UNIVERSITY OF CALICUT
(Abstract)

Scheme and Syllabus of IV Semester M.Sc General Biotechnology under Credit Semester System PG 2010 for affiliated colleges - implemented with effect from 2010 admission - orders issued.

GENERAL & ACADEMIC BRANCH-IV 'J' SECTION

No. GA IV/J1/4207/2010 Dated, Calicut University PO, 31.12.2011

Read:
1. U.O.No.GAIV/J1/1373/08 dated 23.07.2010.
2. U.O.No.GAIV/J1/4207/2010 dated 19.11.2010.
3. U.O.No.GAIV/J1/4207/2010 dated 31.03.2011.
4. U.O.No.GAIV/J1/4207/2010 dated 18.07.2011.
5. Letter No.DBT/GBT/002/2011-12 dated 22.12.2011 from the Chairman, Board of Studies in Biotechnology.
6. Orders of Vice-Chancellor in the file of even number 28.12..2011.

O R D E R

Credit Semester System (CUCSS PG-2010) has been introduced for the PG programmes of all affiliated colleges of this University with effect from 2010 admission vide paper read as (1) above.

The meeting of the Board of Studies in Biotechnology held on 08.06.2010 discussed in detail the syllabus of M.Sc Biotechnology programme and the Chairman was authorized to bring out the final version of the syllabus. The syllabi of 1st, 2nd, 3rd semesters were implemented vide U.O read as (2), (3) & (4) respectively.

Vide paper read as (5) above, the Chairman has submitted the syllabus of IV semester of M.Sc Biotechnology programme under Calicut University Credit Semester System PG 2010.

The Vice-Chancellor in view of exigency, exercising the powers of Academic Council has approved the syllabus for implementation subject to ratification by the Academic Council.

Sanction has therefore been accorded for implementing the scheme and syllabus of IV semester M.Sc Biotechnology programme under Calicut University Credit Semester System PG – 2010 for affiliated colleges with effect from 2010 admission.

Orders are issued accordingly. Scheme and Syllabus of IV semester appended.

Sd/-
ASSISTANT REGISTRAR (G&A IV)

For REGISTRAR

To

The Principals of all affiliated Colleges offering M.Sc. General Biotechnology.

Forwarded/By Order

Copy to:

PS to VC/PA to Registrar/CE/Enquiry/
Information centers/DR III (Exams)/EG-I/
DR PG/Tabulation section/GAI 'F' 'G' sections

SECTION OFFICER

System Administrator (with a request to upload
In University website.)

M. SC. GENERAL BIOTECHNOLOGY CURRICULUM

(Syllabus for Affiliated Colleges)

From the academic year 2010-2011 onwards

UNIVERSITY OF CALICUT

SEMESTER- WISE COURSE TITLES, DURATION OF THEORY AND LABORATORY EXERCISES FOR EACH COURSE AND CREDITES

Semester – 1

COURSE CODE	COURSE TITLE	CREDITES
GB1C1	Cell Biology	4
GBIC2	Biomolecules	4
GB1C3	Microbiology	4
GB1P4	Laboratory – 1 (Cell Biology, Biomolecules and Microbiology)	6
Total		18

Semester – II

COURSE CODE	COURSE TITLE	CREDITES
GB2C1	Metabolism and Basic Enzymology	4
GB2C2	Molecular Biology	4
GB2C3	Environmental Biotechnology	4
GB2C4	Biostatistics & Bioinformatics	4
GB2P5	Laboratory – II (Enzymology, Molecular Biology and Environmental Biotechnology)	6
Total		22

Semester – III

COURSE CODE	COURSE TITLE	CREDITES
GB3C1	Genetic Engineering	4
GB3C2	Bioprocess Technology	4
GB3C3	Plant Biotechnology	4
GB3C4	Immunology	4
GB3P5	Laboratory – III (Genetic Engineering, Bioprocess Technology, Plant Biotechnology, and immunology))	8
Total		24

Semester – IV

COURSE CODE	COURSE TITLE	CREDITES
GB4P1	Project Work	5
GB4V2	Comprehensive Viva-Voce	3
Total		8
	Grand Total (All core courses including Practical/Project and Viva-Voce)	72
ELECTIVE COURSE	Elective Course offered only in IVth Semester	
GB4E3	Industrial Food Biotechnology	3
GB4E4	Nanobiotechnology	3
GB4E5	Stem Cell Biology	3

