detailed explanation to various downstream processes of fermentation industries.
- Emphasizing the importance of immobilization, Biotransformation and their applications.
- To give an overview of IPR, patenting and aspects of Bioethics and Biosafety.

Unit 1

Introduction: Scope and importance of bioprocess engineering technology, development and strain improvement of industrially important microorganisms.

3 Hours

Unit 2

Bioreactors: Typical structure of advanced Bioreactor and their working mechanism; Design features; Heat transfer and Mass transfer; Specialised bioreactors- design and their functions; Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photo bioreactors.

10 Hours

Unit 3

Fermentation media and Fermentation Process: Natural and synthetic media; Strategies for media formulation, sources of carbon, nitrogen, vitamins and minerals. Role of buffers, precursors, inhibitors, inducers and antifoam agents.

Types of fermentation processs-submerged fermentation, surface or solid state fermentation, batch fermentation, continuous fermentation, kinetics of fermentation process, bioprocess control, monitoring of variables-temperature, agitation, pH and pressure.

Unit 4

Downstream processing: cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization biosensors-construction and applications,

Food processing: food preservation, and spoilage. Sterilization and pasteurization, canning and packing of foods.

8 Hours

Unit 5

Immobilization and Biotransformation; Methods of immobilization, adsorption, cross-linking, ionic bonding, entrapment, encapsulation; Advantages and industrial applications of Immobilization of enzymes and whole cells.

Biotransformation of antibiotics, steroids and their applications.

5 Hours

Unit 6

Production of Industrially important products: Alcohol: Ethanol, glycerol, butanol; Acetone; Organic acids: citric, acetic, and gluconic acid; Amino acids: lysine, glutamic acid; Antibiotics: penicillin, streptomycin, tetracycline; Vitamins: riboflavin, Enzymes: amylase, protease, biodegradable plastic: polyhydroxyalkanoates (butyarate, propionate.); Recombinant protein- Insulin, hepatitis-B vaccine. Fermented foods-sausages, olives, bread, idly and acidophilus milk.

10 Hours

Unit 7

Intellectual Property Rights (IPRs) and Entrepreneurship: IPRs– implications for India, WTO, WIPO, GATT, TRIPS. Patenting and the procedures involved in the application for patents and granting of a patent, compulsory licenses, patent search, Patent Cooperation Treaty (PCT), examples of patents in biotechnology, legal implications, traditional knowledge commercial exploitation, protection.

Entrepreneurship – Potential entrepreneurship activities in biotechnology, product development, marketing, research and training units. Industrial licensing, venture capital, Biotechnology Industries in India and the potential job opportunities.

8 Hours

References:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.).Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

Course Outcomes

1) Students learn protein structure prediction and drug designing.

2) Students will be well versed with the screening techniques, Microbial assays, Primary & secondary metabolites.

3) Students will gain the knowledge of design of fermentors, types of fermentors , equipments, instruments used, sterilization processes.

4) Students will understand fermentation media, inoculum preparation, Scale up processes and downstream processes of fermentation industries.

BTH-402 MEDICAL BIOTECHNOLOGY

Total Hours: 52

Course objectives:

- Giving an overview of the various diseases that infects humans and their microbial source
- Introduction to Cancer biology and detection techniques
- An overview to Nanobiotechnology, Molecular therapeutics and Drug discovery with the techniques involved and their applications.

Unit 1

Microbial Diseases of Humans: mode of infection, symptoms, detection, epidemiology and control measures of disease caused by

Viruses (AIDS, Hepatitis- B, Rabies, HSV-1) Bacteria (Typhoid, STD, TB, Plague)
Fungi(Aspergillosis, Histoplasmosis, Cryptococcosis) Protozoa(Malaraia, Amoebiasis)

Unit 2

8 Hours

Cancer Biology: Tumors, types of tumors, pre-disposing factors, cellular changes involved in tumor formation, genes associated with cancer (oncogenes, tumor suppressive genes etc.), methods of tumor detection, tumor markers, treatment of cancer-chemo therapy, radio therapy, immunotherapy and gene therapy.

6 Hours

Unit 3

Human Diseases: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von‟Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell aneamia, Beta Thalesimia and Diabetes

Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase

8 Hours

Unit 4

Nanobiotechnology: introduction, types and synthesis of nanomaterials, protein-based nano structures, DNA-based nano structures, Applications of nanomaterials, nanobiosensors, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials.

Unit-5 6 Hours

Molecular therapeutics: Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half life, drugs accumulation, basic concepts of toxic effect. Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery. Cellular therapy; use of stem cells. Recombinant therapy; Erythropoitin; Insulin analogs and its role in diabetes. Streptokinase and urokinase in thrombosis.

