

From

Dr. T.R. Keerthi (**Convenor, Expert Committee in Biotechnology**)

Kottayam

Associate Professor, School of Biosciences

11-06-2012

Mahatma Gandhi University, P.D. Hills, Kotayam-686560

To

Honourable Pro.Vice Chancellor

Mahatma Gandhi University, P.D. Hills, Kotayam-686560

Sir,

**Sub: Submission of P.G Syllabus in Biotechnology/model Question papers under CSS system**

**Ref; No. Ac. AIX/2/6264/2012 dated 22-02-2012**

We have completed the syllabus preparation under CSS system for M.Sc Biotechnology programme of the affiliated colleges in Mahatma Gandhi University. The syllabus has been approved in the last meeting of the core committee held on 29-05-2012.

I am submitting the completed syllabus and model question papers for your concern. I request you to kindly give final approval to the above syllabus..

Thanking you

Yours faithfully

T.R..Keerthi

# **Members in the Expert Committee for M.Sc Biotechnology Programme (CSS)**

**1. Dr.T.R.Keerthi (Convenor)**

Associate Professor

School Of Biosciences, Mahatma Gandhi University

**2. Dr.Jayachandran.K**

Associate Professor

School Of Biosciences, Mahatma Gandhi University

**3. Dr.Linu Mathew**

Assistant Professor

School Of Biosciences, Mahatma Gandhi University

**4. Dr.Indu C Nair**

Assistant Professor

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SASSNDP Yogam College, Konni, Pathanamthitta

**5. Dr.A Sabu**

Associate Professor

Department of Biotechnology

Kannur University, Palayadu Campus

Thalassery

**Suggestions came out in the  
Workshop conducted by Board of studies in Biosciences on  
restructuring the PG Syllabus of MSc Biotechnology,  
Biochemistry and Microbiology**

**Venue- The School of Biosciences auditorium, M.G.University, P.D.Hills, Kottayam**

**Period- From 10-04-2012, to 12-04-2012**

The workshop was inaugurated by Honourable Pro Vice Chancellor of M.G University, Dr.Rajan Varghese .Prof.M.S. Latha, chairman Board of studies in Biosciences made the welcome speech along with Dr,PrakashKumar and Dr.J.G.Ray offering felicitations.Dr. Jayachandran.K offered vote of thanks.

The workshop started with Prof.M.S.Latha introducing the basic content of the credit and semester programme ,after which the whole day was given for discussion. Many suggestions were raised by the participating teachers of the affiliated colleges and the members of the various committees. Group discussions were also conducted among the teachers of Biochemistry, Microbiology and Biotechnology.

The second day (11-04-2012) workshop started with an expert lecture from Prof(Dr).Venugopala Menon ( Professor of Biochemistry) from Annamalai University. This was only expert lecture in the workshop Dr. Menon critically went through the draft syllabus (the syllabus of School of Biosciences) and suggested many modifications as follows.

1. The syllabus of Basic Biochemistry meant for the first semester programme may be modified so as to include the important biochemistry components and to exclude the other topics related to Cell Biology (Cell membrane ) and Molecular Biology ( Replication, transcription and translation) from the syllabus content of Biochemistry. Dr. Menon opined that there are many repetitions in the draft syllabus and requested the individual committees to modify their syllabus accordingly.
2. Dr. Menon opined that the content of the Metabolism paper in the draft syllabus of the second semester should be modified and the title is to be modified as Metabolic regulation.

3. Dr. Menon opined that it is better to include electives from the second semester onwards rather than bringing all the electives in the fourth semester.
4. Dr. Menon suggested to think the possibility of including a paper as Proteomics and Bioinformatics in the first semester.

Afterwards there was discussion among the participants in the presence of Prof. Menon. There was difference of opinion in the incorporation of Physiology as a paper in the first semester. The pros and cons of the same were discussed. However a common conclusion could not be made in the session. One suggestion came was to divide Physiology component into Plant, Animal and Microbial physiology so as to incorporate into Plant Biotechnology (third semester), animal Biotechnology (third semester) and Microbiology (First semester). One advantage of this option is that this will facilitate the possibility of incorporating another relevant paper in the place of Physiology. It was also pointed out that the modification incorporated into the syllabus should not make much changes to the existing work load of the teachers.

In the third day there was effective discussion with respect to the syllabus of the third and fourth semester programme of the different subjects. The titles of the various papers, content of both the theory papers and practical etc were discussed in detail. Regarding the electives, the teachers from various colleges were requested to submit the syllabus for at least three electives from one college so as to prepare a pool of electives for elective 1, 2 and 3.

**Mahatma Gandhi University**  
**Scheme and Syllabus for M.Sc Biotechnology**  
**P.G. Credit and Semester System**

*The syllabus has been set with an objective of training the students in all the fundamentals of the subject of Biotechnology, progressively giving way to all essentials of the subject with good practical training and exposure to most modern concepts. The students need to get trained in all the components of the syllabus for emerging out truly successful through the programme. The content of the syllabus is expected to help the students to mold themselves as competent enough in an international pursuit of knowledge.*

## ***A word about the Syllabus.....***

The M.Sc Biotechnology syllabus has been set for the affiliated colleges of the Mahatma Gandhi University under the credit and semester system. The syllabus has been constructed after intense discussion, analysis and consultation through various workshops and board meetings. The core committee constructed by the University was instrumental in preparing the syllabus. The committee has taken keen interest in collecting expert opinion from the renowned experts in the field as well as from the faculties of the affiliated colleges handling the subjects. The committee has also referred to the syllabus of various other Universities such as that of Cochin University of Science and Technology, Calicut University, Pune University, Allahabad University besides that of University Grants Commission. The committee has taken extreme care in bringing all the basic theoretical and practical components in the first two semesters. In the third and fourth semesters, the Biotechnology specific components have been incorporated. Considering the multidisciplinary, ever growing and diverse nature of the subject of Biotechnology it is extremely challenging to incorporate all the relevant areas into the syllabus. However the syllabus has been set with an objective of training the students in all the fundamentals of the subject progressively giving way to all essentials of the subject along with good practical exposure. Most of the advanced topics have been incorporated as 20 elective topics in the fourth semester programme. The committee is extremely thankful to all the teachers of the affiliated colleges, University and the various experts for their meaningful contributions.

The Core Committee in Biotechnology

Mahatma Gandhi University

P.D.Hills,Kottayam-686560

## **SCHEME OF M.Sc.Biotechnology**

### **Scheme of examination for first semester M.Sc.Biotechnology**

Course code	Subject	Credits	Marks(%)		
			Internal Assess.	End Sem.Exam	Total
BTPG 01	Biochemistry	4	25	75	100
BTPG02	Cell Biology and Genetics	4	25	75	100
BTPG03	Biophysics and Bioinformatics	3	25	75	100
BTPG04	Instrumentation and Biostatistics	4	25	75	100
BTPG05	Laboratory Course I	4	25	75	100
Total admissible credits:19					

### **Scheme of Examination for Second Semester M.Sc.Biotechnology**

Course code	Subject	Credits	Marks(%)		
			Internal Assess.	End Sem.Exam	Total
BTPG06	Microbiology	4	25	75	100
BTPG07	Immunology	4	25	75	100
BTPG08	Molecular Biology	4	25	75	100
BTPG09	Metabolism and Enzymology	3	25	75	100
BTPG10	Laboratory Course II	4	25	75	100
Total admissible credits:19					

### Scheme of Examination for Third Semester M.Sc.Biotechnology

Course code	Subject	Credits	Marks(%)		
			Internal Assess.	End Sem.Exam	Total
BTPG11	Bioprocess Technology	4	25	75	100
BTPG12	Recombinant DNA technology	4	25	75	100
BTPG13	Plant and Animal Biotechnology	3	25	75	100
BTPG14	Environmental Biotechnology	4	25	75	100
BTPG15	Laboratory Course III	4	25	75	100
Total admissible credits: 19					

### Scheme of Examination for Fourth Semester M.Sc.Biotechnology

Course code	Subject	Credits	Marks(%)		
			Internal Assess.	End Sem.Exam	Total
BTPG16	Laboratory Course IV	4	25	75	100
BTPG17	Project	4	25	75	100
BTPG18	Viva-voce	3	25	75	100
BTPG19E	Elective1	4	25	75	100
to	Elective2	4	25	75	100
BTPG38E	Elective3	4	25	75	100
Total admissible credits:23					

# **FIRST SEMESTER**

## **BTPG 01. BIOCHEMISTRY**

**4hours/week**

**Credit: 4**

### **Unit I:**

Composition; basic structure and function of carbohydrates, Mono, di ,oligosaccharides, Glycosidic bonds; glycoproteins (O- linked and N- linked), glycolipids; Polysaccharides: Classification: Homopolysaccharides (Cellulose, Starch, Chitin, and Glycogen), Heteropolysaccharides, bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and heparin and their Structural characteristics and functions, bacterial polysaccharides Purification and Characterization of polysaccharides 16

### **Unit II:**

Glycerophospholipids: Structure and function of (Phosphatic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl glycerol, Phosphatidyl choline, Phosphatidyl inositol), CDP-diacylglycerol, Lung surfactants, Glycosphingolipids: Structure and function of (Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides), Eicosanoids: Prostaglandins, Leukotrienes and Thromboxanes: Chemistry, formation and physiological function. Steroids: Steroids in animal system: Glucocorticoids, mineralocorticoids ,Sterols in Plant system: Phytohormones: Brassinosteroids (functions); Sterols in microbial system 16

### **Unit III**

Fat soluble and water soluble vitamins: structure and function, cofactors and coenzymes: structure and function Coenzymes and their functions - NAD, NADP<sup>+</sup>, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate, biotin and cyanocobalamin. 12

### **Unit IV**

Hormones: Classification; site of formation, target organs; mechanism of action of peptide and steroid hormones :insulin, glucagon, epinephrine, norepinephrin, thyroid hormones, testosterone, estrogen, progesterone, pheromones, hormonal regulation of metabolism by mineralocorticoids. 16

## Unit V

Primary, Secondary, Tertiary and Quarternary structure of Proteins Globular protein Hemoglobin and Myoglobin, Fibrous protein: Collagen, Membrane Protein ,ATP synthetase, Protein sequencing, Evolutionary divergence of organisms and its relationship to protein structure and function, protein folding. Nucleic acids- Forms of DNA, Watson Crick pairing, melting of the DNA molecule; structure of tRNA . 16

## Reference

1. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson Michael M. Cox Publisher: W. H. Freeman; Fourth Edition edition (April 23, 2004) ISBN-10: 0716743396 ISBN-13: 978-0716743392
2. A Text Book of Biochemistry, E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen Oxford and IBH Publishing Co., New Delhi, 1974
3. Biochemistry (2004) by Donald Voet, Judith G. Voet **Publisher:** John Wiley & Sons Inc **ISBN:** 047119350X **ISBN-13:** 9780471193500, 978-0471193500
4. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance **Publisher:** Mcgraw-hill Book Company – Koga **ISBN:**0697142752 **ISBN-13:** 9780697142757, 978-0697142757
5. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K **Publisher:** Pearsarson **ISBN:** 0131977369, **ISBN-13:**9780131977365, 978-0131977365
6. Biochemistry 6th Edition (2007) by Jeremy M. Berg John L. Tymoczko Lubert Stryer **Publisher:** B.i. publications Pvt. Ltd **ISBN:**071676766X **ISBN-13:** 9780716767664, 978-716767664
7. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-245

## **BTPG02.CELL BIOLOGY AND GENETICS**

**4hours/week**

**Credit:4**

### **Unit 1**

Membrane proteins, lipids. Fluid mosaic model, membrane fluidity, asymmetry, lipid raft, functions of membrane proteins & lipids. Functions of the memb: delineation and compartmentalization, localization & organization of function, regulation of transport: porins facilitated diffusion, porter molecules; Facilitated transport: symport, antiport, uniport, anion porter, glucose porter; Active transport: proton pumps; Na<sup>+</sup> K<sup>+</sup> pumps, Ca<sup>2+</sup> pumps; Ionic channels: general characteristics of ionic channels, types of ionic channels . 5

### **Unit 2**

ER: Rough and smooth ER, functions, Golgi complex: structure, types, modification of proteins, protein sorting and trafficking, secretory pathways, exo and endocytosis, coated pits and vesicles, Lysosomes and peroxisomes: enzymatic components and functions, Cytoskeleton: Microtubule, assembly and organization, microfilaments: actin structure and assembly, Intermediate filaments, types, filament based movement in muscle, sliding filament model. Mitochondrion: structural features and functions, Chloroplast structural features and functions, photosystems, LHC, rubisco, Cell junctions- tight, gap junctions. 15

### **Unit 3**

**Signal**

transduction: electrical impulses and their transmission: Structure and electrical properties of neurons, resting potential, action potential, propagation of action potential, voltage gated and ligand gated channels, synaptic transmission ,chemical signals and receptors, second messengers: cAMP, Ca ions, Ras pathway, glycogen breakdown by epinephrine.