GB1C1 - CELL BIOLOGY

1. Cells –diversity of cell size, shape and number, diversity in internal organization – cell theories. Sub cellular organisms Viruses, Prions.
2. Prokaryotic cells and eukaryotic cells- structure and organization. Cellular organelles- plasma membrane, cell wall , mitochondria, chloroplast, endoplasmic reticulum, chromosomes, nucleus, Golgi apparatus, lysosomes, microbodies, peroxisomes.cytoskeleton. Cell motility- cilia and flagella–organization and functions.
3. Cell growth and cell division- apoptosis and cancer, molecular events and model systems. Regulation of cell cycle- cell cycle checkpoints,
4. Transport of molecules across membrane. Endomembranes and membrane trafficking. Cellular responses to environmental signals in plants and animals- mechanism of signal transduction, cell to cell interaction- extra cellular matrix, interaction of cells with other cells, tight junctions, gap junctions, plasmodesmata.
5. Cellular energy transactions- role of mitochondria and chloroplast- oxidative metabolism in mitochondria, translocation of protons machinery of ATP formation.
6. Biosynthesis of proteins in prokaryotes and eukaryotes. Co- and post translational modifications. Posttranslational uptake of proteins by peroxisomes, mitochondria and chloroplasts.
7. Protein targeting-nucleus, mitochondria, chloroplast, peroxisome, molecular chaperons and folding of polypeptides.

reference

1. Molecular biology of cell – Alberts B *et al*
2. Molecular cell biology – Lodish *et al*
3. Reproduction in eukaryotic cells – D M Prescott
4. developmental biology – S F Gilbert, Sinauer Associates
5. Cell in development and inheritance – E B Wilson
6. The coiled spring – Ethan Bier
7. Fertilisation – F T Longo, Champan and Hall
8. Molecular biology of steroid and nuclear hormone receptors – L P Freedman

GB1C2 - BIOMOLECULES

1. Chemical foundations of biology – Introduction to biomolecules, weak bonds,

covalent bonds, weak interactions in aqueous system, ionization of water, weak acids & bases, pH, pK, Henderson-Hassel Balch equation, titration curves, buffers, buffer systems. Diffusion and osmosis.

2. Thermodynamics – Principles, enthalpy, entropy, free energy concept, standard free energy, thermodynamics governing biochemical systems.
3. Sugars – Classification, structure, function and chemical reaction, methods for compositional analysis of polysaccharides.
4. Amino acids – Basic ideas about physiological functions of amino acids, Classification, structure, stereochemistry, physical & chemical properties. Bio-synthesis

   Proteins – Classification, structural hierarchy, Ramachandran map, separation and purification, criteria of homogeneity, end group analysis,
5. Lipids – Classification, structure, functions, physical and chemical properties eicosanoids, separation & analysis of lipids. Bio-synthesis
6. Nucleic acids – Nucleotide structure & function, nucleic acid structure & function. Bio-synthesis
7. Vitamins & Hormones – Classification, structure & physiological functions, Phytohormones.
8. Heterocyclic compounds – Secondary metabolites in living system, pigments, and isoprenoids.
9. Separation techniques – Chromatographic techniques, Electrophoresis and centrifugation techniques and spectrophotometer.
10. Analytical techniques – Analytical techniques in biochemistry & biophysics for small molecules and macro molecules for quantitation. X-ray crystallography & NMR spectroscopy of proteins Mass spectrometry of proteins-MALDI, ESI, MALDI-TOF,

Reference

1. Biochemical Calculations, Irwin H. Segel, John Wiley and sons Inc.
2. General Chemistry, Linus Pauling, W.H.Freeman & Company.
3. Organic Chemistry, DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry, D Voet and JG Voet, J Wiley and Sons.
5. Principles of Biochemistry, Lehninger. A.L., Nelson, D.L. and Cox, M.M, CBS Publishers and Distrubutors.
6. Biochemistry, Jeremy M.Berg, John L. Tymoczko and Lubert Stryer, W. H. Freeman & Company.
7. Physical Biochemistry, D Freifelder, W. H. Freeman & Company.
8. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work.
9. Understanding Chemistry, CNR Rao, Universities Press, Hyderabad.
10. A Biologist's Guide to Principles and Techniques of Practical Biochemistry. K. WilsonKH Goulding, ELBS Edition.
11. Tools of Biochemistry , T.G. Cooper.