10 Hours

Unit 6

Drug discovery: Introduction, conventional drug design approaches, irrational Vs rational, Lipinski's rule of five, ADME, Calculation of LD 50 and ED 50. Acute, subacute and chronic toxicity studies. Irwin profile test, Drug development process (Preclinical , clinical and toxicological studies). Novel Drug Development approaches - QSAR (quantitative structure activity relationship), Highthroughput screening.

6 Hours

Unit 7

Clinical Research: Past, Present and future

Importance, Mile stones of regulations. FDA, US, Indian clinical research, global scenario of clinical research, Regulatory agency.

Designing clinical trials- History, principles, scheme for conducting clinical trials, planning defining, objectives, variables, study populations, testable hypothesis, prediction of errors and bioselection of appropriate study design, Execution steps.

Ethical Issues in clinical research- Introduction, codes, declaration and guidelines, Informed concent, special issues, Roles and responsibilities of IRBS, issues with ethics review.

ICH-GCP- History of ICH, Objectives, ICH structure, Guidelines, Future of ICH.

8 Hours

References:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. S N Jogdand Medical Biotechnology 2nd Edition Himalaya publishers 2008
3. Keith Wilson & John Walker, Practical Biochemistry- 5th edition, Cambridge University Press, UK 2000
4. Bartram G. Katzung, Basic & Clinical Pharmacology, 9th Edition, Mc Graw Hill Publications 2004
5. Devlin TM, Text book of biochemistry with Clinical Correlations 5th edition 2002
6. Richard B Silverman, Organic Chemistry of Drug design and Drug action Elsevier Science, Academic Press
7. Warren Levinson, Ernest Jawetz, Medical Microbiology and Immunology: Examination and Board Review 7th edn. McGraw Hill Publications 2003
8. Jawetz, Melnuk and Adelgerg, Medical Microbiology, Appleton & Lange pub 1971.

Course learning outcomes:

At the end of this course, students should be:

- Familiar with the symptoms, diagnosis and treatment of various diseases and disorders that affect humans
- Conversant with state-of-the-art techniques to improve diagnostics and treatment of diseases
- Aware of the pros and cons of the use of drugs and the globally accepted rules of clinical trials

BTH-403 GENOMICS AND PROTEOMICS

Total Hours: 52

Course outline:

This course aims at:

- Introducing students to the genome sequencing, the fine structure of genomes and the concepts of genome analysis
- Giving an overview about comparative genomics and its significance
- Elucidating the techniques used in the analysis of gene expression, including protein profiling and protein-protein interactions
- Introducing the concept of metabolomics in order to understand the integration of all the omics (genomics, proteomics, transcriptomics and reactomics)

UNIT 1

Introduction: Concept of genomics, structural genomics, Functional Genomics, Transcriptomics, RNAmics proteomics, and metabolomics.

4 Hours

UNIT 2

Genomics: Genome sequencing, Fluorescence method, automated sequencing, shot-gun approach. Clone contig method, Genome sequencing projects of *E.coli*., yeast, and human genome project.

Genome sequence data bases, expressed sequenced tags (ESTs), Gene variation and Single Nucleotide Polymorphisms (SNPs), disease association, diagnostic genes and drug targets, genotyping - DNA Chips, diagnostic assays, Genome sequence analysis. Principle, salient features & drawbacks of methods of gene prediction / gene modeling: GRAIL, GENEMARK, GLIMMER. Promoter prediction methods.

10 hours

UNIT 3

Genome Analysis, Genome Organization and Structure: C-Values of genomes, Repetitive and coding sequences, Genetic and physical maps, Methods of physical mapping**.** Molecular markers, Hybridization based markers restriction fragment length polymorphism (RFLP‟s), random amplification of polymorphic DNA (RAPD‟s) and amplified fragment length polymorphisms (AFLP). Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR).

Approaches to mapping, fluorescence *in-situ* hybridization (FISH) - DNA amplification markers; Telomerase as molecular markers, T-DNA tagging, Transposon tagging, General structural features of Viral and Bacterial genomes. Organization of E.coli genome, Arabidopsis genome, Rice genome, Human genome, Unusual structure of Y chromosome, Chloroplast and Mitochondrial genomes. Commercializing the genomics, polymorphisms.

15 Hours

Unit 4

Functional and Comparative Genomics: Transcriptomes-transcripts of a tissue, use of Northern blot, substractive and additive library, Rnase protection assay, RT-PCR, Analysis of steady state gene expression by EST tags and cDNA library, Microarray techniques, sequence analysis of gene expression (SAGE). Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria.