Nucleus, structure of chromosomes, chromosome banding, mitosis and meiosis, chromosomal organization Cell cycle: G1, S,G2, M phases, model organisms, MPF, cyclins, checkpoints, Role of Rb & p53. Cell cycle inhibitors 25

Cellular differentiation: maternal, segmentation and homeotic genes,hox genes, gene interactions bicoid- nanos system. Differentiation in plants, floral development-apetalous,

pistillate, agamous interactions. Cell death and cancer: Apoptosis and necrosis, apoptotic pathways, theories on apoptosis, types of tumor, induction of cancer, properties of cancer cells, oncogenes and c onco genes, tumor suppressors, Molecular pathways- PIP3 Akt, MAP kinase. Aging.

#### **Unit 4**

Mono, di and trihybrid crosses, dominance, epistasis, pleiotropic interactions, multiple alleles-ABO blood groups, pseudoalleles, atavism, linkage, sex linkage, sex influenced genes, sex limited genes, linkage groups, two point and three point test crosses, determination of gene order, chromosome mapping, inherited disorders in metabolism-maple syrup urine disease, Lesch Nyhan syndrome, Cytoplasmic inheritance, cytoplasmic male sterility, Down's syndrome, polyploidy, aneuploidy, structural and functional genomics. 25

#### **Unit 5**

Behavioral genetics, Hardy Weinberg principle, natural selection, genetic drift, Genetic variation, Allele frequencies and its changes, mutation, gene flow, random mating, inbreeding, outbreeding, assortive mating, hybrid vigour. 10

#### **Reference**

1. Principles of Genetics, Snustad, Simmons and Jenkins, John Wiley And Sons Inc
2. Genetics, Robert Weaver and Philip Hendricks, WH.C. Brown Publishers, Iowa
3. Fundamentals of Genetics, B D Singh, Kalyani Publishers
4. Introduction to Genetic Analysis, Griffiths, Wessler, Lewontin, Gelbart, Suzuki and Miller, Freeman's and Co, New York
5. Principles of Genetics: A.G.Gardner, John Wiley and sons.
6. Cell Biology, Smith and Wood
7. Cell and Molecular Biology by Gerald Karp, Academic Press
8. Cell and Molecular Biology Cooper, Hausman, ASM Press.
9. World of the Cell, Becker, Reece, Poenie, The Benjamin/Cumming's Pub.
10. Cell Biology, Lodish et al, W H Freeman and Co., New York.
11. Cell Biology, Thomas D Pollard and W.C.Earnshaw, Saunder's Publishers

# **BTPG03 BIOPHYSICS AND BIOINFORMATICS**

**3hours/week**

**Credit:3**

## **Unit 1**

Laws of thermodynamics, the concept of enthalpy, entropy and free energy, thermodynamic equilibrium, redox potential, high energy molecules, examples of redox potential in biological system. 6

## **Unit 2**

DNA polymorphism, GC content and denaturation kinetics, Cot curve, DNA-Protein interaction-. Lambda repressor and cro binding to DNA. Interactions of transcription factors, Leucine Zipper, Cys-His, Zinc fingers. Histone-DNA interaction, RNA protein interactions DNA-drug Interaction . 12

## **Unit 3**

Structural implication of peptide bond, ramachandran plot, protein families, alpha domains, beta domains, alpha- beta domains ,Protein-drug interaction peptide mass fingerprinting using MALDI-TOF, MASCOT database. Energy minimization in molecular docking

10

## **Unit 4**

Introduction to Bioinformatics, Internet, - data mining Online databases and search tools, data organization, Biological data bases, structural data bases, DNA and RNA sequence data bases, genomic sequences, protein seq data bases, Distance matrix methods and parsimony. Multiple sequence alignments-tree alignments, star alignments, pattern in pair wise alignment, genetic algorithm 10

## **Unit 5**

Sequence analysis softwares, SS search, BLAST,FASTA,CLUSTAL, Phylogenetic analysis , construction of phylogenetic tree, evolutionary changes in nucleotide and protein sequences , structure prediction, structural alignment tools, homology modeling, drug design

Applications of Bioinformatics: pharmaceutical industry, immunology, agriculture, forestry, basic research, cheminformatics in biology, geoinformatics, legal ethical and commercial considerations 16

**Reference:**

1. Introduction to protein structure: Branden and Tooze, Garland Science Pub.
2. Introduction to Biophysics-Rodney Cotterill
3. Molecular Biophysics- Volkenstein M.V, Academic Press
4. DNA topology- Andrew D Bates, Maxwell, Oxford University Press
5. Introduction to Biophysics-Sokal R.R & Rohlf. F.J, Freeman & Co.
6. Bioinformatics: Sequence and Genome analysis- David Mount, Cold Spring Harbour Lab Press, New York.
7. Bioinformatics and Molecular evolution: Paul G Higgs, Teresa K Attwood. Blackwell pub.

## **BTPG04 INSTRUMENTATION AND BIOSTATISTICS**

**Number of Hours / Week: 4**

**Credits: 4**

### **Unit 1.**

Microscopy: Light, SEM, TEM, phase contrast, polarization, confocal and interference microscopy, CCD camera, Introduction to Atomic force microscopy. Spectroscopy: Beer-Lamberts law, Principle, Instrument Design, methods and Applications of UV-Visible spectra, IR spectra, Raman Spectra, Fluorescence spectra, NMR and ESR spectra. 15

### **Unit 2**

Principle, Instrument Design, methods and Applications of Polarimetry, ORD, CD, Light scattering, Refractometry, Flowcytometry, X-ray diffraction by crystals, Electron diffraction, Application in Biology, autoradiography, GM counter, Liquid scintillation counting biosensor, dialysis, ultrafiltration 20

### **Unit 3**

Principle, Instrument Design, methods and Applications of Chromatography, ion exchange, molecular sieve, affinity chromatography, TLC, GC, HPLC, Centrifugation and Ultra centrifugation, PAGE, SDS PAGE, Capillary Electrophoresis, isoelectric focusing, Potentiometry, pH meter, ion selective electrodes. 20

### **Unit 4**

Introduction to Biostatistics. Scope of Biostatistics, probability and probability distribution analysis. Variables in biology- collection, classification and tabulation of data- graphical and diagrammatic representation- scatter diagrams, histograms- frequency polygon- frequency curve- logarithmic curves. Descriptive statistics- measures of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic mean. Measures of dispersion, standard deviation, standard error, variance, coefficient of variation. Correlation and Regression. 15

## **Unit 5**

Test of significance. Basic idea of significance test- hypothesis testing, levels of significance, Chi-square test and goodness of fit, comparison of means of two samples, three or more samples. Statistical packages. 10

### **Reference**

1. Practical biochemistry Keith Wilson and John Walker Cambridge edn.
2. Modern experimental Biochemistry- Rodney Boyer, Pearson education.
3. Statistical methods in Biology- Briley N.J.T
4. Biostatistics PN Arora and P K Malhan Himalaya Pub.
5. Biophysics- R N Roy, New Central Agency.

## **BTPG05 LABORATORY COURSE 1**

**Number of Hours / Week: 4**

**Credits: 4**

**(Biochemistry, Cell biology & Genetics)**

1. Preparation of solutions:

- Percentage solutions, Molar, Normal solutions, Dilution of Stock solutions

2. Preparation of buffers using the Henderson Hasselbach equation

3. Spectrophotometric experiments:

Verification of Beer Lambert's law, Quantitative estimation of reducing sugars by Dinitrosalicylic acid method, Quantitative estimation of Methionine by Nitroprusside method, estimation of protein- Biuret, Lowry, Bradford Method, Estimation of Cholesterol by Zak's method, Estimation of DNA, RNA.

4. Chromatographic techniques

- Separation of amino acids by Paper chromatography (Descending /Ascending)
- Separation of Plant pigments by Thin layer chromatography

5. Extraction of Polysaccharides (Starch, Glycogen), Proteins, from appropriate source:

- Quantification of isolated polysaccharide (anthrone method), protein and lipids
- Saponification value, iodine value, of fat sample

6. Identification of mitotic cell cycle stages, problems in Genetics.

7. Problems in biostatistics

## **SECOND SEMESTER**

# **BTPG06 Microbiology**

**Number of Hours / Week: 4**

**Credits: 4**

## **Unit I**

The historical foundations and development of microbiology. Microbial diversity - Prokaryotic and eukaryotic microbial diversity .The bacteria and the archaea. Principles of bacterial taxonomy Molecular methods in taxonomy. Morphology and structure of bacteria. Surface structures and inclusions of bacteria. Viruses- unique properties, morphology and structure. Virus, Viral replication. Viral diversity –bacterial, plant and animal viruses. Fungi – properties and classification.

## **Unit II**

Factors influencing microbial growth. Environmental and nutritional factors. Nutritional types of bacteria. Microbial locomotion – flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis and other taxes. Cultivation of bacteria- culture media and methods. Measurement of bacterial growth. Bacterial growth curve. Binary fission, Growth cycle, Thermophiles, mesophiles, halophiles, psychrophiles. Continuous cultures. Maintenance and transport of cultures.

## **Unit III**

Identification of bacteria. Staining reactions. Cultural, physiological and biochemical characteristics. Sterilisation – Principles and methods, physical and chemical methods. Disinfectants – modes of action. Testing of disinfectants. Antibiotics – mechanism of action. Drug resistance in bacteria. Antibiotic sensitivity tests.

## **Unit IV**

Genetic materials in bacteria. Bacterial chromosome. Extrachromosomal genetic elements. Plasmid, Transposons. Mutation, DNA repair, Mutant selection. Mechanism of gene transfer – transformation, transduction and conjugation

## **Unit V**

Microbial metabolism. Central pathways, Glycolysis, Pentose phosphate pathway, Entner Doudoroff pathway, TCA cycles, Electron transport chain, Aerobic and anaerobic respiration. Fermentation. Anaplerotic reaction. Peptidoglycan synthesis, Bacterial photosynthesis

## **Reference**

1. Principles and practice of disinfection, preservation and sterilization – Russel AD et al, Blackwell scientific publications
2. Antimicrobial drug resistance, Bryan LE (Ed.), Academic press
3. Topley and Wilson's Principles of bacteriology, virology and immunology – Arnold – Heinemann.
4. Microbiology. Bernard D.Davis et al., Harper International Edition
5. Zinsser Microbiology. Printice Hall International Inc.
6. Manual of methods for General Bacteriology. Gerhardt P et al., (ED.). American Society for Microbiology
7. Microbiology concepts and applications. Pelczer Jr. Chan. Creig. Mc Graw Hill, Inc
8. Microbiology. Prescott, Harley and Klein wim C Brown publishers

# **BTPG07 Immunology**

**Number of Hours / Week: 4**

**Credits: 4**

## **Unit I**

Types of immunity. Innate and acquired. Mechanisms of innate immunity, Organs and cells with immune functions. Differentiation of Lymphocytes and lymphocyte maturation. Types of infections.

