KONGUNADU ARTS AND SCIENCE COLLEGE (Autonomous)

COIMBATORE-641 029

M.Sc. BIOTECHNOLOGY

Curriculum & Scheme of Examination under CBCS

(Applicable for the Students admitted during the Academic Year 2016 - 2017 onwards)

Semester	Subject Code	Title of the Paper	Instruction hours /cycle	Exam Marks			Duration of Exam (hours)	Credits
				CIA	ESE	Total		
I	15PBT101	C.P.1 – Biochemistry	5	25	75	100	3	5
	15PBT102	C.P.2 – Biostatistics and Bioinstrumentation	5	25	75	100	3	5
	15PBT103	C.P.3 - Cell Biology and Molecular Genetics	5	25	75	100	3	5
	15PBT104	C.P.4 – Microbiology	5	25	75	100	3	5
	15PBT1CL	C.Pr.1- Lab in Biochemistry and Bioinstrumentation	5	40	60	100	6	3
	15PBT1CM	C.Pr.2- Lab in Molecular Genetics and Microbiology	5	40	60	100	6	3
II	15PBT205	C.P.5 – Immunotechnology	5	25	75	100	3	5
	15PBT206	C.P.6 - Animal Biotechnology	5	25	75	100	3	4
	15PBT207	C.P.7 – Genetic Engineering	5	25	75	100	3	5
	15PBT208	C.P.8 – Environmental Biotechnology and Intellectual Property Rights	5	25	75	100	3	4
	15PBT2CN	C.Pr.3 - Lab in Immunotechnology and Animal Biotechnology	5	40	60	100	6	3
	15PBT2CO	C.Pr.4- Lab in Molecular Biology, Genetic Engineering and Environmental Biotechnology	5	40	60	100	6	3
III	15PBT309	C.P.9 - Bioprocess Technology	5	25	75	100	3	4
	15PBT310	C.P.10 - Plant Biotechnology	5	25	75	100	3	4
	15PBT311	C.P.11 – Genomics, Proteomics & Systems Biology	5	25	75	100	3	4
	15PBT3CP	C.Pr.5-Lab in Bioprocess Technology and Plant Biotechnology	5	40	60	100	6	3
	16PBT3E1	Major Elective I	5	25	75	100	3	5
	16PBT3N1	Non-Major Elective I – (On-line)	5	25	75	100	3	5
IV	15PBT4Z1	Project Work *	20	40	160*	200	3	5
	16PBT4E2	Major Elective II	5	25	75	100	3	5
	16PBT4N2	Non-Major Elective II - (On-line)	5	25	75	100	3	5
Total			**120**			**2200**		**90**

PBT 01

SEMESTER I ***15PBT101***

C.P.1 – BIOCHEMISTRY

Total Credits: 5 Total hours: 75

Objective:

On the successful completion of the subject, the student get an overall understanding of structure of atoms, molecules, chemical bonds, enzyme kinetics, biopolymers and metabolic reaction in the living systems.

UNIT I **(15 HRS)**

Water: **Structure of water*,** Hydrogen bonding and solubility, physical properties, cellular reactions of water, ionization of water. pH, pKa, acids, bases and Buffers of biological systems, Henderson – Hassebalch Equation. Molecular interactions, Hydrogen, hydrophobic, disulphide, glycosidic, Phosphodiester, electrostatic and Vander Waal's.

UNIT II **(15 HRS)**

Carbohydrates: Definition, classification, purifications, properties and biological importance, Mono-, di- and tri- saccharides, Polysaccharides and mucopolysaccharides of biological importance. Methods for compositional analysis. Blood group substances glycoproteins & peptidoglycans. Glycolytic Pathway, TCA Cycle, Oxidative Phosphorylation, Electron Transport Chain, **Gluconeogenesis***

UNIT III **(15 HRS)**

Proteins: Amino acids and peptides-classification, chemical reactions and physical properties. Peptide bond - stability & formation. Proteins - physico-chemical properties, structure [primary, secondary, tertiary and quaternary]. Purification and criteria of homogeneity: protein folding-biophysical and cellular aspects. Amino acid catabolism (Transamination, deamination and decarboxylation)

UNIT IV **(15 HRS)**

Lipids: Definition and classification of lipids, Structure, classification and properties of fatty acids, Steroids- Structure and functions of cholesterol. β- Oxidation of fatty acids. Fatty acid biosynthesis. *Nucleic acids:* Component, Structure and Different forms of DNA and RNA. Nucleotide metabolism.

UNIT V **(15 HRS)**

Biochemistry of Small Molecules: Physiological function of vitamins (Vitamin A & C), hormones (Insulin). *Enzymes*: Basic concept, Enzyme Classification, active site, specificity, kinetics (Negative and positive co-operativity) inhibitors (reversible and irreversible), isoenzymes, allosteric enzymes, co-enzymes (NAD), Industrial uses of enzymes (Amylase, protease)

Textbook

Lehninger Principles of Biochemistry, Albert L. Lehninger, David Lee Nelson, Michael M. Cox, Published by W.H. Freeman, 2008, Edition: 5.

References

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer, Published by Horwood Publishing Limited, 2001, Edition: 5.
2. Biochemistry, Donald Voet, Judith G. Voet, Published by J. Wiley & Sons, 2010, Edition: 4.
3. Harper's Illustrated Biochemistry, Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Published by McGraw-Hill Professional, 2012, Edition: 29.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 02

SEMESTER I ***15PBT102***

C.P.2 – BIOSTATISTICS AND BIOINSTRUEMENTATION

Total Credits: 5 Total hours: 75

Objective:

To make the student to understand the methods and tools in biostatistics, to understand the principle and usage of different instruments for their experiments and future research.

UNIT I **(15 HRS)**

Measures of dispersion: Absolute and relative measures. Mean deviation, standard deviation and variance. Coefficient of variation. *Correlation:* Definition, types and Karl Pearson's coefficient of correlation. *Regression*: definition, regression of Y on X and X on Y.

UNIT II **(15 HRS)**

Testing of Hypothesis: Student's t test. Chi-square test and its applications. ANOVA and its significance. Designing of experiments and statistical analysis. Use of softwares for statistical analysis.

UNIT III **(15 HRS)**

Centrifugation: Types of centrifuges, Principles and applications of analytical and preparative centrifuge, density gradient and ultra-centrifuge. Photometry: UV-VIS, Mass, IR and NMR spectrophotometry, Flourimetry and flame photometry – working and applications.

UNIT IV **(15 HRS)**

ELISA reader: Working and applications. Miroscopy: Phase contrast microscope, SEM and TEM- instrumentation. *Chromatography:* Principle and types- ion exchange, HPLC, HPTLC and Gas Liquid chromatography.

UNIT V **(15 HRS)**

Electrophoresis: Principle, factors affecting electrophoresis, AGE, PAGE, 2 D-Gel, isoelectric focusing, pulse field electrophoresis, gel documentation – Application. *PCR*: Principle, types, instrumentation, and applications, Nucleotide sequencing. Lyophilizer, Sonication and X-ray crystallography.

Textbooks

1. Boyer, R, 2000. Modern Experimental Biochemistry, III Edition, Addision Wesley Longman, New Delhi.
2. Wilson, K. and J. Walker 2000, Practical Biochemistry, 5th edition, Cambridge University Press, Cambridge.
3. Pillai R. S. N. and Bhagavathi V., 2000. Statistics, Sultan Chand & Co., New Delhi.
4. Gupta,.S.P., 2001. Statistical Methods, Sultan Chand & Co, New Delhi.

References

1. Sundar Rao, P.S.S., and J.Richard., 2006. Introduction to Biostatistics and Research methods, PHI Publication, New Delhi.
2. Holme and Peck, 1998. Analytical Biochemistry, 3rd Edition, Longman Scientific.
3. Skoog and Leary, 1992, Principles of Instrumental analysis, 4th Ed. Saunder's College Publishing, New York.

** Self Study and Question for Examination must be taken from the self-study portion also*

PBT 03

SEMESTER I ***15PBT103***

C.P.3 – CELL BIOLOGY AND MOLECULAR GENETICS

Total Credits: 5 Total hours: 75

Objective:

To make the students to understand the concept of gene, modulation of gene its regulation, modes of transmission and defects.

UNIT I **(15 HRS)**

Cell Transport: Passive transport - Osmosis, Diffusion, Active transport-Na^+, K^+ pump.Cell signaling: Juxtacrine, Paracrine and Endocrine Signaling-Neurotransmitters & Hormones. G Protein Coupled receptors, their secondary messengers and signal transduction pathway. Cell Signalling pathways that control gene activity-Notch signaling; TGF-Beta and activation of Smads, Jak-STAT pathway.