GB1C3 - MICROBIOLOGY

1. History of Microbiology, Discovery of microbial world, role of microbes in transformation of organic matter and in causation of disease. Microscopy – Light, Phase contrast, Fluorescent, Transmission electron microscope, Scanning electron microscope and scanning tunneling microscope, Confocal microscope, Atomic force microscope. Sterilization methods – Physical, Chemical and Biological
2. Pure Culture Concepts – Culture Media preparation; selective differential and enrichment media, Pure Culture Concepts, Microbial growth – different phases, measurement – Bacterial Growth Curve. Microbial Nutrition – Growth factors, Nutritional Classification of bacteria, uptake of nutrients
3. Diversity of Microbial World, Principles of Classification of microbes, approaches in bacterial taxonomy, Biology of Mycoplasmas, Microbial Staining- Grams, Differential, Motility determination
4. Introduction to Mycology – General characters of Fungi, Cultivation of Fungi, Cultural characters, Microscopic Morphology, Importance of Fungi in industry and Food production. Fungi as pathogen to man, animals and plants
5. Introduction to Virology Bacteriophages.– Discovery and structure, Baltimore Classification, Replication – Lytic and Lysogenic Cycles, Cultivation of Viruses. Detection and Enumeration of Viruses – Viral assay.
6. Microbial Metabolism – Glycolysis, Krebs Cycle, Glyoxylate Cycle, Entner Duodroff pathway, HMP shunt, ATP Synthesis, Aerobic and Anerobic respiration, Photo Synthesis, Fermentation, Methanogenesis,
7. Microflora of Soil – Rhizosphere, Biogeochemical cycles (Phosphorus, Oxygen, Nitrogen, Sulphur, Carbon), Plant Microbe interaction (symbiotic and asymbiotic). Biopesticides and Bioinsecticides. Microbiology of Air and Water- Dust, Droplets and droplet nuclei, Bacteriological examination of drinking water, waste water treatment and management (aerobic and anaerobic process.)
8. Microbes and Man - Saprophytes, Commensals, Pathogen. Sources of infection – Reservoirs, Carriers and Vectors. Congenital infections, Mode and source of infections, pathogenesis and prophyllactic methods of following diseases – Cholera, Tuberculosis, Diphtheriae, Syphilis, Influenzae, Poliomyelitis, Malaria, Amoebiasis, Dermatomycosis.
9. Antimicrobial Agents, Antibiotics, chemotherapeutic agents, major classes and mechanism of action, minimal inhibitory concentration (MIC), Microbial Drug resistance.

Reference

1. Pelczar, M.J.Chan, ECS & Krieg - Text Book of Microbiology.
2. Fundamentals of Microbiology – Alcamo E.
3. Prescott, L.M., Harley J.P & D.A.Klein – Microbiology
4. Benson, H.J. – A Laboratory Mannual in General Microbiology.
5. Cappuccino, J.G. – Laboratory Mannual in Microbiology.

GB1P4 Laboratory – 1 (Cell Biology, Biomolecules and Microbiology)

Cell Biology

1. Microscopy: Bright field, phase contrast and fluorescence microscopy
2. Microtomy
3. Mitosis and meiosis
4. Histochemical techniques
5. Observation of Barr body
6. Subcellular fractionation
7. Squash preparation- polytene chromosome
8. Karyotyping

Biomolecules

1. Titration of amino acids – Determination of pK and pI values.
2. Reactions of amino acids, sugars and lipids.
3. UV, visible & fluorescence spectroscopy, absorption spectra.
4. Quantitation of Sugars & Proteins.
5. Analysis of oils – iodine number, saponification number.
6. Chromatography (Gel permeation, Ion exchange, TLC)
7. Electrophoresis (PAGE, SDS-PAGE, Agarose)

Microbiology

1. Equipments – Hot air oven, Autoclave, Seitz and membrane filter, Microscopy.
2. Media Preparation – Nutrient broth and Nutrient Agar, Mac conkey Agar, Blood Agar, Potato Dextrose Agar, Yeast Extract Mannitol Agar.
3. Staining Techniques – Simple and Gram Staining, Spore and Capsule Staining, Fungal Staining, Acid Fast Staining.
4. Motility Determination – Hanging drop method.
5. Isolation of Pure Colonies of Bacteria – Streak, Spread and Pour Plate Methods.
6. Biochemical Tests – Indole Test, Methyl Red test, Voges Prauskaur test, Citrate Utilisation test, Triple Sugar Iron test
7. Cultivation Microscopic Examination of fungi *Penicillium*, *Aspergillus*
8. Bacteriological Analysis of Water – Presumptive, Confirmed and Completed tests (MPN).
9. Determination of Anti-Microbial Activity by Disc Diffusion method (Kirby Bauer Method), Determination of MIC by Tube Dilution Method.

SEMESTER-II

GB2C1 METABOLISM AND BASIC ENZYMOLOGY

THEORY

1. Introduction to Metabolism – Overview of metabolic pathways (carbohydrates, amino acids, lipids, nucleic acids), key reactions of metabolic pathways, regulation of metabolic pathways, evolution of metabolic pathways-RNA world.