## **Unit II**

Antigens, Antigenicity, Epitopes, Antibodies, Immunoglobulin – structure, classes and functions. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, V(D)J rearrangements; somatic hypermutation and affinity maturation Antigen- antibody interactions, Agglutination, Precipitation, immunodiffusion, Immunofluorescence, Complement fixation, Radioimmuno assay, ELISA, Western blotting, immunoelectrophoresis.

## **Unit III**

Humoral and cell mediated immune response, Receptors on T and B cells , MHC, Antibody production, Primary and secondary immune modulation, Clonal selection theory, Monoclonal antibodies – production and application, Antibody engineering. Complement system, Complement activation and pathways, Biological effects of complements, Antigen processing and presentation, Activation of T-cells, T-cell function, Cytokines, Cell mediated immune response, CTL mediated, NK cells, ADCC

## **Unit IV**

Immunology of organ and tissue transplantation, Allograft reaction and GVH reaction, Factors influencing allograft survival, Immunology of malignancy, Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, ABO and Rh blood group system, Immunology of blood transfusion.

## **Unit V**

Immunological Tolerance, Autoimmunity, Mechanisms of autoimmunization, Autoimmune diseases. Inflammation, Hypersensitivity – immediate and delayed reactions, Clinical types of hypersensitivity, Immunodeficiency diseases, Immunoprophylaxis, Vaccines: types of vaccines, DNA vaccine, recent trends in vaccine development.

## **Reference**

1. Essential Immunology - Ivan M. Roitt and Peter J delves, Blackwell Publishing
2. Immunology - Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, and Janis Kuby, W H Freeman and Co.
3. Immunobiology - Charles A. Janeway Jr., Paul Travers, Mark Walport and Mark J. Shlomchik, Garland Publishing.
4. Essential Clinical Immunology – Helen Chappel and Mansel Haeney, ELBS/Blackwell Scientific Publications
5. Introduction to Immunology – John W, Kimball Maxwell, Mac Millan International Edition.
6. Text book of Microbiology – R. Ananthanarayanan and C K Jayaram Panicker. Orient Longman.

## **BTPG08 Molecular Biology**

**Number of Hours / Week: 4**

**Credits: 4**

### **Unit-1**

Organisation of genome: genes, related sequence, split gene concept, exons, introns, intergenic DNA-repetitive sequences-interspersed repeats-SINE, LINE transposons- types (IS elements, replicative transposons, retrotransposons) & significance, tandem repeats-micro, minisatellites

**5**

DNA Replication Models of DNA Replication, Conservative, Semiconservative and discontinuous, Messelson and Stahl experiment, Steps in initiation of replication, Enzymatic factors involved, Ori site, Okazaki fragments, Termination of replication, DNA polymerases in eukaryotes and prokaryotes, Klenow fragment, Primosome, SSB, Ligase, modes of replication, theta, rolling circle, d-loop replication, repetitive DNA sequences, end problem of replication, microsatellite, telomerase, Inhibition of replication. Role of enzymes in proof reading, Repair mechanisms: Excision Repair, BER, NER, mismatch repair, SOS repair, Recombination repair systems.

**15**

### **Unit-2**

Process of transcription, promoters, Enhancers, stages in initiation, RNA polymerases in prokaryotes and eukaryotes, sigma factor in prokaryotes, elongation, Rho dependant and Rho independent termination, Transcription factors in Eukaryotes, CpG islands, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications, Polyadenylation, capping, r-RNA processing, Splicing-Spliceosome, lariat structure, Group I, II and III Introns, catalytic RNA Importance of ribozyme, properties, application, RNase P, RNase III, RNase H. monocistronic and polycistronic m-RNA, Joint transcript of r-RNA and t-RNA in prokaryotes and their processing, Transplicing, alternate splicing, inhibitors of Transcription, mRNA stability and degradation.

**20**

### **Unit 3**

Process of translation. Stages in translation, genetic code, properties, wobble hypothesis, eukaryotes and prokaryotes ribosomes, m-RNAs, t-RNAs, aminoacyl t-RNA synthetases, protein

factors initiation complex, peptidyl transferase, releasing factors, differences between prokaryotic and eukaryotic systems, inhibition of translation. function, **10**

#### **Unit4**

Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system,+ & -ve regulation; Operon concept, structure of operon, Lac, Trp, Ara operon, Catabolic repression, Attenuation. Multiple levels of eukaryotic gene regulation: Histone acetylation and deacetylases, methylation and demethylation, chromosome remodeling complex, Gene amplification, transcription level: differential transcription, Translational control, Intron splicing. Role of Hormones in gene regulation. **15**

#### **Unit5**

R.N Ainterference, Antisense RNA, SiRNA, MicroRNA, Ribozwitches & their applications; Telomerase structure and function, Nucleic acid as therapeutic agent, prions, prion disease in mammals – CJD, scrapie. Human genome project and its implications. **10**

#### **Reference**

- 1 REA's Problem Solvers in Genetics, Research Education Association, 61, Ethel Roadwest, New Jersey
2. Modern Genetic Analysis, Griffiths, Lewontin, Gelbart, and Miller, Freeman's and Co, New York
3. Genes X: Benjamin Lewin
4. Cell and Molecular Biology by Gerald Karp, Academic Press
5. Genomes: T A Brown, John Wiley & Sons
6. Molecular Biology: David P Clark, Elsevier.
8. Principles of gene manipulation – Old, Twyman and Primrose
9. Gene cloning and DNA analysis – T. A. Brown
10. Genes-Benjamin Lewin

## **BTPG 09 Metabolism and Enzymology**

**Number of Hours / Week: 3**

**Credits: 3**

### **Unit 1**

Metabolism of carbohydrates: Glycolytic pathway, substrate level phosphorylation, oxidative phosphorylation, Electron transport chain: structural components of the chain, complexes, free elements; Chemiosmosis ATP synthesis: structural and functional properties of ATP synthesis; Inhibitor agents and decoupling agents of the respiratory chain and ATP synthesis; Regulation of glycolytic pathway, Gluconeogenesis and Glycogenesis. **10**

### **Unit II**

Metabolism of Proteins, and nucleic acids: Synthesis of amino acids, degradation, deamination, transamination, urea cycle Synthesis of purines and pyrimidines, salvage pathway, degradation, regulation of pathways **10**

### **Unit III**

Metabolism of lipids, Oxidation, synthesis of fatty acids, FAS, synthesis of cholesterol, degradation of cholesterol. **8**

### **Unit IV**

Holoenzyme, apoenzyme, and prosthetic group; Interaction between enzyme and substrate- Features of active site, activation energy, Rate Enhancement Through Transition State Stabilization, Enzyme specificity and types; Enzyme Commission system of classification and nomenclature of enzymes. Measurement and expression of enzyme activity, Definition of IU, katal, enzyme turnover number and specific activity, Isolation of enzymes and the criteria of purity; Characterization of enzymes

Order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction- Derivation of Michaelis -Menten equation and  $K_m$  value determination and its significance, Definition of  $V_{max}$  value of enzyme and its significance, Lineweaver- Burk plot; Bi-substrate reactions: Classification, Reaction mechanisms; Allosteric enzymes: Examples, Sigmoidal Kinetics for Nonallosteric Enzymes. **14**

### **Unit V:**

Enzyme inhibition and regulation: Reversible and irreversible – examples. Reversible-competitive, noncompetitive and uncompetitive inhibition; Structure—Activity Relationships and

Inhibitor Design; Tight Binding Inhibitors: Identifying Tight Binding Inhibition, examples; Time-Dependent Inhibition: examples; Distinguishing between modes of inhibitor interaction with enzyme Covalently modulated enzymes with examples of adenylation and phosphorylation; Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; Allosteric regulation: example Aspartate transcarbamoylase, Isoenzymes- Lactate dehydrogenase and creatine phosphokinase. Application of enzymes: Industrial uses of enzymes: Diagnostic and therapeutic enzymes 12

## Reference

1. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis Stevens (2000) Publisher: Oxford University Press, USA ISBN: 019850229X ISBN-13: 9780198502296, 978-0198502296
2. Enzyme Kinetics and Mechanisms by Taylor Publisher: Spring ISBN: 8184890478 ISBN-13: 9788184890471, 978-8184890471
3. Biochemistry (2004) by Donald Voet, Judith G. Voet **Publisher:** John Wiley & Sons
4. Enzyme Mechanism by P.K. Shivraj Kumar (2007) Publisher: RBSA Publishers ISBN: 8176114235 ISBN-13: 9788176114233, 978-8176114233
5. Biochemistry 6th Edition (2007) by Jeremy M. Berg John L. Tymoczko Lubert Stryer **Publisher:** B.i.publicationsPvt.Ltd **ISBN:**071676766X **ISBN-13:** 9780716767664, 978-716767
6. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K **Publisher:** Pearson **ISBN:** 0131977369, **ISBN-13:**9780131977365, 978-0131977365
7. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (second Edition) by Trevor Palmer, Philip Bonner (2007) Publisher: Horwood Publishing Limited ISBN: 1904275273 ISBN-13:9781904275275,978-1904275275

## **BTPG10 Laboratory Course-II**

**Number of Hours / Week: 4**

**Credits: 4**

### **Microbiology and Immunology**

- Microscopic examination of bacteria in living conditions
- Testing of motility
- Staining procedures- simple stain, differential staining- Gram staining, flagellar staining
- Sterilisation methods
- Cultivation of bacteria and fungi
- Study of cultural characteristics and biochemical reaction of bacteria
- Testing of disinfectants
- Antibiotic sensitivity tests
- Immunodiffusion in gel
- Serological tests for the diagnosis of microbial infections-RPR, RF, ASO.
- Agglutination and precipitation tests
- ELISA

### **Metabolism and Enzymology**

- Estimation of enzyme activity ALP , SGOT, SGPT
- Determination of  $K_m$  and  $V_{max}$
- Effect of pH, Effect of temperature on enzyme activity
- Enzyme inhibition studies- estimation of  $K_I$ .
- Purification of the enzyme- Ammonium sulphate precipitation  
A) Dialysis B)Gel Filtration C)Ion Exchange chromatography  
D) PAGE/SDS - PAGE

# **THIRD SEMESTER**

# **BTPG11 BIOPROCESS TECHNOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

## **Unit 1.**

Isolation of Industrially important microorganism, Primary and secondary screening methods. Methods of strain improvement. Preservation and maintenance. .

## **Unit 2**

Batch culture, specific growth rate, substrate saturation constant, yield coefficient, Monod kinetics, substrate affinity, Continuous culture, Dilution rate, Washing out, Fed batch culture maintenance coefficient, Product yield, solid state, submerged fermentations, Aerobic anaerobic fermentations, Media preparation.

## **Unit 3.**

Bioreactor Parts, function of each part, probes, valves, agitators, aerators, baffles, Types of bioreactors: CSTR, Pneumatically driven fermentors, , Airlift fermentor, Packed Bed, reactor , Fluidized Bed reactor, Reactor performance, oxygen transfer in reactor system , Resistances against oxygen transfer,  $K_La$ , Reynold's number, types of fluids.

## **Unit 4.**

Instrumentation of bioreactor online and offline control. pH probe, temperature probe, DO probe, Tacchometer, Load cells Control of Bioreactor, Downstream processing: filtration, centrifugation, cell disruption, liquid/liquid extraction, dialysis, Purification, Drying, Packing and labeling. Market Potential, Good Manufacturing Practices.

## **Unit 5.**

Primary metabolites, secondary metabolites. Fermentative production of alcohol, acetone butanol, citric acid, acetic acid, lactic acid, amino acids, vitamins. Antibiotics-penicillin, streptomycin, cephalosporin, tetracycline. Microbial production of enzymes-amylase, protease, cellulose, pectinase, SCP production. Bread manufacturing, beer manufacturing, Cheese

manufacturing, rennet preparation, fermented dairy products and production of distilled beverages.