UNIT II **(15 HRS)**

Extracellular matrix components, Cell-cell interactions and cell matrix interactions, Cell differentiation: hormones and growth factors, Apoptotic pathwyas, Cell cycle Control mechanisms: Role of cyclins and Cdks, Cell cycle check points, Molecular events in S. cerevisiae

UNIT III **(15 HRS)**

Replication: DNA (prokaryotes and eukaryotes) and RNA replication – mechanism and enzymology. Gene expression: Transcription, RNA processing, Translation, Posttranslational modifications, Intracellular protein transport, Protein turnover and degradation.

UNIT IV **(15 HRS)**

Chromatin structure and remodeling in relation to gene expression, DNase hypersensitivity, DNA methylation. Control of gene expression in prokaryotes and eukaryotes: operon model- trp operon, gene battery model (eukaryotes), Lytic cascades and lysogenic repression in lambda. Molecular biology of Cancer: Causes and Genetics of cancer, Tumor suppressor genes and onco genes (p53 and pRB).

UNIT V **(15 HRS)**

Inherited disorders - Autosomal and allosomal-molecular and cytogenetics, Teratology, Molecular Screening– Haematological malignancies, Cancer; Pharmacogenetics(Her2 and breast cancer), *Population Genetics* - Hardy-Weinberg principle, Quantitative genetics and multifactorial interactions, causes of variation and artificial selection, genetic load and genetic counseling. Genotoxicity and detection assays.

Textbooks

1. iGenetics: A Molecular Approach (3rd Edition) by Peter J Russell ,Benjamin Cummings publication
2. Lodish, D. *et al*., 2007. Molecular Cell Biology, 6th edition, Scientific American Books, Inc

References

1. Lewin, Genes X. 2009.Oxford University Press, U.K.
2. Hartl. D.L., 2000. A Primer of Population Genetics. 3rd Edition, Sinauer Associates Inc., Sunderland.
3. Alberts *et al*. 2007. Molecular Cell Biology, 5th Edition. Garland Publishing, Inc, NY.
4. Cooper, G. M., 2009. The Cell - A Molecular Approach.5th edition. ASM and Sinauer Press, Washington.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 04

SEMESTER I ***15PBT104***

C.P.4 – MICROBIOLOGY

Total Credits: 5 Total hours: 75

Objective:

To make the students to understand the basic concepts of the biology of microorganisms and its mechanism of action in host cells.

UNIT I **(15 HRS)**

History of microbiology- Development of microbiology in 20th century. Morphology, ultra structure of bacteria. General characters of Fungi, Algae and Protozoa. Virus: Discovery, structure and classification – Baltimore cultivation of viruses – detection and enumeration, viral assays.

UNIT II **(15 HRS)**

Microbial taxonomy – classification systems– Molecular systematics: Polyphasic approach – 16S rRNA gene sequencing, Phylogenetic grouping. Mol % G+C analysis, DNA-DNA hybridization, Fatty Acid Methyl Ester (FAME) analysis. Principles and nutritional requirements for the growth of bacteria - culture media and types. Sterilization - principles and applications of physical and chemical methods. Methods of staining - bacteria and fungi.

UNIT III **(15 HRS)**

Soil Microbiology: Microbial flora of soil – bacteria, fungi, algae and protozoa. Microbial interactions among soil microorganisms - microbial populations and with plants (N_2 fixation) - **Biogeochemical cycles (C, N, P and S cycles)*.** Plant growth promoting bacteria.

UNIT IV **(15 HRS)**

Principles of food preservation - High temperature, low temperature, drying, radiation, Canning and packaging; Contamination and spoilage of meat, fish, milk, egg, vegetables and fruits. - **Food quality and control*.** Preservation and maintenance of microbes.

UNIT V **(15 HRS)**

Medical Microbiology: Host parasite relationship, epidemiology, pathogenesis, prevention and treatment -Staphylococcus, Streptococcus, Salmonella, Clostridium, Rubella, Rabies, Mycoplasma.

Textbooks

1. Willey, J., L. Sherwood, C. Woolverton, 2013, Prescott's Microbiology, 9th Edition. McGraw-Hill Higher Education.
2. Pelczar, M. J. JR. *et al*. Microbiology: Concepts and Applications. Tata McGraw-Hill Publishing Co. Ltd., New Delhi. 1993.

References

1. Stainer *et al*., 1992. General Microbiology, 5th edition. Macmillan Education Ltd., London.
2. Tortora, G.J. *et al*., 1995. Microbiology - An Introduction, 5th edition. The Benjamin/Cummings Publishing Co. Inc., USA.
3. Frazier, W. C. and D. C. Westhoff. 2003. Food Microbiology. 4th Edition. Tata McGraw-Hill Publishing Co. Pvt. Ltd., New York.
4. Ananthanarayan and Paniker, 2013. Textbook of Microbiology Ed. Arti Kapil Orient Black Swan; 9th edition

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 05

SEMESTER I ***15PBT1CL***

C. Pr.1 – LAB IN BIOCHEMISTRY AND BIOINSTRUMENTATION

Total Credits: 3 Total hours: 75

1. Preparations of Standard Solutions
2. Estimation of total sugars by Anthrone method
3. Estimation of total free amino acids by Ninhydrin method
4. Methods of protein estimation (Lowry)
5. Estimation of Ascorbic acid by DNPH method
6. Estimation of cholesterol by modified Zak's method
7. Estimation of total phenolics and flavonoids
8. Estimation of Pigments - Chlorophyll A and B
9. Estimation of albumin
10. Erythrocyte sedimentation rate test
11. Isolation, purification of enzyme amylase.
    - Ammonium sulphate precipitation
    - Dialysis
    - Gel filtration chromatography
    - SDS-PAGE
12. Paper chromatography
13. Thin Layer Chromatography
14. PCR - Instrumentation and Programming
15. Gel Documentation
16. GC (Demo)
17. HPLC (Demo)

PBT 06

SEMESTER I ***15PBT1CM***

C.Pr.2 - LAB IN MOLECULAR GENETICS AND MICROBIOLOGY

Total Credits: 3 Total hours: 75

MOLECULAR GENETICS

1. Isolation of genomic DNA- Plant
2. Isolation of genomic DNA- Blood
3. Estimation of DNA by diphenylamine method
4. Estimation of RNA by Orcinol method
5. Mounting of polytene chromosomes
6. Mitosis onion root tip
7. Meiosis – flower buds of *Rheo discolor*
8. Barr body identification in buccal cavity of females
9. Isolation of chloroplast and mitochondria

MICROBIOLOGY

1. Microbiological culture media preparation and sterilization techniques.
2. Pure culture techniques - Pour, Spread and Streak plate methods.
3. Staining techniques - Simple, Negative, Gram, Spore and fungal staining.
4. Motility test.
5. Bacterial growth curve.
6. Maintenance and preservation of microbes.
7. Biochemical test for identification of bacteria.
8. Isolation of microbes (bacteria, fungi and actinomycetes) from soil, air and water
9. Identification of fungus.
10. Antibiotic sensitivity test.
11. MBRT test for milk quality analysis.
12. Isolation of *Rhizobium* from root nodules of legumes / soil

PBT 07

SEMESTER II ***15PBT205***

C.P.5 – IMMUNOTECHNOLOGY

Total Credits: 5 Total hours: 75

Objective:

To make the student to understand the definition of immunity, how it discriminates self and nonself and its regulation.

UNIT I **(15 HRS)**

Immunity: Types of Immunity, Immune system**:** Innate (NK cells, phagocytes and their killing mechanisms (oxygen dependent and independent mechanisms), PAMP, TLR, **complement Biology (pathways)***; acquired immunity concepts (B, T cells and their activation & differentiation) and organs (primary and secondary lymphoid organs), APCs

UNIT II **(15 HRS)**

Antigen biology: **Antigen properties***, haptens, adjuvants. *Antibodies:* Structure, classification and Functions. *Antibody diversity:* Gene rearrangement (heavy and light chain). Antigen-antibody interactions (bonding, cross reactivity, affinity and avidity)

UNIT III **(15 HRS)**

Cell mediated immune responses. *MHC:* Structure of MHC, Antigen processing and presentation strategies, MHC and predisposition to diseases, HLA typing; Immune regulation (T suppressor cells)

UNIT IV **(15 HRS)**

Hypersensitivity reactions: Types and mechanisms. Autoimmune disorders - types. Immunodeficiency diseases: Primary (B cell deficiencies: X linked immunodeficiencies, T- cell deficiencies (DiGeorge's syndrome), combined B and T cell deficiencies (SCID) and Secondary (SARS). *Transplantation Immunology:* Immune suppression, Graft Vs Host disease

UNIT V **(15 HRS)**

*Tumor immunology**:*** Tumor antigens, tumor immune response and tumor Immuno therapy.