5 Hours

UNIT 5

Proteomics: Expression analysis and characterization of proteins-separation of proteins-2D PAGE (2DGE), multiplexed analysis, multidimensional liquid chromatography, high throughput screening by Mass spectrometry, MALDI-TOF, peptide fingerprinting, protein micro array-antibody arrays, antigen arrays, general protein arrays, biochips.

Analysis of protein structures-Sequence analysis by Tandem Mass Spectrometry, structure prediction, X-ray, NMR and CD and Bio-informatic approaches.

Protein–protein interactions-genetic, comparative genomic, biochemical approaches. Large scale analysis of protein intreractions-yeast two hybrid interaction screens, post-translational modification analysis, proteomics databases & analysis.

10 Hours

UNIT 6

Metabolomics: Concepts, Levels of metabolite analysis, metabolomics in humans, sample selection and handling, over view of different methods used for analysis of metabolites. Metabolic regulation network at genome level, Basic concept of metabolic engineering.

8 Hours

References:

1. Peter M Gresshoff .Plant Genome Analysis (1st Ed.), CRC Press.UK.1994
2. John R S Finchman. Genetic Analysis – Principles, Scope and Objectives (1st Ed.). Blackwell Science. Singapore.1994.
3. Smith D.W. Biocomputing Informatics and the Genome Projects (1st Ed.) Academic Press.USA.1993.
4. Benjamin Lewis. Genes VIII (7th Ed.). Oxford University & Cell Press.UK.1999
5. Benjamin Lewis. Genes IX (9th Ed.). Jones and Bartlett publishres.USA. 2007
6. Principles of Gene manipulation and Genomics, SB Primrose and RM. Twyman, 7th Ed.). Blackwell publishers.UK.2007
7. Dubitzky W et al. Fundamentals of data mining in genomics and proteomics (1st Ed.) Springer publishres.USA.2007
8. Liebler D C. Introduction to Proteomics-Tools for the New Biology (2nd Ed.).John R. Humana Press Totowa. NJ. 2002
9. Terence A B.Genomes (2nd Ed.).Bios Scientific Publishers.UK.2002
10. Griffiths AJF.An Introduction to Genetic Analysis (7th Ed.). W. H. Freeman publisher.NY.2000

11. Michel Blot. Prokaryotic Genomics (1 Ed.) Springer publishers.2002
12. Josip Lovric Introducing Proteomics: From concepts to sample separation, mass spectrometry and data analysis. Wiley-Blackwell publishers.UK.2011
13. Richard Twyman, Principles of Proteomics (1st Ed.).Wiley-Blackwell publishers.UK.2004

Course learning outcomes:

At the end of this course, students should be able to:

- Understand the relation between genome sequence and organism complexity
- Appreciate the connection between genotypes and phenotypes
- Relate the use of various techniques to study proteins and their interaction with other biomolecules
- Integrate the previous semester's learning of biochemical pathways with signal transduction, gene regulation and protein structure

IV SEMESTER (PRACTICAL)

BTP- 404: BIOPROCESS ENGINEERING AND MEDICAL BIOTECHNOLOGY

Total Units: 16

Course outline:
This course aims at:

- Demonstrating simple biotechnological methods used in the production of economically important products
- Introducing the student to commonly used tests for the diagnosis of diseases/disorders

1. Study of fermentor- Demonstration.
2. Production and isolation of antibiotics (Pencillin and Streptomycin)
3. Production and analysis of Single cell protein (Spirulina and yeast)
4. Production of yoghurt and estimation of lactic acid at different time intervals
5. Production of wine – estimation of percentage of alcohol, total acidity & volatile acidity in wine.
6. Production and assay of α-amylase from *Aspergillus niger*
7. Purification and assay of α amylase by simple precipitation using sodium sulphate, poly amines and organic solvents and immobilization
8. Blood urea analysis by diacetyl monoxyme method
9. Analysis of acid and alkaline phosphatase from serum samples
10. Estimation of serum cholesterol
11. Assay of SGOT enzyme activity
12. Assay of SGPT enzyme activity
13. Blood sugar analysis by Folin -Wu method
14. Estimation of Creatine and Creatinine from urine samples
15. Study of cancer cell and visit to cancer research Institute
16. Visit to industries/Biotech park-report to be submitted along with the record

Course learning outcomes:

At the end of this course, students should be able to:

- Design and operate simple fermenters for the production of commercial products
- Perform tests for the determination of diseased states
- Read a diagnostic report and correlate the results with a probable outcome of healthy/disease state