## Reference

1. Principles of Fermentation Technology, P.F.Stanbury, A Whitaker and S.J.Hall, , 2008. Elsevier
2. Bioprocess Technology, P.T. Kalichelvan and I Arul Pandi, , 2009,MJP Publishers, Chennai.
3. Bioprocess Engineering, M.Shuler & F.Kargi (2002). Prentice Hall (I) Ltd., N.Delhi.
4. Bioprocess Technology- Kinetics and reactors ,Antan Moser and Philip Manor,.1998, Springer
5. Fermentation Microbiology and Biotechnology ,E.M.T. Mansi, C.F.A . Bryce. A.L..Dmain, A.R.Alliman. ,2009, Taylor and Francis. New York
6. Comprehensive Biotechnology. Second edition, Elsevier, 2011, Murray Mor. Young ( Editor in chief). ISBN-978-0-08-088504-9
7. Industrial Microbiology, Cassida L.E. 1968.John Wiley and Sons Publishers.

## **BTPG12 RECOMBINANT DNA TECHNOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **Unit I**

Histroy. Enzymes for in vitro manipulation – site specific recombinases, thermophilic polymerases, topoisomerases Restriction Endonucleases , Kinases , Phosphatases , DNA Polymerases, Ligases, Terminal Transferases, isolation of genetic material, Modification of Ends , Adapters, Linkers, Homopolymer Tailing, genomic and c DNA library. 12

### **Unit II**

Cloning Vectors Plasmids, desirable properties, E coli based vectors, pBR, pSC, pUC, , pGEM3Z, M13vectors mp7, Bacteriophages pEMBL Cosmids, Phasmid , Phagemids with special reference to pBluescript, , pLITMUS, Gateway Cloning, TA cloning Shuttle Vectors pCAMBIA, Vectors for Yeast (YEP, YIP, YRP, YCP,YAC) Artificial Chromosomes, BAC, PAC Mammalian Expression vectors , Plant vectors, CaMV, geminivirus, Ti plasmid 16

### **Unit III**

Gene transfer in prokaryotes, Chemical transfection:Calcium phosphate mediated, Polyplexes mediated, Liposomes and lipoplexes mediated. Electroporation, Biolistics Selection of recombinants, markers in prokaryotes, plants, animals. Blue white screening, Antibiotic resistance, Maximising protein expression in Bacteria, fungi and animal cells – Promoters, and reporter systems. Expression vectors ,Fusion tagged expression system, Reporter Assay, studying the translation product- hybrid arrest and hybrid release translations. Nuclear transfer technology and. Inducible expression system and control of transgene expression through naturally inducible promoters – lac and tet. Steroid hormones as heterologous. inducers. Chemically induced dimerisaion (CID) as inducible transgene regulation. Site specific recombination for efficient gene targeting. systems to study translation 20

### **Unit IV**

Blotting techniques:southern, northern, southwestern, PCR types and applications, DNA foot printing, finger printing, gel shift analysis, DNA microarray, RFLP, RAPD, advanced

molecular markers, chromosome walking, chromosome jumping. DNA sequencing, Site directed Mutagenesis: methods. 18

## **Unit V**

Applications of recombinant DNA technology, recombinant hormones, Gene therapy, Metabolite engineering, Imparting new agronomic traits to plants – resistance to abiotic and biotic stress, improving quality and quantity. Gene Silencing, RNA interference, antisense therapy, Gene Knockout, , animal pharming, nanoparticles for labeling, delivery of drugs and DNA, RNA. Bioethics: laws, possible dangers to society or nature. 14

## **Reference**

1. Principles of gene manipulation – Old and Primrose, Blackwell Scientific publishers, Edns 5<sup>th</sup> , 6<sup>th</sup> and 7<sup>th</sup>.
2. Molecular Biotechnology – Glick and Pasternac
3. From gene to genomes – Dale and Shantz
4. Gene cloning :An Introduction, T A Brown, Chapman and Hall Pub.
5. Biotechnology: An Introduction, Susan R Barnum. Pub: Thomson, Brooks/Cole
6. Molecular cloning : A laboratory Manual, Sambrook and Russel, Cold spring Harbor Lab Pub.
7. DNA science : A first course in rDNA Technology: David Mickols, Carolina Biological Supply.

## **BTPG13 PLANT AND ANIMAL BIOTECHNOLOGY**

**Number of Hours / Week: 3**

**Credits: 3**

### **Unit-I**

Animal cell; History of animal cell culture; Laboratory setup and equipments; Types of cell culture media, Selection of media, media constituents ,CO<sub>2</sub> & bicarbonate, Buffering, Balanced salt solution, Cell culture vessels; Preparation &sterilization of cell culture media, Different culture techniques, Secondary culture, Disaggregation of tissue , Trypsinization; cell separation, Continuous cell lines, Passaging number; characteristics of animalcells cultures; Suspension culture; Organ culture and Histotypic cultures; Embryonic and Adult stem cell culture. 10

### **Unit II**

Transfection and Transformation of cell, Vectors for animal cells SV40, Adenovirus vectors, Baculovirus, lenti virus, poxyvirus, Measurement of viability & cytotoxicity; Cell cloning and selection; Cell synchronization; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins. Hybridoma technology and its application; Three dimensional culture and tissue engineering. Transgenesis, transgenic mice, fish, cattle. Maintenance of cell Lines Cryopreservation and Germplasm storage; Application of animal cell culture for invitro testing of drugs and testing of toxicity of environmental pollutants; 10

### **Unit III**

Conventional plant breeding. Introduction to cell and tissue culture; Requirements of tissue culture lab, Tissue culture media: Composition and Preparation. Sterilization and agents of sterilization used in tissue culture labs. Initiation and maintenance of callus and suspension cultures. Shoot tip culture; micropropagation, Rapid clonal propagation and production of virus-free plants. Embryo culture and embryo rescue; Single cell clones. Organogenesis; Somatic embryogenesis; Transfer and establishment of whole Anther, pollen and ovary culture for production of haploid plants and homozygous lines. plants in soil. triploid production, 14

## **Unit IV**

*Agrobacterium* mediated DNA transfer. Basis of tumour formation; Hairy root; Features and Use of Ti and Ri plasmids; Mechanisms of DNA transfer; Role of virulence genes; triparental mating, Binary vectors; Use of 35S and other promoters; Genetic markers; reporter genes; Reporter gene with introns; Methods of nuclear transformation, Viral vectors and their applications; Multiple gene transfers, Vector-less or direct DNA transfer, Transformation of monocots, Transgene stability and gene silencing. 8

## **Unit V**

Protoplast isolation, culture and fusion; Selection of hybrid cells and regeneration of hybrid plants; Symmetric and asymmetric hybrids, cybrids. Chloroplast transformation Sexual incompatibility, Cryopreservation; Slow growth and DNA banking for germplasm conservation.

Application of plant transformation for productivity and performance Herbicide resistance, insect resistance, Bt genes, Non Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated disease resistance, disease resistance, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stressmarker aided breeding –an introduction.– Advantages, Metabolic engineering and industrial products – Plant secondary metabolites. 10

## **Reference**

1. Freshney, culture of Animal cell, 5<sup>th</sup> edition
2. Ed. John R.W Masters Animal cell culture- Practical approach 3<sup>rd</sup> edition, Oxford university press-2000
3. In Vitro cultivation of Animal cells. Elsevier India PVT LTD-17-A/1 Main Ring Road, New Delhi-110024
4. R.Sasidhara, Animal Biotechnology MJP publishers-Chennai.
5. Plant biotechnology – J Hammond, et. al., Springer Verlag.
6. Biotechnology in crop improvement – H S Chawla.

7. Practical application of plant molecular biology – R J Henry, Chapman & Hall.
8. Elements of biotechnology – P K Gupta.
9. An introduction to plant tissue culture – M K Razdan.
10. Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
11. Principles of plant biotechnology: An introduction to genetic engineering in plants – SH Mantell, et. al.
12. Advances in biochemical engineering / Biotechnology – Anderson, et. al.
13. Plant cell and tissue culture – S Narayanswamy, Tata Mc

## BTPG14 ENVIRONMENTAL BIOTECHNOLOGY

Hour/ week: 4

Credits: 4

### Unit 1

Xenobiotics, biological impacts of polychlorinated biphenyls and dioxans, synthetic polymers, alkylbenzyl sulphonates, hydrocarbons, chlorinated pesticides, heavy metals. biomagnification of recalcitrant molecules Microbial infallibility, types of biodegradation, factors affecting biodegradation, enzymes involved in biodegradation, catabolic plasmids, Molecular Approaches, Biodegradation of Hydrocarbons, cellulose, lignin, pesticides. Bioremediation strategies. 16

### Unit 2

*Bacillus thuringiensis* as a pesticide, viral pesticide, use of biological fertilizers, biological nitrogen fixation: AM, cyanobacteria, molecular mechanism of nitrogen fixation in root nodules, nonsymbiotic nitrogen fixation- *Clostridium* sp., biosurfactants, biofouling, bioleaching. 15

### Unit 3

Types of industrial effluents, characterization of the wastewater. Chemical Oxygen Demand, Biological Oxygen Demand, Total organic carbon, Nitrogen contents, Suspended solids. Total heterotrophic bacterial population. Bacteriological analysis of drinking water, Presumptive, completed, and confirmed test. Treatment strategies primary, Secondary and tertiary treatment. Floc based and film based strategies, aerobic and anaerobic methods. Activated sludge process, different stages, Types. Trickling filter process, Rotating Biological contactor, UASB, Submerged aerobic filters, Fluidized Bed Reactor, Packed bed reactor, Oxidation lagoons. Bioreactors for wastewater treatment 22

### Unit 4

Advanced treatment strategies Tertiary treatment methods, Disinfection, Chlorination, chlorination derived byproducts Solid waste, Types, Problems, Characterization and sorting of

wastes. Land fill, composting, stages in composting, Types of composting vermicomposting. Methanogenesis, stages in anaerobic digestion, methanogens Anaerobic reactors Biogas generation, Household treatment strategies, Present problem and Possible remedies. 15

## **Unit 5**

GLP, GMP, Biosafety , laws and concerns at different levels-individual, institution, society, IPR forms, IPR in India, patents, process of patenting, Indian and International agencies involved in patenting, GATT 12

## **Reference**

1. Environmental Biochnology, Christopher. F Forster, D.A.John Wase, 1987 Ellis Harwood.
2. Comprehensive Biotechnology. Second edition, Elsevier, 2011, Murray Mor. Young ( Editor in chief). ISBN-978-0-08-088504-9
3. Waste water Microbiology, Gabriel Bitton, 2005, John Wiley and Sons, Wiley series in Ecological and Applied Microbiology.
4. Microbial Ecology. Fundamentals and Applications. Atlas and Bartha, Pearson Education , Benjamin Cummingspublishing company.Inc. New Jersey
5. Environmental Biotechnology, sries in Handbook of Environmental Engineering.Vol.10.Wang, L.K., Ivanov V.,Tayi,J.H and Hung Y.T (eds),2010, Humana Press...