Vaccines: Recombinant vaccines, anti-idiotype vaccines, Hybridoma technology: Production of clones, monoclonal antibodies and applications: catalytic, chimeric and humanized antibodies. *Immunotechnology:* Immunoprecipitation, Immunohistochemistry and Flow cytometry, Immunodeficient mouse models: SCID, nude mouse

Textbook

1. Kuby J. *et al*., 2006. Immunology, 6th Edition. W.H. Freeman and Company, New York,.
2. Chakravarthy A, 2009. Immunology and Immunotechnology, Oxford University Press, India

References

1. Rao, C.V., 2002. An introduction to Immunology, Narosa Publishing House, Chennai.
2. Khan, Fahim Halim. 2009. The elements of Immunology, Pearson Education (India) Pvt. Ltd.
3. Tizard, I. R., 1995. Immunology: An Introduction. 4th Edition. Saunder's College Publishing, NY.
4. Roitt, I., 1994. Essential Immunology. Blackwell Science, Singapore.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 08

SEMESTER II ***15PBT206***

C.P.6 - ANIMAL BIOTECHNOLOGY

Total Credits: 5 Total hours: 75

Objective:

To enable the students to understand and learn various culturing techniques of animal cells (in vitro) gene transferring methods and production of transgenic animals.

UNIT I **(15 HRS)**

Animal cell culture, Culture media, balanced salt solutions and simple growth medium. Role of carbon dioxide, serum, growth factors and glutamine in cell culture, serum and protein free defined media and their applications. Contamination: sources, types, monitoring and eradication

UNIT II **(15 HRS)**

Types of cell culture: primary and established culture, cell separation, cell synchronization and cryopreservation, biology and characterization of cultured cells, measuring parameters of growth, measurement of cell death (Cytotoxicity tests: MTT, clonogenic assay), Organotypic culture: Bone tissue engineering

UNIT III **(15 HRS)**

Molecular techniques in cell culture, Cell transformation; physical, chemical and biological methods of gene transfer, **Stem cells and Gene therapy (iPSCs for Sickle cell anemia)***, manipulation of genes: gene silencing (transcriptional and post-transcriptional) and gene targeting (Knock-in and knock-out).

UNIT IV **(15 HRS)**

Expression vectors for animal cells–viral- SV40, Adeno, AAV, Retro-, Vaccinia- virus and hybrid viral vectors. Bacculo virus in biocontrol and foreign gene expression, plasmid expression vectors in animal cells-classes and common modular components-pSV and pRSV.

UNIT V **(15 HRS)**

Transgenics: Transgenic animals as models for human diseases, **applications of transgenic animals and their products***. Reproductive and therapeutic cloning, *In vitro* fertilization and embryo transfer: composition of IVF media, steps involved in IVF, fertilization by means of micro insemination, PZD, ICSI. Ethical and religious issues.

Textbook

1. Animal Biotechnology, M.M. Ranga. 2nd Edition. Agrobios (India), Jodhpur. 2004.

References

1. Culture of Animal Cells: Manual of Basic technique, R.I. Freshney. 5th edition. John Wiley Publications. 2006.
2. Animal Cell Culture: A practical approach series, J.R.W. Masters. 3rd Edition. Oxford University Press, London. 2000.
3. Developmental Biology.9th edition. Scott.F. Gilbert.Sinauer Associates (2006)
4. Primrose, S.B. & Twyman R.M. Principles Of Gene Manipulation And Genomics.7th edition. Wiley Publications.2006.
5. Molecular Biotechnology. Bernard R.Glick and Jack G/Pasternak.4th edition.2010

**Self Study and Question for Examination must be taken from the self study portion also*

PBT 09

SEMESTER II ***15PBT207***

C.P.7 – GENETIC ENGINEERING

Total Credits: 5 Total hours: 75

Objective:

To enable the students to learn the various molecular biology techniques, principle and application of genetic engineering which includes cloning strategies and its applications.

UNIT I **(15 HRS)**

Genetic Engineering: Introduction and applications, DNA manipulative enzymes – Properties and applications of Restriction enzymes, DNases, Polymerases, Modifying enzymes and Ligases. Linkers, Adaptors and Homopolymer tailing.

UNIT II **(15 HRS)**

Cloning Vectors and cloning strategies: Plasmids (pBR322 and pUC18), Phages (λ phage and M13 vectors), Phagemids (pBluescript, pGEM), Cosmids (pJB8) and Artificial Chromosomes (BAC and YAC). Physical, Chemical and Biological methods.

UNIT III **(15 HRS)**

Functional analysis: Production of recombinant protein (Insulin), recombinant vaccines (Hepatitis B). Gene cassettes and gene fusion. Problems encountered in expressing foreign gene in *E. coli.* DNA analysis in **forensics, medicine and Agriculture***.

UNIT IV **(15 HRS)**

In vitro transcription and *in vitro* translation. Cell free translation systems: HRT and HART selection. . Transposons - Types, Transposon tagging, Operon and gene fusions. Site directed Mutagenesis - Types and uses.

UNIT V **(15 HRS)**

Alternative cloning strategies: Shot gun cloning. Construction of genomic and cDNA library, RT-PCR, Real Time PCR. Probes-Types (DNA and RNA), properties and methods of labeling. Screening of libraries - Plaque and colony hybridization. Southern and **Northern hybridization***, Antibody based screening. Metagenomic libraries

Textbook

Watson, J. D. *et al*., 1992. Recombinant DNA, 2nd Edition. Scientific American Books, New York.

References

1. Winnacker, E. L., 2003. From Genes to Clones, Panima Publishing Corporation, New Delhi..
2. Old, R.W. *et al*., 2001, Principles of Gene Manipulation, 6th Edition. Blackwell Science, London.
3. Brown, T.A., 1998, Gene Cloning: An Introduction. 3rd Edition. Stanley Thornes Pvt. Ltd.
4. Jogdand, S. N., 1997. Gene Biotechnology. 1st Edition. Himalaya Publishing House, Mumbai. .
5. Nicholl, D.S.T., 2002. An Introduction to Genetic Engineering, 2nd edn., Cambridge University Press, Cambridge, UK

**Self Study and Question for Examination must be taken from the self study portion also*

PBT 10

SEMESTER II ***15PBT208***

C.P. 8 – ENVIRONMENTAL BIOTECHNOLOGY AND INTELLECTUAL PROPERTY RIGHTS

Total Credits: 5 Total Hours: 75

Objective:

To make the students to understand the concepts of ecology and conservation of environment with Intellectual Property Rights (IPR) for the safety of the property belonging to the nature and nation.

UNIT I **(15 HRS)**

Water Pollution and control – Introduction- Need for water management, measurement and sources, water pollution. Physio-chemical characteristics of wastewater, Effluent treatment - aerobic and anaerobic (UASB), Use of GEO for waste water treatment.

UNIT II **(15 HRS)**

Removal of specific pollutants: Use of aquatic plants including transgenics in biotechnology, biodegradable and eco-friendly products. Phytoremediation. Microbial system for heavy metal accumulation, Biosorption, Bioleaching (Copper, Uranium). Bioremediation: Types, applications and examples. Bioindicators, Biosensors and Environmental impact assessment.

UNIT III **(15 HRS)**

Xenobiotic compounds - recalcitrants, hazardous wastes, genetic engineering approach for biodegradation, degradative plasmids detoxification methods. Solid-waste management (4R principle) and sewage-sludge disposal and utilization. Biodegradation of wastes from pesticide, textile, tannery, paper, food and allied, and distillery industries.

UNIT IV **(15 HRS)**

Biomass from wastes- ethanol from lignocellulosic wastes and SCP. Biofuels and sources, Advantages, Genetic improvement through metabolic engineering. Green chemicals, Nanoparticles and composts for waste water treatment and management. Consequences of deliberate release of GMOs into environment. **Current status, controversies and knowledge gaps in Environmental Biotechnology and future***.

UNIT-V **(15 HRS)**

Intellectual property rights: meaning, evolution, Classification and forms, Patents : Concepts and principle of patenting – patentable subject matter, Procedure for obtaining patent – Rights of patent, Infringement of patent right, Remedies for infringement of patent rights-patentability and emerging issues

Textbook

1. Jogdand, S. N. 1995. Environmental Biotechnology. Himalaya Publishing House, New Delhi.
2. Singh, K., 2000. Intellectual Property Rights on Biotechnology, BCll, New Delhi.

References

1. Cheremisinaff, N.P., 2003. A textbook for waste and waste water treatment. Prentice Hall of India Pvt. Ltd., New Delhi.
2. Cruger, W. and A. Cruger 2003. A Textbook of Industrial Microbiology. Panima Publishing Corporation, New Delhi.
3. Glick, B.R. and J.J. Pasternak 1998, Molecular Biotechnology. 2nd Edition, ASM Press, Washington.
4. Glazer, A.N. and H. Nikaido, 1995. Microbial Biotechnology, W.H. Freeman and Co., NY.