2. Bioenergetics – Standard free energy concept, energy of activation, standard free energy, relationship between Standard free energy & equilibrium constant, energy coupled reactions in Metabolism, , high energy & low energy phosphate compounds, Biological oxidation- reduction reactions.

3. Carbohydrate Metabolism – Glycolytic pathway, Citric acid cycle, glycogenolysis, gluconeogenesis, pentose phosphate pathway.

4. Electron transport systems – Electron transport systems in mitochondria & chloroplast, alternate pathways, glyoxylate pathway, cyanide insensitive respiration.

5. Amino acid metabolism – Biosynthesis and degradation of amino acids, Urea cycle, overview of nitrogen metabolism, biosynthesis of proteins.

6. Lipid metabolism – Biosynthesis and Oxidation of fatty acids, phospholipids & glycolipid metabolism, biosynthesis of cholesterol.

7. Nucleic acid metabolism – Biosynthesis and degradation of purine, and pyrimidine nucleotides, General account of nucleic acid biosynthesis.

8. Enzymes – Classification and nomenclature of enzymes, Mechanism of enzyme action, Lock and key and induced fit hypothesis, factors influencing Enzyme activity, Isolation and purification of enzymes, Expression of enzyme activity, unit of activity, measurement of activity, Specific activity. Kinetics of enzyme, K_m value determination – methods. Enzyme inhibition- types and the method for the determinations of inhibitor constants. Transition state analogs, Abzymes.

9. Mechanism of Enzyme Catalysis, Role of coenzymes and metals. Regulation of enzyme activity.. Allosterism, positive and negative modulations, zymogens, covalent modifications . Multienzyme complexes, compartmentation of enzymes, Isozymes, Immobilized enzymes, Enzyme engineering. Applications of Enzymatic analysis in medicine and industry.

BOOKS

1. Lehninger, A.L., Nelson, D.L. and Cox, M.M. Principles of Biochemistry. CBS Publishers and Distributors.
2. Voet, D. and J.G. Voet. Biochemistry, John Wiley & Sons, Inc.

3. Murray, R.K., D.K. Granner, P.A. Mayes and Rodwell V.W. Harper's Biochemistry: Appleton & Lange.
4. Gumport, R.I., Jonas, A. Mintel, R. and Rhodes C. Students companion for Stryer's Biochemistry. Freeman and Company.
5. Stumpf, P.K. and Conn, E.E. The Biochemistry of Plants. A comprehensive treatise (Series) Academic Press.
6. Gowenlock, A.H., McMurray, J.R. and McLauchlan, D.M. Practical Clinical Biochemistry. CBS Publishers & Distributors.

GB2C3 MOLECULAR BIOLOGY

THEORY

1. Molecular Basis of Life –Nucleic Acids and Polypeptides, Structure of DNA – Genetic material, Chargoff's Rule, X-ray Crystallographic studies, Denaturation and Renaturation, super- coiling, Different forms of DNA- Circular DNA.
2. DNA Replication – General features; semi-conservative, Mechanism of Replication – Elongation and Termination, Replication of Circular DNA(rolling circle model), Enzymology of Replication – primase, DNA Polymerase, Gyrase, Topo isomerase, Helicase; Replication Fork.
3. DNA Repair – Mechanism, Proof Reading, Types of DNA damage, Types of DNA Repair. Mutation- Types and various Mutagens.
4. Molecular Genetics -DNA Recombination- Molecular Mechanism; Transformation, Transduction and Conjugation – Holliday Model, Molecular Basis of Recombination in Eukaryotes, Transposons – Examples in Eukaryotes; Transposable Elements, classification of Transposons.
5. Gene Structure – Salient Features of Genes, Fine Structure of Prokaryotic and Eukaryotic Genes; Transcription – Mechanism in Prokaryotes, Types of Transcripts, Eukaryotic Transcription, Post Transcriptional Modification of mRNA, mRNA Maturation, Promoters.
6. RNA Splicing – Chemistry of Splicing, Spliceosome Machinery, Splicing Pathways, Modifications in RNA - 5'-cap Formation, 3' end Processing and Polyadenylation, RNA Processing, RNA Editing, Ribozymes.
7. Gene Regulation – Prokaryotic Gene Regulatory Mechanism; Operon Concept: Lac, trp, gal and arabinose operons. Gene Regulation in Eukaryotes – Attenuation control Regulation by DNA Methylation, Regulation of mRMA stability, Transcription Factors, Enhancer Element.
8. Genetic Code – Salient Features; Code is Degenerate, Deciphering the Code, Multiple Recognition of Codons and Wobble Hypothesis – Initiation and Termination Codon.
9. Proteins Synthesis Mechanism in Prokaryotes and Eukaryotes – Translation initiation, Types of RNA, Termination of Translation, Post Translational Modifications.
10. Biology of Cancer – Oncogenes and Tumour Suppressor Genes, Viral and Cellular Oncogenes, Tumour Suppressor Genes of Humans

BOOKS

1. Molecular Biology of the Genes – J.D.Watson, N.H.Hopkins
2. Moleculary Cell Biology, J.Darnell, H.Lodish
3. Gene VIII, Benjamin Lewin
4. Genomes, T.S.Brown
5. Molecular Cloning: a Laboratory Manual, J.Sambrook.