## **BTPG15 Laboratory course III**

**Number of Hours / Week: 4**

**Credits: 4**

1. Bacteriological examination of water. MPN Method
2. Bacteriological examination of food and milk sample
3. Fermentative production of wine and estimation of alcohol content
4. Fermentative production through Solid state fermentation
5. Immobilisation of microbial cells for enzyme production
6. Estimation of COD
7. Estimation of BOD
8. Bioreactor studies for waste management
9. Biogas production
10. Composting techniques
11. Mushroom cultivation
12. Fermentative production of industrially useful enzyme
13. Plant tissue culture techniques
14. Surface sterilization
16. Callus culture
17. Anther culture
18. Emryo culture
19. Protoplast isolation
20. Somatic Hybridization

# **FOURTH SEMESTER**

## **BTPG16 Laboratory Course IV**

**Number of Hours / Week: 4**

**Credits: 4**

1. DNA isolation
2. RNA isolation
3. Conjugation
4. cDNA preparation
5. Competent cell preparation
6. Transformation
7. Plasmid isolation
8. Restriction enzyme digestion
9. Ligation
10. Screening of recombinants
11. Expression and purification of recombinant proteins
12. Blotting techniques
13. RFLP,
14. Amplification of selective gene by PCR
15. Molecular marker studies: RAPD, SCAR, AFLP, SNP
16. Basics of Bioinformatics

## **Elective Papers in Fourth Semester**

*In the revised Credit and Semester System three electives are being offered in the fourth semester programme. The student can select three electives, from the following list. The electives are being scheduled as twenty topics which includes specific Biotechnology related topics along with certain fundamental topics. The content of each course is carefully scheduled so as to bring out the latest trends in the subject for student review. The title and the syllabus content has been primarily formulated by the faculties of the Biotechnology post graduate programme in various affiliated colleges of Mahatma Gandhi University **The student should register for three electives selected from the list of the twenty electives as per the advice given by their concerned course coordinator. All the electives carry 4 credits***

## **ELECTIVES**

- 1. Advanced methods in molecular diagnostics**
- 2. Biotechnology in molecular pathogenesis and clinical diagnosis**
- 3. Biotechnology in forensic medicine**
- 4. Genomics, Proteomics and Nanotechnology**
- 5. Molecular Breeding**
- 6. Molecular markers in cancer**
- 7. Cancer Biology**
- 8. Project management, Pharmacoeconomics and pharmacogenomics**
- 9. Biopharmaceuticals and applications of Nanotechnology**
- 10. IPR, Biosafety and Biodiversity**
- 11. Biotechnology and IPR**
- 12. Microbial Biotechnology**
- 13. Microbial food safety**
- 14. Food Biotechnology**
- 15. Nutritional Biochemistry**
- 16. Neurobiochemistry**
- 17. Developmental Biology**
- 18. Physiology**
- 19. Environmental Science**
- 20. Evolution and behavior**

## **ELECTIVE 1**

### **BTPG19E ADVANCED METHODS IN MOLECULAR DIAGNOSTICS**

#### **Unit I**

Introduction. Nucleic Acid Extraction: Human Genomic DNA-Phenol Chloroform Extraction, Salting-Out Method, Solid-Phase Adsorption, Magnetic DNA Extraction; RNA Isolation- Phenol-Chloroform Extraction, Other Chemistries.

Electrophoretic Methods for mutation detection: SSCP, heteroduplex analysis, DGGE, Chemical Cleavage of mismatched nucleotides, Ribonuclease cleavage of mismatched DNA: RNA duplexes

#### **Unit II**

PCR based methods: Polymerase Chain Reaction (PCR), DNA Polymerases, Multiplex Amplification, Labeling PCR, Allele-Specific PCR, Real-Time PCR, Quantitative fluorescent PCR, Rolling-Circle Amplification (RCA) and Multiple Displacement Amplification (MDA), ARMS-PCR, Oligonucleotide Ligation Assay, Primer Extension, Isothermal Amplification: TMA, NASBA, SDA, Multiple Thermal Amplification: Linked Linear Amplification, Ligase Chain Reaction, Representational Difference Analysis (Rda), Serial Analysis Of Gene Expression (SAGE), Differential Display, Sequencing Of Expressed Sequence Tags (EST)

#### **Unit III**

Signal Amplification Methods (enzymatic & non-enzymatic): Branched DNA Amplification, Hybrid Capture, In situ hybridization, Invader Technology, Cleavage reactions, Ramification Amplification.

Methods for Detecting miRNA: Preparation of RNA Sample Containing miRNA, miRNA Detection Methods SNP detection methods and Applications

#### **Unit IV**

The Lab-on-a-Chip Approach: On-Chip Sample Preparation for Molecular Diagnostics, On-chip Extraction of Cell Contents (Protein and Nucleic Acid), PCR-Based Genetic Analysis:

Miniaturization of PCR Devices, Microfluidic DNA Synthesizer , Microfluidic DNA Sequencer; Single Molecule Detection (SMD), Electrokinetic Molecule Focusing, Alternative Three-Dimensional Focusing for SMD Using the Microfluidic Drifting Technique

## **Unit V**

Next-Generation Sequencing: Massively Parallel Sequencing Platforms, 454 GS FLX Titanium, Illumina Genome Analyzer II, SOLiD 3 System; Genomic Isolation Techniques; Paired-End Sequencing; DNA Bar coding Data Analysis and Storage; Clinical Potential and Utility

## **Reference**

1. Molecular Diagnostics : Techniques and Applications for the Clinical Laboratory  
Edited by: Contributors, Wayne W. Grody, M.D., Ph.D., Robert M. Nakamura, M.D., Charles M. Strom, M.D., Ph.D., and Frederick L. Kiechle, MD, PhD. ISBN: 978-0-12-369428-7
2. Molecular Diagnostics: For the Clinical Laboratorial William B. Coleman, Gregory J. Tsongalis
3. Next-Generation Genome Sequencing: Towards Personalized Medicine Michal Janitz
4. Molecular Biomethods Handbook. John M. Walker, Ralph Rapley

**ELECTIVE 2**  
**BTPG20E BIOTECHNOLOGY IN MOLECULAR PATHOGENESIS AND**  
**CLINICAL DIAGNOSIS**

**Unit I**

**Microbes and parasites:** Historical introduction; Bacteria, Fungi, Viruses, Protozoas, Helminthes and Arthropods, Prions; Host-parasite relationship; Infection-mode of transmission in infection, factors predisposing to microbial pathogenecity, types of infectious diseases

**Unit II**

**Invasion of Microbes:** Adsorption to the potential sites, membrane trafficking in eukaryotic cells, routes of invasion and selection of intracellular niche, bacterial manipulation of host cell cytoskeleton, nosocomial infection; Normal microflora of human body; Bacterial toxins and virulence genes; Strategies of host defense.

**Unit III**

**Methods of Disease Diagnosis:** Sampling site-normally sterile and with normal microflora; Sample collection-method of collection, transport and processing of samples, interpretation of results; Diagnostic methods- cultured: microscopy, microbial antigen; non-cultured: PCR based microbial typing: Eubacterial identification based on 16s rRNA sequences-Amplified ribosomal DNA Restriction analysis(ARDRA)-Culture independent analysis of bacteria-DGGE and TRFLP; Molecular diagnosis of fungal pathogens based on 18s rRNA sequences; Detection of viral pathogens through PCR; Monoclonal antibodies.

**Unit IV**

**Diagnosis of Infections :** Bacteria- *Streptococcus*, Coliforms, *Salmonella*, *Shigella*, *Vibrio* and *Mycobacterium*; Fungi-Major fungal diseases, Dermatophytoses, Candidiosis and Aspergillosis  
DNA and RNA Viruses- POX virus, Rhabdo Virus, Hepatitis Virus and Retro Virus.

**UNIT V**

**Diagnosis of Infections** Viruses-AIDS Virus; Protozoan diseases-Amoebiosis, Malaria, Trypanosomiosis, Leishmaniasis; Helminthis diseases-*Fasicola hepatica* and *Ascaris lumbricoides*; Filariasis and Schistomiosis.

## Reference

1. Bailey and Scott's Diagnostic Microbiology (2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissefeld, Ernest A Trevino. Published by C.V. Mosby
2. Medical Microbiology (1997). Edited by Greenwood. D, Slack. R and Peutherer. J, ELST Publishers.
3. Fundamental of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders group.
4. Henry's Clinical Diagnosis and Management by Laboratory Methods (2007). Mepherson.
5. Molecular Diagnostics for the Clinical Laboratorian 2nd ed. (2006). W.B.Coleman. Humana Press.

### **ELECTIVE 3**

## **BTPG21E BIOTECHNOLOGY AND FORENSIC MEDICINE**

### **Unit I**

Immunoglobulin- types, physico-chemical properties and function, raising of anti-sera, Lectins - their forensic significance. Buffers and serological reagents, methods of sterilization employed for serological work. Composition of blood, Formation of blood, Blood groups – history, biochemistry and genetics of ABO, Rh, Mn and other systems. Methods of ABO blood grouping (absorption-inhibition, mixed agglutination and absorption elution) from blood stains and other body fluids/stains viz. menstrual blood, semen, saliva, sweat, tear, pus, vomit, hair, bone, nail etc., blood group specific ABH substances. Secretors and non- secretors. Blood groups that make racial distinctions. Lewis antigen, Bombay Blood groups. HLA antigens and HLA typing . Role of sero-genetic markers in individualization and paternity disputes. Pitfalls in red cell typing.

### **Unit - II**

Determination of human and animal origin from bones, hair, flesh, nails, skin, teeth body tissue, fluids/ stains viz. blood, menstrual blood, semen, saliva, sweat, tear, pus, vomit, etc., through immunodiffusion and immuno - electrophoresis, cross reactivity among closely related species. Individualization of blood stains: Determination of blood groups, sex age and racial origin from dried bloodstains

### **Unit III**

Red cell enzymes : Genetics , polymorphism and typing of PGM, GLO-I, ESD, EAP, AK, ADA etc. and their forensic significance. Serum proteins: Genetics, polymorphism and typing of - Hb, HP, Tf, Bf, C3 etc. and their forensic significance.

### **Unit IV**

Concept of sequence variation - VNSTR, STRs, Mini STRs , SNPs. Detection techniques - RFLP, PCR amplifications, Amp-FLP, sequence polymorphism, Y-STR, Mitochondrial DNA. Evaluation of results, frequency estimate calculations and interpretation, Allele frequency determination, Match probability – Database, Quality control, Certification and Accreditation.

## **Unit –V**

History of DNA profiling applications in disputed paternity cases, child swapping, missing person's identity, civil immigration, veterinary , wild life and agriculture cases . legal perspectives – legal standards for admissibility of DNA profiling – procedural & ethical concerns, status of development of DNA profiling in India & abroad. Limitations of DNA profiling. Population databases of DNA markers –STRs, Mini STRs, SNPs. New & Future technologies: Analysis of SNP, DNA chip technology- Microarrays Cell free DNA , Synthetic DNA.

### **Reference**

1. Rudin, Norah; An Introduction to Forensic DNA Analysis, CRC Leviw Publishers, (2002)
2. Kobiinsky, Lawrence; DNA, John Wiley & Sons, (2005)
3. Newton, David E. ; DNA Evidence and Forensic Science, Viva books private limited, (2010)
4. Kirby, Lorne; DNA fingerprinting, W H Freeman and Co,(1992)
5. T.Burke, Terry; DNA Fingerprinting: Approaches and applications., Birkhauser Verlage, (1991)
6. Singh, Yashpal; DNA tests in Criminal Investigation Trial & Paternity Disputes, Alia Law Agency,(2006)
7. J. Thomas Mcclintock; Forensic DNA analysis, Lewis Publications, (2008)
8. Boorman, Kathleen E, Churchill ; Blood group serology Livingstone,1977

## **ELECTIVE 4**

### **BTPG22E GENOMICS, PROTEOMICS AND NANOTECHNOLOGY**

#### **Unit I**

Overview: Genomes of Bacteria, Archaea, and Eucarya; Genome and topology; chromatin, supercoiling and packaging; Study of genomes- Mapping; Genetic and Physical mapping, Single Nucleotide Polymorphism and RFLP's. Human Genome project.

#### **Unit II**

Biological information of macromolecules. The central dogma of molecular biology. Introduction to Databases, Types of Databases- Flat file database and Relational database. NCBI, Genome and organism specific database-retrieval, Entrez, SRS; Similarity search, amino acid substitution matrices- FASTA, BLAST. Various types of protein family-protein domain families.

#### **Unit III**

Gene finding and annotation; sequence annotation and bioinformatics tools for genomics and genome comparison; analyzing gene expression-DNA microarray-design, analysis and visualization of data. Application of DNA microarrays in prokaryotes, Microarray data analysis. Prediction tools, Bioinformatics in Drug discovery. ESTs.

#### **Unit IV**

Protein structure and function- Methods to quantitative proteins; densitometry and classical methods; two dimensional gel electrophoresis, mass spectrometry - ESI, MS and MALDI; protein expression profiling, protein - protein interactions; RNA interference, Genetic analysis of biomedical diagnostics. Application of bioinformatics for development of vaccine.

#### **Unit V**

Nanotechnology: Basic concepts and introduction; Nanomechanics- Nanotribology; Scanning probe microscopy; nanomaterials and its handling; nanobots and nanofuture, nano-fying Electronics, nanofibres and nanotubes.