**Self-study and Question for Examination must be taken from the self-study portion also*

PBT 11

SEMESTER II ***15PBT2CN***

C.Pr.3 - LAB IN IMMUNOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Total Credits: 3 Total hours: 75

I - IMMUNOLOGY

1. Production and purification of IgG.
2. Immunoassay for particulate antigens.
3. Qualitative and Quantitative Haemagglutination.
4. Radial immunodiffusion.
5. Ouchterlony double diffusion.
6. Immunoelectrophoresis.
7. Rocket immunoelectrophoresis.
8. Immunodiagnosis (ELISA).
9. Western blotting.
10. Peripheral Blood mononuclear cell separation.

II - ANIMAL TISSUE CULTURE

1. Preparation of tissue culture medium and membrane filtration
2. Chick fibroblast cells isolation
3. Preparation of primary cells
4. Cell counting and cell viability
5. Trypsinization of monolayer and subculturing
6. Cytotoxicity test-MTT assay
7. DNA fragmentation analysis
8. Demonstration of animal handling for experimental purposes, cervical dislocation, dissection of mice, cardiac puncture, blood sample preparation and its handling

PBT 12

SEMESTER II ***15PBT2CO***

C.Pr.4 - LAB IN MOLECULAR BIOLOGY, GENETIC ENGINEERING AND ENVIRONMENTAL BIOTECHNOLOGY

Total Credits: 3 Total hours: 75

I - MOLECULAR BIOLOGY

1. Isolation of genomic DNA-Bacteria.
2. Agarose gel electrophoresis.
3. Isolation of plasmid DNA from bacteria.
4. Bacterial transformation.
5. Isolation of RNA.
6. Polyacrylamide gel electrophoresis.

II - GENETIC ENGINEERING

1. Phage titration
2. Restriction digestion and Ligation
3. Southern blotting.
4. Northern blotting.
5. Amplification by Polymerase Chain Reaction - Colony PCR, Differential temperature PCR and Touch-down PCR.
6. cDNA synthesis
7. Gene Expression - Real time PCR (demo only)

*III - **ENVIRONMENTAL BIOTECHNOLOGY***

1. BOD
2. COD
3. Water Quality analysis by MPN test

PBT 13

SEMESTER III ***15PBT308***

C.P.9 - BIOPROCESS TECHNOLOGY

Total Credits: 4 Total hours: 75

Objective:

To understand the basics of fermentation techniques and to learn the concepts of screening, optimization and maintenance of cultures.

UNIT I (15 HRS)

Introduction: Basic principles, **scope and advantages of bioprocess technology***. *Fermentation systems and kinetics:* batch, fed batch and continuous. Isolation, screening, and maintenance of microbes for industrial process. Strain selection and improvement methods.

UNIT II (15 HRS)

Bioreactor: Components design and functions. *Types of bioreactors:* CSTR, packed bed, batch, Air lift bioreactor, Bioreactors for immobilized cells, animal cells, waste water and effluent treatment. Specialized bioreactors: pulsed, fluidized and photobioreactors.

UNIT III (15 HRS)

Upstream processing: Introduction, principles of microbial nutrition, Media formulation and optimization. Sterilization: Methods of sterilization- Batch and continuous sterilization. Air sterilization, design and air filters, aseptic operation of fermentor. Inocula development for Industrial fermentations. Scale up and scale down.

UNIT IV (15 HRS)

Transport phenomena: Mass and heat transfer mechanism. Mass, heat and oxygen transfer coefficients. Rheological properties of a fermentation broth.

Bioprocess monitoring and control: On-line and Off-line analysis. *Monitoring variables:* pH, temperature, DO_2, agitation and foam level. PID control and computer aided control.

UNIT V (15 HRS)

Downstream processing: Introduction. Primary separation - Cells, Solid matter and foam-precipitation, filtration, centrifugation, cell disruptions (Mechanical, enzymatic and chemical). Product isolation - solvent extraction, adsorption, aqueous two-phase system and precipitations. Purification techniques: Chromatography (ion-exchange, gel-permeation and affinity), membrane separation (microfiltration, Ultrafiltration and reverse osmosis). Product recovery; product polishing (drying and crystallization).

Textbook

Stanbury, P. F. & A. Whitaker, 2003. Principles of Fermentation Technology. Pergamann Press, Oxford.

References

1. Bioprocess engineering: Basic Concepts M.L. Shuler and F. Kargi. Prentice Hall, Engelwood Cliffs. 2003.
2. A Textbook of Industrial Microbiology. W. Cruger & A. Cruger. Panima Pub. Corp., New Delhi. 2003.
3. Heat and Mass Transfer in SI units R.K. Rajput. S., Chand and Co. Ltd., New Delhi. 2003.
4. Industrial Microbiology. L.E. Casida. New Age International Pvt. Ltd., New Delhi. 1999.
5. Molecular Biotechnology, S.B. Primrose. 2nd Ed. Blackwell Scientific Publishers, Oxford. 1994.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 14

SEMESTER III ***15PBT309***

C.P.10 - PLANT BIOTECHNOLOGY

Total Credits: 4 Total hours: 75

Objective:

To enable students to learn various culturing technologies of plant cells (invitro) gene transferring mechanism and production of transgenic plants.

UNIT I **(15 HRS)**

Genome organization in Plants: Nucleus, Chloroplast and Mitochondria, Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, Microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP AFLP, QTL, map based cloning, molecular marker assisted selection.

UNIT II **(15 HRS)**

Plant Tissue Culture: Plant tissue culture medium- Preparation and **sterilization***, types of media and growth regulators. Propagation of plants: Micropropagation, callus culture, cell culture, protoplast isolation, culture and fusion, somatic hybridization, somatic embryogenesis and synthetic seed preparation, anther, pollen and embryo culture, and somaclonal variation, secondary metabolites, PTC in agriculture and forestry.

UNIT III **(15 HRS)**

Direct and indirect gene transfer (agroinfection and floral dip), binary and cointegrate vectors systems. *Agrobacterium* characteristics, Ti and Ri plasmids, viral vectors, mechanism of T-DNA transfer and chloroplast transformation, gene tagging.

UNIT IV **(15 HRS)**

Plant viral vectors- CaMV and Gemini viruses, gene constructs, markers genes for selection of transformants, gene silencing. Application of plant transformation: Nutraceuticals, herbicide-glyphosphate, insect and virus resistance, terminator technology and pathogenesis related proteins and marker free transgenics

UNIT V **(15 HRS)**

Transgenic plants for abiotic stress resistance (salt, drought and cold), recombinant proteins, plantibodies, plantigens and biodegradable plastics. Metabolic engineering for plant secondary metabolites: Introduction, alkaloid and flavonoid biosynthesis.

Textbooks

1. Slater, Scott and Fowler, 2003. Plant Biotechnology. Oxford University Press.

References

2. Dubey, R. C., S. Chand and Co., 2004. An Introduction to Biotechnology. New Delhi.
3. Razdan. M.K., 2002. An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co., New Delhi.
4. Chawla, S. 1998, Biotechnology in crop improvement. International Book Distributor Company, New Delhi.
5. Bhojwani, S.S. and M.K. Razdan, 2004. Plant Tissue Culture: Theory and Practice, A Revised Edition, Elsevier Publications, Netherlands
6. Biochemistry and Molecular Biology of Plants.2002 Bob Buchanan, Wilhelm Gruissem and Russell Jones. John Wiley Publications.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 15

SEMESTER III ***15PBT311***

C. P.11 – GENOMICS, PROTEOMICS AND SYSTEMS BIOLOGY

Total Credits: 4 Total hours: 75

Objective:

To understand the molecular characterization of genomes, proteomes leading to the design and development of novel drugs and to learn the technical details of several current experiments or technologies used in the field of systems biology.

UNIT I **(15 HRS)**

Genetic markers in mapping of genomes: SNP, SSLP, AFLP. Physical mapping: Restriction mapping, STS mapping, Radiation hybrid mapping, FISH to identify chromosome landmarks. Sequencing: **Gene sequencing methods*,** clone by clone approach, short-gun sequencing, automated DNA sequencing.

UNIT II **(15 HRS)**

Transcriptosome: Serial analysis of gene expression, gene expression analysis by microarray technology – types and their applications. Proteomics – structural proteomics based NMR and X ray crystallography. Mass Spectometry - MALDI, TOF, SELDI.

UNIT III **(15 HRS)**

Pharmacogenomics: Immunomics and vaccinomics - Introduction. Role of proteomics in drug discovery, identification of drug targets and drug development and its applications.

Functional Proteomics: Expression profiling, protein arrays – definition and applications, protein interactions – Yeast two hybrid systems. 2D - PAGE – first and second dimension criteria and its applications.

UNIT IV **(15 HRS)**

Introduction to Systems Biology: Developmental biology and differential gene expression – regulation of genes – microarray, tagging – documentation – Stanford microarray database – data normalization – self-organizing maps. Tools and data formats for modeling - simulation techniques, simulation tools, data formats – SMBL, BioPAX, standard for systems biology, data resources – pathway databases, kinetic database, model database and biomodels.