GB2 C3 ENVIRONMENTAL BIOTECHNOLOGY

THEORY

1. Environment - Basic concepts and issues.
2. Environment Pollution – Sources, types of pollution, Methods of Measurement of pollution.
   Air Pollution, sources and control measures.
   Water Pollution – Water as a scarce natural resource, Need for Water management, Measurement of Water Pollution, sourcing of water pollution, control measures of water pollution.
3. Microbiology of waste water treatment
   Waste water collection, physical, chemical and biological waste water treatment methods.
   Aerobic waste water treatment, Activated sludge process, Oxidation Ponds, Oxidation ditches, trickling filters, towers, rotating discs.
   Anaerobic processes – Anaerobic digestion, anaerobic distillery, tannery, antibiotic industries.
4. Solid waste Management – sources, types of solid wastes, Strategies for Management (composting, wormiculture, and methane production), treatment of hazardous wastes, and Biomedical wastes.
5. Bioremediation of contaminated solid and wasteland-Insitu, Exsitu Bioremediation, phytoremediation
   Biofertilizers – Symbiotic and asymbiotic nitrogen fixers, Benefits and limitations of Biofertilizers.
6. Microbiology of degradation of xenobiotics in environment, bioaccumulation, biodegradation of xenobiotics, Role of degradative plasmids, degradation of hydrocarbons- substituted hydrocarbons, fate of polychlorinated biphenyls, and fate of surfactants, detergents, and fate of oil spillage, bioleaching, and biosorption.
7. Pesticides and its adverse effect on Environment. Biopesticides in integrated pest management – Preventive IPM Strategies, types of Biopesticides.
8. Bioplastics - PHA, PHB, BIOPOL-A
9. Biofuels - Production of Alcohols, Methane, Hydrogen from Biomass, the future applications
10. Global Environmental Problems - Ozone depletion, UV-B Radiation Flux increase, effect of UVB on biological system, Green house effect , Implications of global warming, Effects and measures to control Acid rain.

BOOKS

1. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy.
2. Comprehensive Biotechnology Vol.4, M.Moo-Young.
3. Environmental Chemistry, A.K.De,
4. Introduction to Biodeterioration, D.Allsopp and K.J.Seal.

GB2C4 BIOSTATISTICS AND BIOINFORMATICS

1. Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, per diagram, and cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion : range, variance, standard deviation , coefficient of variation, symmetry : measures of skew ness and kurtosis
2. Simple lenear regression and correlations.
3. Understand and interpret results from Analysis of Variance (ANOVA), a technique used to compare means amongst more than two independent populations flow charts and programming techniques in statistics with R Programming
4. Introduction to programming in BASIC : Understanding the computer – problem solving and flowcharts- Basics of Basic – constants AND variables – Expressions in Basic – Printer controls- Jumping, Branching & looping – subscripted variables. Introduction to programming in C : Overview of C – constants, variables and data types- operators and expression – Managing input and output operations- Decision making and branching – Decision making and looping – Arrays user defined functions
5. Introduction to data structures – Arrays – stacks – Queues – List operations on Arrays – stacks- Queues – List. Database Management System :- Characteristics of DBMS- advantages of DBMS over file processing – Actors on the scene- database models- structure of DBMS.
6. Introduction to MSEXCEL- use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to MSWORD word processor-editing, copying moving formation, table insertion, drawing flow charts etc.
7. Computer- oriented statistical Technique : Frequency table of single discrete variable, bubble sort, computation of mean, variance and standard deviation, the test correlation coefficient.
8. Introduction to Internet and use of the same for communication, searching of database, literature, references etc.
9. Introduction to Bioinformatics, Databank search, Data management and interpretation, BLAST, Sequence alignment
10. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions, Genes, Primer designing, Phylogenetic Analysis.