## Reference

1. Genomes. Brown, T.A., Wiley - Lis Publications, 2002.
2. Mount David W. Bioinformatics Sequence and Genome Analysis. Cold Spring Harbor Lab Press, CSH New York, 2002.
3. Stephen Misener and S. A. Krawetz. Bioinformatics Methods and Protocols. Humana Press. 2000.
4. Rastogi, S.C, N. Mendiratta, P. Rastogi. Bioinformatics Methods and Applications. Prentice Hall of India, 2004.
5. Bharat Bhushan., Nanotribology and Nanomechanics - An introduction, Springer, Ist edition, 2002

## **ELECTIVE 5**

### **BTPG23E MOLECULAR BREEDING**

#### **Unit I**

Plant Genome – Nuclear and cytoplasmic; Significance of organelle genomes; Genome size and sequence components; Modern gene concept - Gene structure, structural and functional genes.

#### **Unit II**

Molecular markers – Restriction based and PCR based; DNA profiling using different assays- RFLP, RAPD, AFLP, ISSR, SNP etc. Development of SCAR and SSR markers.

#### **Unit III**

Gene flow in plants – Development of mapping population - Marker Assisted Selection (MAS), screening and validation; Trait related markers and characterization of genes involved; Mapping genes on specific chromosomes; QTL mapping; Gene pyramiding; Transcript mapping techniques. Development of ESTs.

#### **Unit IV**

Molecular markers for plant genotyping and germplasm analysis; Fidelity analysis; settling IPR issues; Marker Assisted Breeding in transgenics – herbicide resistance; Pest and disease resistance; Quality enhancement etc.

#### **Unit V**

Recent advances – Non gel based techniques for plant genotyping – Homogenous assays – Qualitative/RealTime assays; DNA Chip and its technology.

#### **Reference**

1. Anolles, G. C. and Gresshoff, P.M., DNA markers – protocols, applications and overviews. Wiley – Liss, New York, 1997
2. Clark, D. P., Molecular Biology, Elsevier, USA, 2005.
3. Henry R. J., Plant Genotyping: The DNA fingerprinting of plants. CABI, New Delhi, 2005.
4. Patterson, Molecular dissection of complex traits, CRC Publications, Washington, 1998.
5. Purohit, S. S., Biotechnology – Fundamentals and Applications, 8th Edition, Agrobios, India, 2007.

**ELECTIVE 6**  
**BTPG24E MOLECULAR MARKERS IN CANCER**

**Unit I**

Introduction and Modern Concepts of Cancer; Biomarkers: single versus multiple; Epigenetics : Methylation of CpG Island

**Unit II**

The Role of Micro-RNAs in Cancer: Concept of RNA Interference (RNAi), Difference between miRNA and siRNA, Role of miRNAs in Cancer, Epigenetics and miRNAs, Expression Profile of miRNA in Various Types of Cancer, Methods for Detecting miRNA, Potential Therapeutic Applications of miRNA in Cancer Treatment

**Unit III**

Current cancer markers: Nucleic-acid-based markers, Cancer-associated mutations., Loss of heterozygosity and microsatellite instability, Single Nucleotide Polymorphisms (SNPs), DNA methylation, Mitochondrial DNA mutations, Viral DNA, RNA-based approaches, Protein markers, Immunological markers, Metabolic biomarkers, Suppressor Genes , MiRNA as a Molecular Tumor Marke, Telomerase, Circulating DNA (Cell-Free), Circulating Nucleic Acids and Proteomics of Plasma/Serum, Serologic Tumor Markers , Glycans as Possible Biomarkers of Tumor

**Unit IV**

Molecular Diagnostic Techniques for Cancer: Genomic technologies: RFLP, LOH, SSCP, sequencing based approaches, PCR, RT\_PCR, Real Time PCR, COLD PCR; Gene expression profiling, cancer cytogenetics, Detection of biomarkers of DNA methylation, PET, Proteomic technologies: Antibody microarray, Aptamers, Phage display, Protein chip technology; Detection of tumour cells in body fluids; Modifications of Mass spectrometry; Assays based on proteins and enzymes: p53, telomerase, survivin

**Unit V**

Examples of Molecular Markers for the early Detection of Cancer: Predictive Markers in Breast and Other Cancers; Circulating Serum/Plasma Tumor DNA, Colorectal Carcinoma, Pancreatic Carcinoma, Lung Carcinoma, Cervical Carcinoma

## Reference

1. The Handbook of Biomarkers By Kewal K. Jain
2. Molecular Diagnostics :**Techniques and Applications for the Clinical Laboratory Edited by:** Contributors, Wayne W. Grody, M.D., Ph.D., Robert M. Nakamura, M.D., Charles M. Strom, M.D., Ph.D., and Frederick L. Kiechle, MD, PhD.
3. Biotechnology- Applying genetic revolution. David P Clark , Nanette J Pazdernik.Elsevier, New York
4. Lewin's Cells. Lynne Cassimeris,Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London
5. The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.

## **ELECTIVE 7**

### **BTPG25E CANCER BIOLOGY**

#### **Unit I**

Fundamentals of cancer biology: Introduction to Cancer Biology, Tumor suppressor genes, modulation of cell cycle in cancer, Different forms of cancers, Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

#### **Unit II**

Principles of carcinogenesis: Theory of Carcinogenesis, Chemical carcinogenesis, principles of physical carcinogenesis, X-ray radiation-mechanisms of radiation carcinogenesis, Diet and cancer.

#### **Unit III**

Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes, Oncogenes/proto oncogene activity, Growth factors related to transformation, Telomerases.

#### **Unit IV**

Principles of cancer metastasis : Clinical significances of invasion, Metastatic cascade, Basement membrane disruption, proteinase and tumor cell invasion.

#### **Unit V**

New molecules for cancer therapy: Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.

#### **Reference**

1. Maly B.W.J, "Virology A Practical Approach", IRLI Press, Oxford, 1987.
2. Dunmock N.J And Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, Oxford, 1988.
3. Biotechnology- Applying genetic revolution. David P Clark , Nanette J Pazdernik.Elsevier, New York
4. Lewin's Cells. Lynne Cassimeris,Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London
5. The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.

## **ELECTIVE 8**

### **BTPG26E PROJECT MANAGEMENT AND PHARMACOECONOMICS AND PHARMACOGENOMICS**

#### **Unit- I**

Research Methods Module, Overview of research methods. Planning a research project, Literature searching and systematic reviews, Quantitative and qualitative research methods, Data collection and analysis, Critical appraisal of published research articles. Presentation skills (written and oral).

#### **Unit- II**

Sponsor's Perspective: Managing a Clinical Trial, Selecting Investigators and Monitors, Maintaining and Managing Essential Documents (e.g. FDA Form 1572); Case Report Form Data Transmission and Generation of the Clinical Study Report.

#### **Unit- III**

Overview of Medicinal Product Research and Development Drug Discovery and Pre-Clinical Research; the Clinical Research and New Drug Application Approval Process; the Biologics Research, Development, and Licensing Process; Medical Device Research, Development, and Marketing.

#### **Unit- IV**

Drug Development Processes: History of drug development, Discovery and selection of compounds for human investigation, Toxicological requirements, Pharmacokinetics and pharmacodynamics, Pharmacogenomics and its application in clinical research.

#### **Unit V**

Regulatory Affairs and Pharmacovigilance, Regulatory requirements in Europe, the USA and Japan, Regulatory requirements for biotechnology products, medicinal devices and veterinary products, Regulatory requirements for the preparation, packaging, labeling and storage of clinical trial drugs, Health economics; Pharmacoeconomics and quality of life

assessment, Safety reporting. Methods of monitoring drug safety, responding to drug safety alerts, Post marketing surveillance.

### **Reference**

1. Introduction to Applied Pharmacoeconomics by F. Randy Vogenberg - Medical - 2000
2. Strategies in Pharmacoeconomics and Outcomes Research by Reinhard Rychlik - Medical - 2002
3. Pharmacogenomics: Methods and Applications by Federico Innocenti - Medical - 2005

## ELECTIVE 9

### BTPG27E BIOPHARMACEUTICALS AND APPLIED NANOTECHNOLOGY

#### Unit I

##### General pharmacology

Introduction of pharmacology, sources of drugs, route of administration, Pharmacodynamics and Pharmacokinetics: absorption, distribution, metabolism and excretion of drugs, GMP

#### Unit II

**Drug discovery** : Overview of the drug discovery process, Modern methods of drug discovery, Various phases of Drug discovery, Computer aided drug design, Drug Receptor interactions.

#### Unit III

**Biopharmaceutical & novel drug delivery system:** Various categories of therapeutics like vitamins, antibiotics, hormones and biological, Transdermal delivery system, liposomes and Nanoparticles.

#### Unit IV

**Production and characterization of nanoparticles:** Introduction to Nanoscience Techniques used in Nanobiotechnology: Optical Microscopy, Atomic Force, Microscopy, SEM; Production of nanoparticles: Collision / Coalescence mechanism of primary particle formation, nanoparticles agglomerates & aerogels, Biological production of nanoparticles: fungi, bacteria, yeast and actinomycetes

#### Unit V

**Applications of nanoparticles:** DNA nanotechnology-structural DNA assembly-Nanopore, Use of nanoparticles as molecular imaging probes, Nano biotechnology for human health: nanoparticles for drug delivery, gene delivery, Understanding the mechanism of macromolecular interactions; Use of nanoparticles as sensors

#### Reference

- 1 Medical pharmacology , K.D.Tripathi
2. Pharmacology and therapeutics-Satoskar
3. Pharmaceutical dosage forms:tablets volume-3 by liberman and lachman.
4. Theory and practice of industrial pharmacy by lachman.
5. Nanobiotechnology- next big idea by Mark, Ratner Daniel Ratner

## **ELECTIVE 10**

### **BTPG28E IPR, BIOSAFETY & BIODIVERSITY**

#### **Unit I**

##### **Introduction to Intellectual Property**

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

#### **Unit II**

Types of patents; Indian Patent Act 1970; Recent Amendments; Patent application- forms and guidelines, fee structure, time frames; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes.

#### **Unit III**

##### **Biosafety**

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India;

#### **Unit IV**

Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

#### **Unit V**

##### **Biodiversity**

Biodiversity Legislation in India; Indian Biodiversity Act and provisions on crop genetic resources. Convention on Biological Diversity (CBD) and Cartagena protocol on Biosafety;

Biodiversity Act 2002; Agricultural biodiversity; International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA); Conservation strategies for seed gene bank; Climate change and conservation of plant genetic resources; Global efforts for management of crop genetic resources; Strategies on PVFR and Biodiversity Acts; Impact of GE crops on Biodiversity. Functions of International union for the protection of new varieties of plants (UPOV); International treaties relating to Biodiversity; Tutorials shall comprise of Seminars, Group Discussions based on recent case studies.

## **Reference**

1. P. Narayanan, Intellectual Property Laws, Eastern Law House.2001
2. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.2009
3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.
4. John E. Smith, Biotechnology, 3<sup>rd</sup> Ed. Cambridge University Press.
5. Prithipal Singh, **An Introduction to Biodiversity**, Ane Books India, 2007.
6. B R Goel, **An Introduction to Biodiversity**, Arise Pub, 2006.
7. Nirmal Chandra Pradhan, **Basics of Biodiversity**, Anmol, 2008.
8. Padmanabh Dwivedi; S K Dwivedi and M C Kalita, **Biodiversity and Environmental Biotechnology**, Scientific, 2007.

## **9. Important Links**

<http://www.w3.org/IPR/>

<http://www.wipo.int/portal/index.html.en>

[http://www.ipr.co.uk/IP\\_conventions/patent\\_cooperation\\_treaty.html](http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html)

[www.patentoffice.nic.in](http://www.patentoffice.nic.in)

[www.iprlawindia.org/](http://www.iprlawindia.org/) - 31k - Cached - Similar page

<http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

## **ELECTIVE 11**

### **BTPG29E BIOTECHNOLOGY AND IPR**

#### **Unit-I**

GM crops- versus organic and traditional crops, global status of GM crops, genetic engineering of Bt brinjal and Bt cotton , advantages and disadvantages of GM foods, Biosafety and environmental safety concerns, Public perceptions, Regulatory bodies of India-RCGM and GEAC.