UNIT V **(15 HRS)**

Analysis of high-throughput data: High-throughput experiments, Next generation sequencing, image analysis and data quality control, grid finding, spot quantification, linear models, **analysis of gene expression data***, DNA arrays, ROC curve analysis, clustering algorithms, hierarchical clustering, self-organizing map (SOMs).

Text Book

1. Brown, T.A., 2002, Genomes, Wiley – Liss Publications.
3. Edda K et al. Systems Biology: A Textbook. 2009, Wiley Publication.

References

1. Primrose, S. B. and R. M. Twymann. Principles of Gene Manipulation and Genomics –7th Edition, Blackwell Publications.
2. Daniel C. Liebler, 2006. Introduction to Proteomics. Humana Press, Brown TA, Genomes, 3rd Edition, Garland Science.
3. Campbell, A.M. and L. J. Heyer, 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Benjamin Cummings.
4. Sangtun C. Introduction to Systems Biology. Humana Press, Totowa, New Jersy
5. Kitano H. Foundations of Systems Biology. 2001, The MIT Press.

**Self Study and Question for Examination must be taken from the self study portion also*

PBT 16

SEMESTER III ***15PBT3CP***

C.Pr.5 - LAB IN BIOPROCESS TECHNOLOGY AND PLANT BIOTECHNOLOGY

Total Credits: 3 Total hours: 75

I - BIOPROCESS TECHNOLOGY

1. Parts and design of a bioreactor.
2. Isolation of Protease producing bacteria
3. Optimization of culture condition for growth and protease production (media, pH & temperature).
4. Wine production and estimation of ethanol.
5. Production of organic acid- Lactic acid.
6. Immobilization of cells and test for its activity
7. Purification of fermentation product by Ion exchange Chromatography
8. Preparation of Biofertilizer
9. Mushroom Production

II - PLANT BIOTECHNOLOGY

1. Laboratory organization
2. Preparation of media and sterilization
3. Micropropagation- Nodal and shoot tip culture
4. Callus culture- DPPH assay
5. Cell suspension culture
6. Synthetic seed preparation
7. Somatic Embryogenesis
8. Anther culture
9. Regeneration and Hardening
10. *Agrobacterium* mediated transformation - GUS assay

PBT 17

SEMESTER - IV ***15PBT4Z1***

DISSERTATION WORK AND *VIVA-VOCE* WITH INTERNAL AND EXTERNAL EXAMINERS

Total Credits: 5

DIRECTIONS

- Students are allocated a dissertation topic individually under the supervision of faculty of the department.
- The dissertation must be similar to the thesis style and encompass:
  - (i) Introduction / Rationale and Review of Literature
  - (ii) Materials and Methods
  - (iii) Results
  - (iv) Discussion
  - (v) Bibliography
- The dissertation should be submitted in type-written, bound form to the department for record.
- While evaluation of dissertation, 40 marks (20+20 as internal) should be based on oral presentation before the faculty members of department in the presence of concerned supervisor during the period of CIA examinations, and 160 marks (external) should include:
  - (i) Evaluation of project work (100 marks) based on:
    - (a) Scientific content (25marks)
    - (b) Experiments and final outcome (50 marks)
    - (c) Presentation (25 marks)
  - (ii) Viva-voce by external examiner (30 marks)
  - (iii) Assessment through presentation by internal examiner (30 marks) at the time of examination.

PBT 18

MAJOR ELECTIVE – PHARMACEUTICAL BIOTECHNOLOGY

Total Credits: 5 Total hours: 75

Objective:

To enable the students to learn about various drugs, its effects, drug metabolism, drug receptors, drug tolerance, dependence and resistance with therapeutic monitoring of drugs.

UNIT I (15 HRS)

Drugs – sources, dosage forms and routes of administration. Drugs – structural features and pharmacological activity, Prodrug concept. Absorption, factors, modifying drug absorption. Distribution, metabolism and excretion of drugs – phase I, II reactions, action of cytochrome P450.

UNIT II (15 HRS)

Drug receptors – localization, types and subtypes, models and theories. G-protein coupled receptor and ion-channel linked receptors. **Examples of drug-receptor interactions*.** Agonists and antagonists.

UNIT III (15 HRS)

Drug tolerance and drug dependence. Principles of basic pharmacokinetics. Adverse response to drugs, drug intolerance, pharmacogenetics, drug allergy, tachyphylaxis, drug abuse, vaccination against infection, factors modifying drug action and effect. Assay of drug potency: chemical, bioassay and immunoassay.

UNIT IV (15 HRS)

Biotechnology and Pharmacy: Genetically engineered protein and peptide agents. Drug delivery systems: Non-conventional routes of administration, anti-AIDS drug development, oncogenes as targets for drugs, multidrug resistance, production of secondary metabolites by plant culture.

UNIT V (15 HRS)

Mechanism of action of drugs used in therapy of Respiratory system – cough, bronchial, asthma, pulmonary tuberculosis, Antimicrobial drugs – sulfonamides, trimethoprim, penicillins, aminoglycosides and bacterial resistance, **Cancer chemotherapy*,** Thyroid and antithyroid drugs, insulin and oral antidiabetic drugs, antifertility and ovulation inducing drugs.

Textbooks

1. The pharmacology, Volumes I and II – Goodman, Gilman.
2. Pharmacology 3rd edition – Rang, Tale.
3. Principles of medicinal chemistry – Foye, Waverks Pvt. Ltd. New Delhi.

References

1. Basic and clinical pharmacology 7th edition – Katzung, Printice Hall, New Delhi
2. Pharmacology and pharmacotherapeutics – Satoskar *et al.*, Popular Prakashar, Mumbai
3. Burger's medicinal chemistry and drug discovery: principles and practice – Wolf, John Wiley
4. Molecular basis of inherited diseases – Davies, Read, IRL Press
5. Molecular biotechnology 2nd edition – Glick, Pasternak, Panima Publishers, 2002

** Self Study and Question for Examination must be taken from the self-study portion also*

PBT 19

MAJOR ELECTIVE - NANOBIOTECHNOLOGY AND COMPUTATIONAL BIOLOGY

Total Credits: 4 Total hours: 75

Objective:

To understand the new concept of nanotechnology applied to the area of biotechnology and to acquire requisite skills for the design and development of high throughput screening and to retrieve and submit the data, genome database and other databases and analysis.

UNIT-I (15HRS)

Basic concepts of Nano science and technology - Quantum wire – Quantum well – Quantum dots. Superior properties of nano-compared with bulk materials. Use of Bio-molecules such as Proteins, DNA, RNA, Aptamers, Peptides, Antibody, Virus as nanoparticles for drug targeting and therapy.

UNIT – II (15HRS)

Strategies for synthesis of nanoparticles: top-down & bottom-up approach. Physical, chemical and biological), Physical methods- Microwave Synthesis, Physical Vapour deposition, Laser pyrolysis. Chemical methods- Coprecipitation, Sol-gel Processing, Microemulsions. Biological method- bacteria, fungi, virus, plants.

UNIT – III (15HRS)

Bionanostructures*:* Characterization of nanomaterials: **Scanning Tunneling*** and Atomic Force Microscopy, Structural and Functional principles of bionanotechnology, microbial systems for assembly of nanostructures

UNIT- IV (15HRS)

Synthesis, Characterization, and Functionalization of nanoparticles for targeted Cancer Theranostics**.** Scope and applications of nanobiotechnology. Nanoparticles for waste water treatment and management. Nanoparticle synthesis in plants, Bacteria and yeast

UNIT V (15 HRS)

Computational Biology: Introduction, biological databases, data retrieval, types of genome data bases, gene prediction methods, FASTA, BLAST - types and its applications. *Proteome analysis:* Types, tools and protein data bases, Protein prediction methods, protein visualization – RASMOL, **Protein engineering*** and drug designing.

Text Book

1. Lee, S and Savage, LM (2010) Biological Molecules in Nanobiotechnology.
2. Principles of Bioinformatics, Shanmughavel, P., Pointer Publishers, India. 2005.

Reference

1. Goodsell, DS (2004) Bionanotechnlogy: Lessons from Nature, Wiley-Liss, Inc., NY.
2. Strocio, MA and Dutta, M (2004) Biological Nanostructures and Applications of Nanostructures in Biology: Electrical, Mechanical, and Optical properties, Kluwer Academic / Plenum Publishers, USA.
3. David E. Reisner (2009). Bionanotechnology Global prospects. CRC Press. Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300.
4. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University, 2002.

**Self Study and Question for Examination must be taken from the self study portion also*

PBT 20

MAJOR ELECTIVE - ENTREPRENEURSHIP, BIOETHICS, BIOSAFETY AND RESEARCH METHODOLOGY

Total Credits: 5 Total hours: 75

Objective:

To understand the concepts of biosafety, ethics to be followed in science research and various tools to be used in research.

UNIT I (15 HRS)

Entrepreneurship: Concept, Definition, Structure and theories of entrepreneurship, Types of entrepreneurship, process of entrepreneurial development, entrepreneurial leadership, Product planning and development, Project management, Concept of projects, Project identification, formulation, project report and project appraisal.