Books

1. Applied Bioinformatics – an introduction – (springer) Selzer P.M and others
2. Bioinformatics Basics – (CRC) – Rashidi, Hooman H , Lukas K Buchler
3. Structural Bioinformatics – (CRC) – Burkowski
4. Bioinformation a practical guide to the analysis of genes and proteins Bexevanis Andress D - ed
5. Practical Bioinformatics (springer) - Bujnicki, Janusz M.- ed
6. Biostatistics refoundation for analysis in health sciences (John wiley) Wayne W Daniel
7. Fundamentals of Biostatistics a practical approach (Kanishka) – Narenkumar Dutta
8. Statistical methods in Biology (Cambridge University Press) – Bailey, Norman T. J
9. Principles of Biostatistics (Wadsworth,USA) – Pagano Marcello.
10. Biostatistics for the biological and health sciences (Pearnon) Triola, Mare M , Triola, Mario F

GB2P5 Laboratory II (Metabolism and Basic Enzymology, Molecular Biology and Environmental Biotechnology)

Metabolism and Basic Enzymology PRACTICALS

I. Extraction and purification of Enzymes. (Choose suitable enzymes)

1. Extraction from plant tissues/Animal in suitable media and its activity measurement
2. Fractional precipitation using ammonium sulphate/ organic solvents.
3. Dialysis and desalting by gel filtration.
4. Purification by Ion exchange, adsorption chromatography and molecular sieving.
5. PAGE for the enzymes.

II. Enzyme assay and quantitative measurement of activation by methods such as colorimetry and spectrophotometry.

1. Velocity measurements and calculation of specific activity.
2. Determination of optimum pH, enzyme concentration, temperature and time for enzyme activity.
3. Substrate saturation and determination of Michaelis – Menton constant
4. Determination of temperature coefficient. Determination of energy of activation.

5. Effect of inhibitors: Competitive and non-competitive inhibition. Determination of inhibitor constant.

Environmental Biotechnology-PRACTICALS

1) Detection of coli forms for determination of the purity of potable water.
2) Determination of dissolved oxygen concentration of water sample.
3) Determination of biological oxygen demand (BOD) of a sewage sample.
4) Determination of Chemical Oxygen demand (COD) of a sewage sample.
5) Isolation of xenobiont degrading bacteria by selective enrichment technique.
6) Survey of degradative plasmids in microbes growing in polluted environment.
7) Effect of sulphur dioxide on crop plants.
8) Estimation of nitrate in drinking water.
9) Study on biogenic methane production.

Molecular Biology - PRACTICALS

1. Preparation of Buffers – Phosphate, Acetate, Tris HCl and Borate.
2. Quantitation of Nucleic Acids.
3. DNA and RNA Agarose Gel Electrophoresis, SDS – PAGE.
4. Restriction Digestion and Ligation Experiments.
5. Isolation of Total RNA.
6. Isolation of Plasmid DNA.
7. Isolation of Genomic DNA from bacteria, plant and animal tissues.

Third Semester

GB 3C1 GENETIC ENGINEERING

THEORY

1. Basic principles of genetic engineering. Scope of genetic engineering. Basic tools: restriction and modifying enzymes, Gene cloning vectors:Plasmids, Bacteriophages, Phagemids, Cosmids, Artificial chromosomes. Introduction of recombinant DNA into prokaryotic and eukaryotic systems. cDNA and genomic libraries.
   Recombinant screening and selection – markers, nucleic acid hybridizations: colony, plaque, dot blot, southern and northern.

2. DNA sequencing techniques, Sanger- Coulson method, Maxam Gilbert method, Automated DNA sequencing PCR and its applications. PCR steps, Primer design Studying PCR products, Types of PCR Study of gene regulation, DNA transfection, Northern analysis, S1 mapping, Primer extension, RNase protection and Reporter assays

3. Expression vectors Expression in prokaryotic and eukaryotic systems. Antibody based screening for recombinant proteins. Expression of heterologous genes: Bacterial, Yeast, Insects Baculovirus system. Mammalian cells(Human viral vectors shuttle vector)
   Production of protein drugs for clinical trial

4. Processing of Recombinant proteins, Intra cellular periplasmic and extra cellular expression of protein. Purification and refolding. Characterization of recombinant proteins. Stabilization of proteins. Phage display system

5. Molecular mapping of genome. Genetic and physical maps, Chromosome microdissection and microcloning, Molecular markers in genome analysis(AFLP, RAPD, and AFLP analysis, molecular markers linked to disease resistant genes), Application in forensic, Disease prognosis, Genetic counseling, Pedigree analysis, Taxonomy and biodiversity

6. Transgenic and gene Knockout technologies, Gene therapy, Vectors and gene delivery, Gene replacement/augmentation, Gene correction, Gene editing, Gene regulation and silencing DNA Micro array technology

7. Genetic engineering guidelines, cloning and patenting of life forms Biosafety Introduction, GMOs, General Concerns, Hazards of environmental engineering, Bio-safety Guidelines and regulations Operation of Biosafety guidelines and regulations