#### **Unit-II**

Ethical and legal implications of biotechnology, Human genome project, genetic testing and screening, Gene therapy, edible vaccines, stem cell research, Vaccine trials. Antiviral Drug designing, phases of drug trials, Bioweapons and bioterrorism.

#### **Unit-III**

Biosafety - definitions - biosafety levels - framework of biosafety regulation in India; Structure and functions of Committees; DBT guidelines on biosafety rules, regulations, guidelines and protocols. Guidelines in conducting research in biology / biotechnology. - Regulations of Genetically modified Organisms in India - Biosafety regulation for transgenic plants and animals - labeling of GM foods.

#### **Unit-IV**

IPR and copyrights, Importance of protecting scientific discoveries, Qualification for a Patent – Novel, Commercial & Non-obvious, Jurisdiction of Patent laws, Patent applications- Rules and regulations. fees structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures Filing of a patent application; Precautions before patenting-disclosure/non-disclosure

#### **Unit V**

IPR policy of Government of India, Indian & International Patent laws, Indian Patent Act 1970; Recent Amendments; Financial assistance for patenting-introduction to existing schemes. Role of patents in Bbiotechnology. The patentability of microorganisms - IPR and

WTO regime - consumer protection and plant genetic resources-GATT and TRIPS, Patenting gene. Issues and case studies.

## **Reference**

- 1.P. Narayanan, Intellectual Property Laws, Eastern Law House.2001
- 2.Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.2009
- 3.Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.
- 4.John E. Smith,Biotechnology,3<sup>rd</sup> Ed.Cambridge University Press.

## ELECTIVE 12

### BTPG30E MICROBIAL BIOTECHNOLOGY

#### **Unit I: Microbial Biotechnology**

Historical perspectives, Scope and applications. Industrially important microbes, Strain improvement and selection. Isolation and cultivation of microbes and their preservation methods, Growth of microorganisms; batch and continuous culture.

#### **Unit II: Application of Microbes in Agriculture**

Bio-fertilizers - Mass inoculum production of Rhizobium, Azospirillum, Azotobacter. Mycorrhizal inoculants, Blue green algae, **Azolla**, Probiotics and synbiotics, bioinsecticides, biopesticides, SCP. Microbial biotechnology in Phytotransgenics (Abiotic stress tolerant plants – drought, flooding, salt and temperature. and biotic stress resistant to insects, fungi, bacteria, viruses, weeds).

#### **Unit III: Application of Microbes in Bioremediation of Pollutions**

Biological monitoring of environmental pollution. Biosensors and Biochips. Bioremediation of hydrocarbons and xenobiotic compounds, *In situ* and *ex-situ* bioremediation. Application of microbial biotechnology in sewage and wastewater treatment, Biodegradation, Bioleaching, Biomining, Biopaints, Bioantifouling agents, Bioelectricity, Biodetergents, **Biopolyesters**, Biocement and Bioplastics.

#### **Unit IV: Application of Microbial Biotechnology in Medicine**

Recombinant proteins, vaccines, antibiotics, hormones, interferons, lycopene (pigment), melanin and microbial biosensors. Bioweapons.

#### **Unit V: Industrial Microbial Biotechnology**

Production of enzymes, ethanol, organic acids, vitamins, fatty acids, amino acids, bioflavours, biofuels. Microbes in renewable energy production: Hydrogen, methane and hydrocarbons. Biopolymers, Biocosmetics (hyaluronic acid)

## Reference

1. Fermentation Microbiology and Biotechnology ,E.M.T. Mansi, C.F.A . Bryce. A.L..Dmain, A.R.Alliman. ,2009, Taylor and Francis. New York
2. Environmental Biochnology, Christopher.F Forster, D.A.John Wase, 1987 Ellis Harwood.
3. Comprehensive Biotechnology. Second edition, Elsevier, 2011, Murray Mor. Young ( Editor in chief). ISBN-978-0-08-088504-9
4. Microbial Ecology. Fundamentals and Applications. Atlas and Bartha, Pearson Education , Benjamin Cummings publishing company.Inc.New Jersy
5. Industrial Microbiology, Cassida L.E. 1968.John Wiley and Sons Publishers.
6. Microbiology,Prescott, Hasley and Klein, Wiley Publications
7. Soil Microbiology – N.S. Subha Rao, 1999
8. Agriculture Microbiology – Rangaswamy
9. Microbial control and pest Management – S. Jayaraj.

## **ELECTIVE13**

### **BTPG31E MICROBIAL FOOD SAFETY**

#### **Unit I Role of Microbes in Food**

General concepts of food safety: adulteration, filth, microorganisms, chemical additives and genetically manipulated organisms; Types of microorganisms (yeast, bacteria, molds, viruses) and their possible roles (fermentation, bioreactors, disease, spoilage) in foods; Microbial growth in foods: intrinsic and extrinsic parameters.

Significance of food safety assessments & surveillance; emerging food safety challenges: new pathogens, emerging foodborne diseases, food safety of ready-to-eat (RTE) foods and minimally processed foods and antibiotic resistance.

#### **Unit II Microbiological Hazards in Food**

Foodborne diseases: infections, poisoning, toxico-infections; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination; Microbiological hazards: *Clostridium botulinum*, *Vibrio*, *Salmonella*, *Hepatitis A*, *E. coli* O157:H7, *Campylobacter*, *Listeria*, *Bovine Spongiform Encephalopathy*; Fungal Toxins.

#### **Unit III Control of Microbes in Food**

Means of control: food formulations, cooking, preservatives, Hurdle Concept; Food Processing: Irradiation -Packaging - Bioprocessing of meat, fisheries, vegetables, dairy products; enzymes and chemicals used in food processing;

#### **Unit IV Food Quality Regulations**

Quality control; case studies on Biotechnology in the evolution of food quality, HFCS (High Fructose Corn Syrup) and mycoproteins. Microbial detection and indicator organisms: approach and techniques; pathogen indicators: indicators of human contamination;

Government regulatory agencies and food policies -Food and Drug Administration, The Centers for Disease Control and Prevention, The Environmental Protection Agency; significance of surveillance; HACCP concepts and risk assessment.

## **Unit V Genetically Engineered Foods**

GM food: Risks, public perception- facts and myths; labeling of GM food; Bovine Somatotropin in Milk; Chymosin -Lite beer; Transgenic plants-tomato; Methionine-enriched oil; Frost-resistant food; Insect Resistance-*Bacillus thuringiensis* toxin - B.t. maize; Fungal Resistance potatoes; Virus Resistance; Plant Pharmaceuticals -beta -carotene in rice -transgenic "heart-healthy" canola oil; Edible vaccines -Hepatitis B vaccine in maize-Cholera vaccine in potatoes; Transgenic Animals -Growth hormone gene in pigs - alpha-lactalbumin and lactoferrin in milk; Transgenic Fish -Atlantic salmon.

### **Reference**

1. Potten N.M. "Food Science" The AVL Publishing Co. 2002
2. Piefzer F.M. "Food Microbiology" Academic Press, 1989
3. Lindsay, Willis Biotechnology, "Challenges for the flavour and food industries", Elsevier Applied Science, 1988
4. Roger A., Gorden B., and John T., " Food Biotechnology", 1989
5. George J.B., "Basic Food Microbiology", CBS Publishers & Distributors, 1987
6. James M.J. "Modern Food Microbiology", CBS Publishers & Distributors, 1987

## **ELECTIVE14**

### **BTPG32E FOOD BIOTECHNOLOGY**

#### **Unit I**

Micro organisms in food production- Bread making, cheese production-process, starter culture, types of cheese, other fermented dairy products- buttermilk, acidophilus milk, yoghurt, butter, paneer, marine fermented foods, koji, tempeh, fermented bevarages- beer and wine.

Applications of enzymes in food processing: amylase, protease, lipase, cellulase, hemicellulase, pectinase, pectin lyase, catalase, glycosidase, invertase, glucose oxidase, glucose isomerase

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#### **Unit II**

Single cell protein- from bacteria and algae, probiotics, prebiotics, mushroom production, microbial production of vitamins-riboflavin, vitamin c.

5

#### **Unit III**

Food production through biotechnology- Bovine Somatotropin in Milk; Chymosin -Lite beer; Transgenic plants-tomato; Methionine-enriched oil; Frost-resistant food; - Starlink corn, B.t. maize; Fungal Resistant potatoes; Plant Pharmaceuticals, Biopharming -beta -carotene in rice; Edible vaccines -Hepatitis B vaccine in maize-Cholera vaccine in potatoes; HFCS (High Fructose Corn Syrup) and mycoproteins. Growth hormone gene in pigs - alpha-lactalbumin and lactoferrin in milk; Transgenic Fish -Atlantic salmon.

12

#### **Unit IV**

Food preservation:, contamination of milk, Preservation of milk, microbial contamination and spoilage of food, foodborne illness- salmonellosis, listeriosis, botulism, staphylococcal infection, preservation methods: E ffect of low temperature, freezing, effect of heat, drying, concentration, fermentation, canning, radiation, chemical prteservatives. 12

#### **Unit V**

Significance of food safety assessments & surveillance GM food: Risks, possible danger to individuals, society or nature, labeling of GM food; Terminator genes, loss of biodiversity

Government regulatory agencies and food policies -Food and Drug Administration, The Centers for Disease Control and Prevention, The Environmental Protection Agency; HACCP concepts and risk assessment. 10

**Reference:**

1. Biotechnological innovations in foodprocessing: Editor : Dr. J Green, Butterworth-Heinman Pub.
2. Food-Facts and PrinciplesII Ed: N Shakuntala Manay, M. Shadakshara Swamy. New Age International Pub:
3. Bioprocess Technology: P T Kalaichelvan, I Arul Pandey : MJP Publishers.
4. George J.B., "Basic Food Microbiology", CBS Publishers & Distributors, 1987
5. Roger A., Gordon B., and John T., " Food Biotechnology", 1989

## ELECTIVE 15

### BTPG33E NUTRITIONAL BIOCHEMISTRY

#### Unit I

**Basic concepts:** Energy content and thermogenic effect of foods; measurement of energy expenditure; direct and indirect calorimetry; Factors affecting energy expenditure and requirements, - Energy imbalance. Calorific value, definition of BMR and SDA and their affecting factors,,Respiratory quotient, RDA, thermal equivalent of oxygen, calorogenic action of the foods .

**Nutritional assessment:** Direct parameters- Anthropometry, Clinical examination, Biochemical, Biophysical, Dietary surveys. Indirect parameters - vital statistics  
Ecological - cultural influences, food production, socioeconomic factors, health and educational services.

#### Unit II:

**Nutrients -Role of Carbohydrates in diet:** dietary types, requirements, physiological action, non-starch polysaccharides, Resistant starch, Fructose oligosaccharides (FOS), Glycemic index: Factors affecting GI of foods and GI in chronic diseases, Dietary fiber, Physiological effects and Potential health benefits.

**Role of lipids in diet:** dietary types, dietary needs of lipids; essential fatty acids Tran's fatty acids, Role of omega 3 and omega 6 fatty acids, Deriving nutritional requirements of fats and oils for different age groups.

**Role of proteins in diet:** nutritive value of proteins and the methods for its determination, Protein reserves of human body; nitrogen balance studies and factors influencing nitrogen balance; essential amino acids and concepts of protein quality; cereal proteins and their limiting amino acids; Improvement of quality of protein in diet, amino acid imbalance, Methods of estimating and assessing protein requirements.

#### **Role of vitamins, minerals, water and electrolytes in diet**

**Food components other than essential nutrients:** Functional food- Probiotics, prebiotics, GM food, organic foods, Therapeutic foods, Nutraceuticals. Bioactive substances from protein foods, Non glycerides in edible oils. Phytoestrogens. Dietary sources and physiological effects.