UNIT II (15 HRS)

Bioethics : **Principles of bioethics***, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

UNIT III (15 HRS)

Biosafety: Definition of Biosafety. Requirements, Biosafety for human health and environment Use of genetically modified organisms and their release into the environment, biosafety assessment procedures for biotech foods & related products, Catagena protocol on biosafety, bioterrorism and convention on biological weapons, WIPO, **GATT*.**

UNIT IV (15 HRS)

Research: Scope and significance, Types of Research, Research Process, Characteristics of good research, Problems in Research, Identifying research problems. Seminar paper preparation and presentation.

UNIT V (15 HRS)

Thesis Writing: Literature collection and citation, Research report writing: Result analysis and Discussion, content, table, figure formatting and typing. Plagiarism, Research Article writing, Reference writing.

Text books

1. Sasson A. 1993, Biotechnologies in developing countries present and future, UNESCO Publishers.
2. Gurumani, N., 2006. Research Methodology for Biological Sciences. M JP Publishers,

References

1. Shantharam S. and Jane F. Montgomery, 1999. Biotechnology Biosafety, and Biodiversity**,** Scientific and Ethical Issues for Sustainable Development, CC Now Science Publishers.
2. Drucker, P.F., 1999. Innovation and entrepreneurship: Practice and Principles, - Butterworth-Heinemann, Harper Business, NY.
3. Singh M. P., Bijay S. Singh and S. Dey, 2004. Conservation of Biodiversity and Natural Resources, Daya Publications, Delhi.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 21

MAJOR ELECTIVE – MEDICAL BIOTECHNOLOGY AND MARINE BIOTECHNOLOGY

Total Credits: 5 Total hours: 75

Objective:

To understand the concepts, needs and applications of Medical and Marine Biotechnology

UNIT I (15 HRS)

Introduction to Biotechnology and medicine: Medicine field of 21st century, Role of Biotechnology in medicine, rDNA technology, Vaccines, MoABS. Molecular Diagnostics: Importance of diagnosis-PCR based diagnosis for infectious diseases (HIV, Hepatitis and Typhoid), Cancer and genetic disorders

UNIT II (15 HRS)

Recent developments in medical biotechnology– Gene therapy; outline and methods-Pharming for human proteins and neutraceuticals. Tissue engineering and therapeutic cloning, Application of nanotechnology in biomedical sciences-Green nanaosubstances, gene delivery, drug delivery. Nanotechnology in replacing defective cells.

UNIT III (15 HRS)

Marine ecosystem – intertidal zone, inhabitants and ecology of estuaries, salt marshes, mangrove swamps, coral reefs and the deep sea. Plankton, nekton and benthos. Composition of seawater. Major and minor elements in the seawater. Oceanographic instruments and general sampling procedures. Applications of ocean remote sensing, Bioluminescent bacteria. Carbon sequestration.

UNIT IV (15 HRS)

Unculturable bacteria, occurrence, characteristics, characterization and exploitation. Bioactive compounds – Antimicrobials and antioxidants from Microorganisms, Sponges, Corals, Bryozoans and Tunicates. **Biofouling and prevention*** Probiotic bacteria and their importance in aquaculture. Vaccines for aquaculture. Transgenic Fish with growth hormone (GH) and antifreeze genes.

UNIT V (15 HRS)

Importance of marine viruses. Red sea tide and its control. Molecular Biology of Green mussel adhesive protein, Marine organism as a source of Polysaccharides.

Commercial important enzymes from marine microorganisms: Xylanase, agarase, proteases, chitinases. Giant bacteria and their ecological significance. **Marine pollution and its control***.

Textbooks

1. Medical biotechnology by S. N. Jogdand, Himalaya Publications.
2. Nair N. B. and Thampy, D. M. 1989. Text book of Marine Ecology.
3. Thurman, H. V. and Webber, H. H., 1984. Marine Biology.
4. Meadiws, P. S. and Campbell, J. J., 1988. An introduction to Marine Sciences.

References

1. Drugs from sea (2000). Fusetani, N.
2. Microbiology of deep sea hydrothermal vents (1995). Karl, D.M.
3. The search from bioactive compounds from microorganisms (1992). Omum, S.
4. Biotechnology and Biodegradation (1990). Kamely, D. Chakraborty, A. & Omenn, G.S.
5. Recent Advances in Marine Biotechnology, Vol.2 (1998). Fingerman, M., Nagabushanam, R., Thompson, M.

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 22

NON MAJOR ELECTIVE - COMPETITIVE SCIENCE-I

Total Credits: 5 Total hours: 75

Objective:

Been updated with the current syllabi followed in UGC/ CSIR/NET examinations

UNIT I **(15 HRS)**

Principles and methods of taxonomy, nomenclature of plants. Photosynthesis-Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO_2 fixation – C3, C4 and CAM pathways. Photorespiratory pathway. Nitrogen metabolism: Nitrate and Ammonium assimilation; amino acid biosynthesis.

UNIT II **(15 HRS)**

Tissue culture methods for plants, Plant hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Sensory photobiology: Structure, function and mechanisms of phytochromes, cryptocromes and phototropins; photoperiodism and biological clocks. Translocation; transpiration.

UNIT III **(15 HRS)**

Secondary metabolites – Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Plant viral vectors, transgenic plants. Stress physiology: Responses of plants to biotic (pathogen and insects) and biotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

UNIT IV **(15 HRS)**

Microbial fermentation and production of small and macro molecules*. Application of immunological principles (vaccines, diagnostics). Molecular approaches to diagnosis and strain identification, molecular clocks; molecular tools in phylogeny. Genomics and its application to health and agriculture, including gene therapy.

UNIT V **(15 HRS)**

The Environment: Physical environment; biotic environment, Habitat and niche: Concept, Fundamentals and characters of habitat and niche. Population ecology, Species interactions, Community ecology, Ecological succession, Ecosystem and function, **Major terrestrial biomes***, Conservation biology. Biodiversity management approaches.

Textbook

Jain, V. K., 2003. Fundamentals of Plant Physiology. S. Chand and Co., New Delhi.

References

1. Dubey, R. C., 2004. An Introduction to Biotechnology. S. Chand and Co., New Delhi.
2. Slater et al., 2003. Plant Biotechnology: The genetic manipulation of plants. Oxford University Press, Oxford.
3. Razdan, M. K., 2002. An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co., New Delhi.
4. Stanbury P. F. and Kargi, F. 2003. Bioprocess engineering: Basic concepts. Prentice Hall, Engelwood Cliffs.
5. Joshi *et al.* 2004, Biodiversity & Conservation. APH Publishing Corporation, New Delhi

** Self Study and Question for Examination must be taken from the self study portion also*

PBT 23

NON MAJOR ELECTIVE - COMPETITIVE SCIENCE-II

Total Credits: 5 Total hours: 75

UNIT I (15 HRS)

General Sciences: Common Elementary Computer Science; General awareness of computer hardware: CPU and other peripheral devices-Input and Output, Auxiliary and Storage device; Basic Mathematical Methods: Linear algebra, Matrices. Linear differential equations; Laws of thermodynamics and their consequences, Thermodynamic potentials and Maxwell's relations; Electromagnetic waves – reflection and refraction.

UNIT II (15 HRS)

Biofertilizers:- Definitions and types (nitrogen fixers, P-solubilizers and P-mobilizers. Isolation, purification and characterization of microorganisms, which are potential biofertilizers. Screening for their efficiency and strain improvement. Biopesticides: Definition and significance, mass production and formulation of microbial control agents: Bt and NPV

UNIT III (15 HRS)

Cell Biology: Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes): mechanism of cell division including (mitosis and meiosis) Microscopic techniques for the study of cells; Diversity of Cell size and Shape; Cell differentiation and Cell signaling.

UNIT IV (15 HRS)

Bio-chemistry and Physiology: Structure of atoms, molecules and chemical bonds; Structure, function and metabolism of carbohydrates, lipids and proteins; Enzymes and coenzyme; Respiration and photosynthesis; Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps; Electrical properties of membranes.

UNIT V (15 HRS)

Genetics and Evolutionary Biology: Chromosome structure and function; Gene Structure and regulation of gene expression. Linkage and genetic mapping; Mutation: DNA damage and repair, chromosome aberration: Transposons; Concepts of evolution; Theories of organic evolution; Mechanisms of speciation; Hardyweinberg genetic equilibrium, genetic polymorphism and selection.