REFERENCE

1. Molecular cloning : A laboratory manual- Sambrook
2. DNA cloning: A practical approach- D.M Glover and B,D, Hames

3. Molecular and cellular methods in biology and medicine- Kaufman
4. Methods in enzymology- Vol 152: A guide to molecular cloning techniques- S.L. Berger and A.R. Kimar
5. Methods in enzymology: VOl 185: gene expression technology- D.V. Goeddel
6. DNA science: A first course in recombinant technology: D. A. Mickloss and G. A. Frier
7. Molecular biotechnology- S.B. Primrose
8. Molecular biotechnology- Glick

GB3C2 BIOPROCESS TECHNOLOGY

THEORY

1. Introduction to Bioprocess engineering. The chronological development of the fermentation industryMicrobial biomass, Microbial metabolites, Recombinant products, Transformation process

2. Bioreactors: A typical bioreactor. Configuration of a bioreactor. Body construction. Aeration and agitation. Achievement and maintenance of aseptic conditions. Sterilization of fermenter, air supply exhaust gas from fermenter. Inoculation, Different ports and Probes. Valves and steam traps

3. Isolation, preservation and maintenance of microorganisms Selection of natural variants important characteristics. Screening methods Strain improvement Random mutagenesis and Site directed mutagenesis Isolation of induced mutants synthesizing improved levels of primary metabolites and secondary metabolites

4. Kinetic of microbial growth and death Batch culture Continuous culture Multistage systems Feedback systems Comparison of batch and continuous culture in industrial processes. Fedbatch culture Variable volume Fixed volume and Cyclic fed batch culture. Specific growth rate. Monod equation

5. Media for fermentation Typical media composition. Medium formulation. Carbon, Nitrogen, Minerals and Energy sources. The addition of precursors and metabolic regulators to media Medium optimization. Oxygen requirements. Antifoams. Air and media sterilization- Media and Air sterilization. Batch, continuous and Filter sterilization

6. Types of fermentation processes Types of reactors. Analysis of batch fed batch and continuous bioreactions. Stability of microbial reactors. Analysis of mixed microbial populations. Bioreactors like pulsed, fluidized, photobioreactors, Plug flow

7. Measurement and control of bioprocess parameters Methods of measuring Process Variables. Online Analysis of other chemical factors. Control systems.

Computer applications in fermentation technology. Mass/Oxygen transfer resistance. Aeration and agitation. Yield and energy consideration. Reynolds number and power number

8. Downstream processing. Removal of microbial mass and solid matter. Foam separation Filtration, Precipitation, Centrifugation. Cell disruptions methods. Liquid- liquid extraction. Chromatography Membrane process. Drying and crystallization

9. Industrial production of chemicals. Alcohol (ethanol) Acids(citric, acetic and gluconic) Solvents(glycerol, acetone and butanol) Antibiotics(penicillin, streptomycin and tetracycline) Amino acids(lysine, glutamic acid) Single cell protein Whole cell immobilization and their industrial applications

REFERENCE

1. Biochemical engineering, Alba.S, Humphrey,A.Eand Millis
2. Biochemical reactors,Atkinson,B,
3. Principles of fermentation technology, Stanbury,P.F and Whitaker
4. Bioprocess technology, fundamentals and applications, KTH, Stockholm
5. Process engineering in biotechnology, Jackson, A.T., Prentice Hall, Engelwood
6. Bioreaction engineering principles, Nelson,J and Villdsen, J. Plenum Press

GB3C3 PLANT BIOTECHNOLOGY

THEORY

1. Plant tissue culture introduction and techniques- lab organization, media preparation and types, aseptic manipulation, contamination, disease indexing and eradication,

vitrification. The cell biology of plant cell culture and development-Major cell types in culture, separation of cell types, growth of cells in suspension, role of growth regulators in growth and differentiation in culture, hormone habituation.

2. a. Micro propagation - Principle, stages, applications, micro propagation in commercial perspectives, advantages, economics, robotics and automation. Regeneration *in vitro*- Pathways and factors controlling regeneration, Organogenesis. Somatic embryogenesis-Induction, development and maturation, somatic embryo vs zygotic embryo, synseed production and applications

4. Somatic hybridization-Protoplast isolation, purification, viability test ,culture-conditions and media, culture methods, microcalli, regeneration, fusion methods-mechanical, chemical,selection and isolation of heterokaryons, genetic consequences, cybridization.

5. Haploid production-anther and microspore culture, pathways of androgenesis, media, factors controlling androgenesis, applications in plant breeding.Triploid production-Techniques, media, explants, organogenesis, factors affecting callus and shoot bud formation, appllications in plant breeding.