Naturally occurring Anti-nutrients, Diet derived antioxidants .Loss of nutrients during processing and cooking.

Brief introduction to Nutritional supplements, food additives, artificial sweeteners and, fat replacers

### **Unit III**

#### **Nutritional requirements of different age group in the life cycle**

**Balanced diet-** Definition, Recommended dietary allowances for different categories of the human beings.

**Nutrition in Pregnancy & lactation:** Importance of nutrition prior to (pre maternal period) and during pregnancy (pre natal period), Intra-uterine growth retardation, Congenital malformation and gestational diabetes mellitus, factors affecting breastfeeding and fertility.

**Nutrition in Infancy:** Nutritional requirements, Breast feeding - Reasons for encouraging breast feeding, artificial feeding - Comparative composition of human & bovine milk, humanization of bovine milk. Formula foods, Weaning and supplementary feeding, Feeding of premature and immature babies, feeding problems.

**Nutrition in school children and Adolescents:** Nutritional requirements, Nutritional issues, problems and common diseases.

**Geriatric Nutrition:** Nutritional requirements of the elderly & dietary management to meet nutritional needs.

**Vegetarianism:** Importance of vegetarian diet, Principles of planning nutritionally adequate vegetarian diet, Role of vegetarian food in health & diseases.

### **Unit IV:**

#### **Nutrition in prevention and treatment of diseases:**

***Disorders related to nutrition-*** Starvation, underweight, Obesity, genetic and environmental factors leading to obesity, management of obesity, Malnutrition- Causes, Measure to combat malnutrition. Food allergy- cause, symptoms, pathophysiology

***Role of diet-up nutrition in the prevention and treatment of diseases:*** Diabetes: metabolism, factors affecting blood sugar levels, meal management, dietary treatment, oral hypoglycemic drugs, sweeteners- nutritive and non-nutritive, role of exercise, Prevention of diabetes. Dietary management in acute and chronic Renal Diseases, Diet in cardiovascular diseases:

cardiovascular risk factors Dyslipidemia , atherosclerosis, angina pectoris, myocardial infarction, rheumatic heart disease, prevention of CVD. Diet for hypertension. Diet and cancer.

## **Unit V**

### **Trends in nutrition science**

Nutrigenetics, Nutrigenomics, its aims and advantages, Nutrient-gene interactions, The effect of nutrients in genetic and epigenetic events, Nutrigenomics and personalized nutrition, The challenges in applying nutrigenomic data to nutrition, Nutrition and metabolomics, Ayurvedic nutrition.

### **Reference**

1. A Text Book of Medical Biochemistry- M.N.Chatterjea and R.Shindea, Jaypee pub.
2. Harper's Illustrated Biochemistry- R.K.Murray, D.K.Grannes and V.W.Rodwell, McGraw Hill
3. Medical Physiology- A.C.Guyton and J. E. Hall, Saunders pub.
4. Human Physiology- C. C. Chatterjee, Medical Allied Agency
5. Nutritional Biochemistry- Swaminathan
6. Life span nutrition: Conception through life – S R Rolfes, L K DeBruyne and E N Whitney
7. Normal and Therapeutic nutrition – C H Robinson and M R Lawler
8. Understanding normal and clinical nutrition – E N Whitney C B Cataldo and S R Rolfes

## **ELECTIVE 16**

### **BTPG34E NEUROBIOCHEMISTRY**

#### **Unit 1**

Structure of neurons. Central, peripheral and autonomic nervous system- Classification and properties. Metabolism and functions of nerve fibre.

#### **Unit II**

Mechanism of conduction of nerve impulse. Synapse- properties and functions. Mechanism of synaptic transmission. Myoneural junction. Disorders associated with conduction of nerve impulse.

#### **Unit III**

CNS- Composition, Chemistry, Structure and Functions. Neurotransmitters of CNS- Serotonin, Histamine, Glutamine, Aspartate, GABA, Glycine, Nitric oxide, Substance P- Chemistry, metabolism and function. Nervous system in regulation of endocrine function and vice versa, disorders associated with CNS.

#### **Unit IV**

ANS- Sympathetic and Parasympathetic neurotransmitters- Ach, Adrenaline, Noradrenaline. Chemistry, metabolism and functions. Disorders associated with ANS.

#### **Unit V**

Biochemistry of learning and memory. Aging, circulation and energy metabolism of brain. Blood – Brain-Barrier. Molecular biology of hearing, vision, olfaction and taste. Neurodegenerative disorders- Parkinson's, Alzheimer's disorders, ALS, Senile dementia etc

#### **Reference**

1. Basic Neurobiochemistry- G.J. Siegel et al.
2. Neuron to brain- J.G. Nicholls et al
3. The pharmacological basis of therapeutics- Goodman and Gillman.

4. Lewin's Cells. Lynne Cassimeris, Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London
5. The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.

## ELECTIVE 17

### BTPG35E DEVELOPMENTAL BIOLOGY

#### Unit-1

**Basic concepts of development :** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

#### Unit-II

**Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

#### Unit-III

**Morphogenesis and organogenesis in animals :** Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

#### Unit IV

**Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*

#### Unit V

##### **Programmed cell death, aging and senescence**

Necrosis, Apoptosis, caspases, Extrinsic and intrinsic pathway, aging, theories of aging mitochondrial stress, senescence

## Reference

1. Lewin's Cells. Lynne Cassimeris, Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London
2. The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.
3. Scott F. Gilbert, Developmental Biology, Seventh Edition, 2003, Sinauer Associates, Inc., Sunderland, MA, ISBN 0-87893-258-5
4. John Gerhart and Marc Kirschner, Cells, Embryos, And Evolution, 1997, Blackwell Science, ISBN 0-86542-574-4,
5. Fred H. Wilt & Sarah C. Hake, Principles of Developmental Biology, 2004, W.W. Norton & Company, Inc., New York, NY, ISBN 0-393-97430-8
6. Sally A. Moody, Editor, Cell Lineage and Fate Determination, October 1998, Academic Press, Inc., ISBN 0-12-505255-3
7. Lewis Wolpert, Rosa Beddington, Thomas Jessell, Peter Lawrence, Elliot Meyerowitz, Jim Smith, Principles of Development, Second Edition, 2002, Oxford University Press, ISBN 0-19-924939-3

## ELECTIVE 18

### BTPG36E PHYSIOLOGY

#### **Unit I: Circulatory System, Respiratory System and Excretory System**

**Circulatory System:** Circulation. Composition and functions of blood. Haemopoiesis and formed elements. Plasma - function, Blood volume, Blood volume regulation, Blood groups, Haemoglobin, , Haemostasis– mechanisms. Blood groups: ABO system, determination, importance, Rh. Structure of Heart, Myogenic heart, Specialized tissue, ECG – its principle and significance, Cardiac cycle, blood pressure, Neural and chemical regulation. **Respiratory System:** Functional anatomy, Phases of respiration transport of gases, Exchange of gases, Neural and chemical regulation of respiration. **Excretory System:** Physiology of excretion, Kidney, Urine formation, Urine concentration, Micturition, Regulation of water balance, electrolyte balance, acid-base balance.

#### **Unit II: Nervous and Hormonal Coordination, Reproductive System.**

**Nervous system** - Neurons, Action potential, Gross neuro – anatomy of the brain and spinal cord, Central and peripheral nervous system, Neural control of muscle tone and posture. **Sense organs** - Vision, Hearing, Smell, Taste and Tactile response. **Endocrinology and reproduction** - Endocrine glands, Basic mechanism of hormone action, Hormones and diseases; Reproductive processes, Gametogenesis, Ovulation, Neuroendocrine regulation.

#### **Unit III: Photosynthesis and Respiration**

**Photosynthesis** - Light harvesting complexes, mechanisms of electron transport, photo protective mechanisms, CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub> and CAM pathways. **Respiration** – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis, photorespiration. Transpiration.

#### **Unit IV: Plant Physiology**

Absorption and transport of water, Macro & micro nutrients, Plant hormones, plant movements, photoperiodism, vernalization, **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

#### **Unit V: Microbial Physiology**

Growth yield and characteristics, strategies of cell division, stress response.

## Reference

1. Vander's Human Physiology- The Mechanism of Body function. Widmaier, Raff, Strang
2. Text book of Medical Physiology. Arthur. C. Guyton & John. E. Hall
3. Physiological basis of Medical Practice. John. B. west
4. Review of Medical Physiology. William. F. Ganong
5. Essentials of Medical Physiology. K. Sembulingam & Prema Sembulingam

**ELECTIVE 19**  
**BTPG37E ENVIROMENTAL SCIENCE**

**Unit 1**

Principles and scope of environmental science, autecology, synecology, habitat, niche, fundamental and realized niches, trophic levels, food chains, foodweb, ecosystem, biotic and abiotic components, pyramid of numbers ,pyramid of biomass, energy transfer in ecosystem.

**Unit II**

Biogeochemical cycles- nitrogen, sulfur, phosphorus, carbon, calcium, significance of microorganisms in biogeochemical cycling, microorganisms in extreme environment

**Unit III**

Conservation of biodiversity: Biodiversity status, monitoring and documentation Biodiversity management approaches, principles of conservation and wild life management, ex situ and in situ methods of conservation , biological parks, nature reserves, sanctuaries, cryopreservation, gene bank, germplasm conservation, Hotspots of biodiversity

**Unit IV**

Environment protection-issues and problems, International and national efforts for environment Protection. Global environmental problems-Ozone depletion, global warming ,climatic change, acid rain, pollution by oil spillage, desertification, eurtrophication , underground water pollution, heavy metal poisoning, hazards of radio activity, bioweapons.

**Unit V**

Biomes: tropical rain forest, grassland, desert, estuaries and sea shores. Ecological succession –hydrosere, Edges and ecotones, pollution in extreme environment, Endangered and Threatened Species .

**Reference**

1. Chapman and Reiss, Ecology principles and applications. Cambridge University.
2. Jobs A. M., Environmental biology, Routledge, London.

3. Odum E. P and Barret G W .Fundamentals of ecology. W. B Saunders company, Philadelphia.
4. Odum E. P. Basic ecology. Saunders College.
5. A textbook of environmental sciences, Arvind kumar.
6. Alleby M.Basics of environmental science. Routledge, Newyork
7. Cunningham, W. P and Siago, B. W ,Environmental science.
8. Kewin T. P and Owen C. A., Introduction to global environmental issues. Routledge, London.Chiras,D.D, Environmental science
9. Microbial Ecology. Fundamentals and Applications. Atlas and Bartha, Pearson Education, Benjamin Cummings publishing company.Inc.New Jersey

**ELECTIVE 20`**  
**BTPG38E EVOLUTION AND BEHAVIOUR**

**Unit 1 Emergence of evolutionary thoughts**

Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

**Origin of cells and unicellular evolution:**

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

**Unit 11 Paleontology and Evolutionary History:**

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms;

**Unit 111 Molecular Evolution:**

Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

**Unit 1V The Mechanisms:**

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

**Unit V Brain, Behavior and Evolution**

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism;

Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care;

## **Reference**

1. Principles of Genetics, A.G.Gardner, Wiley Publications
2. Raven Biology,*Raven* et. al. Biology. Ninth Edition. Eighth Edition. ©2010 McGraw-Hill Higher Education, a division of The McGraw-Hill Companies, Inc. All rights reserved.
3. Fundamentals of Ecology by Eugene Odum and Gary W. Barrett (Jul 27, 2004)
4. Title Ecology: Theories and applications AuthorPeter D. StilingEdition2, illustrated Publisher Prentice Hall, 1996 Original from the University of California Digitized
5. Animal Behavior; An Evolutionary approach, John Alcock, Ninth edition, Sinauer Associates Inc.sunderland, Massachusetts
6. Animal Behavior, mechanism, Development, Function and Evolution, Christopher J Bernard, Pearson Education, 2004.
7. Animal behavior, mechanisms, ecology, evolution.,Lee.C.Drickamer, Stephan H Vessen, Elizabeth M. Jakob, Mac Graw-Hill, 2001