References

1. A.R.Vasistha. Matrices. Emerald Publications.
2. P.C.Joshi et al. 2004, Biodiversity and Conservation. A.P.H.Publishing Corporation, New Delhi.
3. G.M.Cooper. The Cell-A Molecular Approach. ASM Press, Washington.
4. Lodish et al, 2001. Molecular Cell Biology, W.H.Freeman & Company, New York.
5. D.L. Nelson and M.M.Cox, 2003. Lehninger's Principles of Bio-Chemistry, 3rd Edition Macmillan/Worth Publishers, New York.
6. K.Wilson and J. Walker. 2000, Practical Biochemisrty, 5th Edition, Cambridge University Press, Cambridge.
7. P. S. Verma and V. K. Agarwal. 2003. Genetics. S. Chand & Co, New Delhi.
8. Fundamentals of Computer Hardware- Mandeep Singh Bhatia.
9. Motion Studies and Thermodynamics - V K Shrivastava.

PBT 24

NON MAJOR ELECTIVE - FOOD TECHNOLOGY

Total Credits: 5 Total hours: 75

UNIT I (15 HRS)

Carbohydrates: Structure and functional properties of mono-oligo-polysaccharides including starch, cellulose, pectic substances and dietary fibre; Proteins: Classification and structure of proteins in food; Lipids: Classification and structure of lipids, Rancidity of fats, Polymerization and polymorphism; Pigments: Carotenoids, chlorophylls, anthocyanins, tannins and myoglobin; Food flavours: Terpenes, esters, ketones and quinones.

UNIT II (15 HRS)

Enzymes: Specificity, Kinetics and inhibition, Coenzymes, Enzymatic and non-enzymatic browning; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutrition deficiency diseases.

UNIT III (15 HRS)

Characteristics of microorganisms: Morphology, structure and detection of bacteria, yeast and mold in food, Spores and vegetative cells; Microbial growth in food: Intrinsic and extrinsic factors, Growth and death kinetics, serial dilution method for quantification; Food spoilage: Contributing factors, Spoilage bacteria, Microbial spoilage of milk and milk products, meat and meat products.

UNIT IV (15 HRS)

Foodborne disease: Toxins produced by Staphylococcus, Clostridium and Aspergillus; Bacterial pathogens: Salmonella, Bacillus, Listeria, Escherichia coli, Shigella, Campylobacter; Fermented food: Buttermilk, yoghurt, cheese, sausage, alcoholic beverage, vinegar, sauerkraut and soya sauce.

UNIT V (15 HRS)

Food processing principles: Canning, chilling, freezing, dehydration, control of water activity, CA and MA storage, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging, cleaning in place and food laws. Production concept in dairy industries, Solvent extraction, refining and hydrogenation of oil, processing principles in fruits vegetables and plantation products: Extraction, clarification concentration and packaging

References

1. Foods: Facts and Principles – N. Shakuntalamanay M Shadakshara Swamy
2. Food Science - B Srilakshmi
3. Food science, Chemistry and Experimental Foods - M Swaminathan
4. Text Book on Foods Storage and Preservation - Vijayakhader

PBT 25

NON MAJOR ELECTIVE - CANCER BIOLOGY

Total Credits: 5 Total hours: 75

UNIT I **(15 HRS)**

Introduction to Cancer: Cancer: Definition; Cancer incidence and mortality; Origin of neoplastic cells; Cancer as cellular disease; Types of Cancer: Benign Tumors Vs. Malignant Tumors, Common Symptoms, Causes of Cancer: Chemical Carcinogenesis; Irradiation Carcinogenesis; Oxygen Free Radicals, Aging and Cancer; Genetic Susceptibility and Cancer; Multiple Mutations in Cancer; DNA repair defects and their relationship to cancer; Viral Carcinogenesis.

UNIT II **(15 HRS)**

Cell Cycle Regulation and Cell Signaling in Cancer: Growth Characteristics of Malignant Cells; Cell Cycle Regulation; Evasion of Apoptosis (Programmed Cell Death); Growth Factors; Signal Transduction Mechanisms-G protein linked receptors, The phosphoinositide 3-kinase pathway, mTOR, Tyrosine kinase pathways, JAK-STAT pathway, Estrogen receptor pathway, Hypoxia-inducible factor, Tumor necrosis factor receptor signaling, Tumor growth factor-β signal transduction, Heat shock protein mediated events; Angiogenesis; Invasion and Metastasis; Biology of Tumor Metastasis.

UNIT III **(15 HRS)**

Molecular Genetics of Cancer: Molecular Basis of Cancer-DNA Methylation and Cancer; Loss of Heterozygosity; Telomeres and Telomerase; Molecular Genetic Alterations in Cancer Cells - Translocations and Inversions, Chromosomal Deletions, Gene Amplification, Point Mutations, Aneuploidy, Disomy, Trinucleotide Expansion, Microsatellite Instability, Mismatch DNA Repair Defects, Gene Derepression in Cancer Cells, Oncogenes, Tumor Suppressor Genes: pRb and p53, DNA Tumor Viruses - V40 and Polyoma, Papilloma Viruses E6 and E7, Adenoviruses E1A and E1B, Hepatitis B Virus and Herpes Viruses.

UNIT IV **(15 HRS)**

Tumor Immunology: Mechanisms of the Immune Response to Cancer: Antigen Presenting Cells; Antigen Processing; T Lymphocytes and T Cell Activation; The Immunological Synapse; B Lymphocytes and B Cell Activation; Natural Killer Cells; Cell-Mediated Cytotoxicity; Role of Gene Rearrangement in the Tumor Response; Heat Shock Proteins as Regulators of the Immune Response; Inflammation and Cancer; Immunotherapy

UNIT V **(15 HRS)**

Cancer Diagnosis and Treatment: Tumor Markers; Gene Expression Microarrays; Proteomic Methods; Circulating Epithelial Cells; Circulating Endothelial Cells and Endothelial Progenitor Cells; Molecular Imaging; Haplotype Mapping. Molecular Mechanisms of Aging and cancer: Somatic Mutation; Telomere Loss; Mitochondrial Damage; Formation of Oxygen-Free Radicals; Cell Senescence; DNA Repair and Genome Stability; Caloric Restriction. Diet and Cancer Prevention; Chemoprevention; Antiproliferative Agents; Antioxidants; Protease Inhibitors; Histone Deacetylase Inhibitors; Statins; Multiagent chemoprevention

References:

1. Cancer Biology, Raymond W. Ruddon, 2007, 4th edition, Oxford University Press,
2. Molecular Biology of Cancer by F. Macdonald, C.H.J. Ford, and A.G. Casson; Garland Science / Bios Scientific Publishers
3. The Biology of Cancer, Weinberg. Robert A, 2007, New York: Garland Science.
4. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz Springer.
5. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics 2nd Ed. by Lauren Pecorino. Oxford University Press.

PBT 26

JOC 1 - MUSHROOM TECHNOLOGY *15PBT0J1*

UNIT I

Mushroom biology – Types of mushrooms: varieties of mushroom, edible and non-edible mushrooms. Economic importance of mushrooms, factors influencing mushroom cultivation. Types of mushroom based food, nutritive values of mushrooms and medicinal values

UNIT II

Mushroom cultivation – lab organization – infrastructure facilities – design of mushroom huts. Raw materials for mushroom cultivation. Spawn production – types of spawn, raw materials, spawn production techniques – inoculation, maintenance and supply of spawn. Cultivation aspects - bed preparation, cropping of oyster, milky and button mushrooms.

UNIT III

Maintenance aspects of mushroom cultivation – harvesting, storage, packaging or mushrooms. Quality control, marketing and management of mushroom.

UNIT IV

Recycling of substrate. Mushroom waste management - disposal, composting and conversion into organic fertilizer.

UNIT V

Pest and diseases of mushroom – insects, bacterial and fungal pathogens, disease symptoms, economic loss, precautions and control measures

Text books

1. Mushrooms; cultivation, nutritional value, medicinal effect and environmental impact by Shu-Ting Chang and Philip G. Miles, 2004, Second edition, CRC press London.
2. Experiments in microbiology, plant pathology, tissue culture and mushroom cultivation by Aneja, K. R., 1996, Wishwa Prakashan, New Delhi
3. Mushroom biology: Concise Basics and Current Developments by Philip G. Miles, Shu-ting Chang, 1997. World Scientific Publishing Co., USA.

PBT 27

15PBT0J2

JOC 2 - HERBAL TECHNOLOGY

UNIT I

Phytochemistry: Biosynthesis of primary and secondary metabolites, Classification and metabolisms of alkaloids, terpenoids, carotenoids, flavonoids, tannins and phenolic acids.

UNIT II

General extraction isolation and purification techniques for alkaloids, terpenoids, carotenoids, flavonoids, tannins and other phenolic compounds from plants.

UNIT III

Biotechnology of medicinal plants: Production of secondary metabolites from cultured plant cells, elicitation, immobilization and biotransformation.

UNIT IV

Bioactive studies: DNA fingerprinting of medicinal plants – DNA isolation and fingerprinting techniques. Chemical fingerprinting – HPLC and HPTLC.

UNIT V

Anticancer, antidiabetic, anti-inflammatory, hepatoprotectives, antimicrobials from medicinal plants. Antioxidants of plant origin – Reactive Oxygen Species (ROS), antioxidant polyphenols. Toxicity studies on medicinal plants and herbal formulations.

References

1. Harborne, J.B., 1998. Phytochemical methods to modern techniques of plant analysis. Chapman & Hall, London.
2. Trease G. E, M. C. Evans, 1979. Textbook of Pharmacognosy 12th ed. Balliere-Tindal, London.
3. Irfan A. Khan and Atitya Khanum (Eds.). 2004. Role of Biotechnology in medicinal and Aromatic plants, Vols. I-X. Ukaaz Publications, Hyderabad.

PBT 28

15PBT0D1

ALC.1 - FRONTIER TECHNOLOGIES IN BIOSCIENCES

UNIT I

Stem cell technology**:** Stem cell, definitions, types and properties. Scientific terms, factors governing manipulations and culturing of stem cells. Micro-environmental factors governing stem cell propagation. Applications: Tissue engineering, reprogramming of genome function through epigenic inheritance. Ethical and social considerations of stem cell technology.

UNIT II

Neurobiology: Chemistry, synthesis, storage and release of neurotransmitters. Classes and mode of action of neuropeptides. Neuropeptide receptors, coexistence of neuropeptides with other neurotransmitters in "Dorsomedial Hypothalamic Nucleus". Neurodegenerative Disorders: Parkinson's, Alzheimer's disease, amyotrophic lateral sclerosis, senile dementia.

UNIT III

Nanobiotechnology: Definitions and terms, molecular motors, DNA hybridization control using metal ion crystal antennae. DNA-Based Nanofabrication. Self-Assembling DNA Tilings as Structural Templates, Molecular Electronics Microarray chips:- Microarray probes / chips, array fabrication, targets, assays, read out, image analysis, uses and examples.

UNIT IV

Diagnostic Techniques**:** Immunoassay Classification and Commercial Technologies, assay development. Cell Based and DNA based diagnostics.

Functional Proteomics**:** Proteome, Mass spectroscopy of various protein complexes, Organization of proteome in an organism and its systematic study, Protein chips and Computation.

UNIT V

Biosensors: Concepts and applications, Noninvasive Biosensors in Clinical Analysis, Surface Plasmon Resonance, Biosensors based on Evanescent Waves, Applications of Biosensor-based instruments to the bioprocess industry, Application of Biosensors to environmental samples, Biochips and their application in modern Sciences.

Textbook

Biotechnology. U. Satyanarayana. Books and Allied (P) Ltd. August 2007.

References

1. The Science of Laboratory Diagnosis, J. Crocker and D. Burnett 2nd Edition. John Wiley Publishers. 2005.
2. Nanotechnology: A Gentle Introduction to the Next Big Idea, M. Ratner and D. Ratner. Prentice Hall. 2002
3. Text book of Medical Physiology, A.C. Guyton & J.E. Hall. 10th Edition. Harcourt, Asia. 2001.
4. Principles of Cell Biology. G. Ramsay.1998. Commercial Biosensors. John Wiley and Son, Inc. K. Smith and M. Kish. Harper-Cellins Pub. Inc. New Delhi.

PBT 29

15PBT0D2

ALC. 2 – STEM CELLS TECHNOLOGY

UNIT I

Cell Diversification and responses in the early animal embryo: *Xenopus* - Blastomeres and Spatial Segregation, inductive interactions, progressive pattern of new cell types generation. Morphogen gradient organization of complex pattern of cell responses, cell signal response, intracellular signals, early mammalian embryo and developmental potential, responses of mammalian embryonic stem cells to environmental stress and their pathway of development.

UNIT II

Renewal by stem cells: Stem cells division, epidermis and differentiated progeny, various keratins synthesis during stem cell development, basal cells, basal cell proliferation and thickness. Epidermal stem cells, secretory cells in the epidermis and population kinetics.

UNIT III

Specialized cells and their functions. Genesis, modulation, and regeneration of skeletal muscle: myoblasts fusion, muscle cells properties and protein isoforms, quiescent stem cells in the adult.

UNIT IV

Fibroblasts and their transformations: the connective-tissue cell family fibroblasts response to signals in the extracellular matrix, connective-tissue cell differentiation, fact cells signaling and production, bone remodeling, osteoblasts and bone matrix, osteoclasts and their ole to connective-tissue framework and body structure.

UNIT V

Hematopoietic stem cell: Types and functions. Hematopoietic stem cell disorders-classification and manifestations of aplastic, myelodysplastic, myeloproliplastic disorders. Clinical applications of colony stems. Complications of germline therapy, replacement therapy and marrow transplantation. Immunological principles, preservation and clinical use of blood and blood components, hemapheresis procedures and oxiplantation.

Textbook

Gilbert. S.F. 2000Developmental Biology. 6th Edition. Sinauer Associates, Inc. NY.

References

1. Kiessling A.A. and C.S. Anderson, 2003. Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential. Amazon Publishers.
2. Alberts, B., 2002. Molecular Biology of the Cell. 4th Edition. Garland Publishing, Inc., NY.

PBT 30

QUESTION PAPER PATTERN FOR CIA & END OF SEMSTER EXAMINATION

M. Sc., BIOTECHNOLOGY

1. THEORY Max Marks = 75
Time = 3.00 hrs

SECTION - A (10 x 1=10 marks)

Choose the correct answer type.

Q.No. 1 to 10: Multiple choice type ***alone.***
Questions with four alternative (distracter) answers each (Two questions from each unit).

SECTION - B (5 x 5=25 marks)

Short answer questions

Q.No. 11-15: Either (a) or (b) short note type (One question 'a' or 'b' from each unit)

SECTION - C (5 x 8=40 marks)

Essay type of questions:

Q.No. 16-20: Either (a) or (b) essay type (One question 'a' or 'b' from each unit)

2. BREAK UP OF INTERNAL MARKS (25 marks)

Internal marks (25) = CIA (out of 15**) + Attendance (**out of 5**) + Assignment (**out of 5**)**

***CIA marks (out of 15 marks) = I CIA marks + II CIA marks / 150 X 15**

3. PRACTICALS – Question Pattern & Break-up of marks

END OF SEMESTER PRACTICAL EXAMINATION

Max. Marks: 60
Duration: 3hrs

I.	**Major**	(One question)	(1 x 20 = 20)
II.	**Minor**	(One question)	(1 x 10 = 10)
III.	**Spotters**		(3 x 5 = 15)

Examine, identify and critically comment on the spotters A, B, C, D and E.

IV.	**Viva**	(05)
V.	**Record / Observation***	(10)

**Record for ESE; Observation for CIA exam.*

INTERNAL - PRACTICAL MARKS

From Model Practical Examination	-	25
Observation	-	10
Attendance	-	5
Total	-	40

QUESTION PAPER PATTERN FOR JOC AND ALC SUBJECTS EXAMINATION

THEORY Max Marks = 100

Time = 3.00 hrs

SECTION - A (10 x 10=100 marks)

Essay type of questions:

Q.No. 1-10: Either (a) or (b) essay type (Two questions 'a' and 'b' from each unit)

Major Elective Papers ***(2 papers are to be chosen from the following 4 papers)***

1. Pharmaceutical Biotechnology
2. Nanobiotechnology and Computational Biology
3. Entrepreneurship, Bioethics, Biosafety and Research Methodology
4. Medical Biotechnology and Marine biotechnology

Non-Major Elective Papers *(2 papers are to be chosen from the following 4 papers)(On-line)*

1. Competitive Science – I
2. Competitive Science- II
3. Food Technology
4. Cancer Biology

Tally Table:

Part	Subject	No. of Subjects	Total Marks	Credits
I	Core – Theory / Practical / Project	18	1800	70
	Major Elective Paper	2	200	10
	Non Major Elective Paper	2	200	10
	Grand Total	**22**	**2200**	**90**

Advanced Learner's Course (ALC) under self-study scheme (optional)

Subject Code	Title of the Paper	Exam Marks		Duration of Exam (hours)	Credits
		ESE	Total		
165BT0D1	ALC.1- Frontier Technologies in Biosciences	100	100	3	2
15PBT0D2	ALC.2- Stem Cell Technology	100	100	3	2

- CBCS – Choice Based Credit System
- CIA-Continuous Internal Assessment
- ESE- End -of - Semester Examination
- C.P. - Core Paper; C. Pr. – Core Practical
- 25 % CIA is applicable to all theory subjects. Proportion of CIA and ESE for practical is 40 : 60.
- JOCs are optional for earning extra credits and are conducted 4 hours / cycle after college hours.

Job Oriented Courses (JOC):

1. JOC 1 - Mushroom Technology (*15PBT0J1*)
2. JOC 2 – Herbal Biotechnology (*15PBT0J2*)

Note: *JOC and ALC which are offered at present will be applicable for the students admitted during the academic year 2016-2017 and will be considered as extra credit courses.*

M.Sc., BIOTECHNOLOGY

Curriculum & Scheme of Examination under CBCS
Academic Year 2016-17 onwards