6. Embryo culture-Types of embryo, media, role of suspensor, precocious germination, morphogenesis of undifferentiated embryo, embryo rescue, applications in plant breeding. Culture of ovule and ovary, factors affecting seed-set after *in vitro* pollination, applications.

7. Somaclonal and Gametoclonal variation-Molecular basis of variation, variants, Selection. Application in plant breeding.Mutation breeding in tissue culture-Spontaneous, induced, chimeras, adventitious bud technique. Germplasm conservation- Modes of conservation, *in vitro* methods of conservation,viability testing, applications.

8. Secondary metabolite production- Factors affecting production, bioreactors Biotransformation, immobilized plant cells, hairy root cultures, applications.

9. Plant transformation-Ti & Ri plasmids as vectors, basis of tumor formation Mechanism of DNA transfer, role of *vir* genes, binary and co integrate vectors, viral vectors, use of 35s , inducible, tissue specific promoters, nuclear transformation, multiple gene transfer, direct gene transfer methods-macro- and micro- injection, particle gun method , electroporation ,transformation of monocots.

10. Applications of plant transformationHerbicide resistance: phosphinothricin, glyphosphate, sulfonyl urea, atrazine; insect resistance: Bt genes, non Bt like protease and amylase inhibitor, Gene, virus resistance: coat protein mediated, nucleocapsid gene; disease resistance: chitinase, 1-3 β glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance; abiotic stress, post harvest losses, long shelf life of

fruits and flowers, use of ACC synthase, polygalacturonase, ACC oxidase, male sterility, carbohydrate composition and storage ADP glucose pyrophosphate.

REFERENCES

1. Bhojwani,S.S and Razdan.M.K. Palnt tissue culture,Elsevier,Amsterdam.
2. Debergh,P.C. and Zimmerman,R.H.(Eds.) 1991.Micropropagation technology and application,Kluwer,Dordrecht.
3. Dixon.R.A. & Gonzales,R.A.(Eds.) Plant cell culture-A practical approach,IRI,Press,Oxford.
4. Gamborg O.L and Phillips,G.C.,Plant cell,tissue and organ culture.Narosa publishing house,New Delhi.
5. Plant tissue culture I & II E.F.George,Exegetics.
6. Radenbaugh K. (ed.).Synseeds: application of synthetic seeds to crop improvement,CRC Press, Boca Raton,FL.

GB3C4 IMMUNOLOGY

THEORY

1. Introduction to Immune system. Types of immunity- Innate, Acquired, Passive and Active. Factors affecting Immune System.
2. Hematopoeisis and differentiation- Regulation. Cells of Immune system – lymphocytes, null cells, mononuclear cells, granulocytes, dendritic cells. Organs of Immune System – primary lymphoid and secondary lymphoid organs, lymphatic system.
3. Antigens – properties- types. Immunogenecity and antigenecity. Factors affecting immunogenecity. Antigenic epitopes, adjuvants, haptens, superantigens. Antibodies- basic structure, Immunoglobulin domains, antigenic determinant on immunoglobulin- isotype, allotype, idiotype. Immunoglobulin classes and sub classes.
4. Antigen – antibody interactions – Affinity and avidity, cross- reactivity, precipitation, agglutination and agglutination inhibition reactions, Hemagglutination, Bacterial agglutination and particle agglutination and its applications.
5. MHC- structure and organization- immune response, disease susceptibility, T-cell and B-cell receptors. Antigen processing and presentation. Effector responses- Humoral

and Cell- mediated response. NK cell mediated cytotoxicity, Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity. Regulation of immune response. Activation of B and T lymphocytes.

6. Cytokines- Properties and therapeutic use. Complement system- Pathways- Role in immune regulation.
7. Hypersensitivity – types. Diagnosis and treatment approaches Autoimmunity and Autoimmune diseases – Organ specific :thyroid and Systemic: SLE Diagnosis and treatment approaches
8. Immunity to infectious agents – viral, bacterial, protozoan and helminthes infections. Immune aversion mechanisms.
9. Transplantation immunology – Tissue and organ transplantation. Immunogy of rejection-mechanism, Immunosuppressive agents, Tumor Immunology – Oncogenes and cancer induction. Tumor antigens and immune response. Cancer immunotherapy
10. Monoclonal antibody. Hybridoma technology. Production of Monoclonal antibodies, its therapeutic applications.

REFERENCE

1. Kuby- Immunology (Freeman)
2. Immunology – A short course – Eli Benjamine *et. al*
3. Fundamentals of Immunology – William Paul
4. Immunology – Roitt and others

GB3P5 PRACTICALS III

GENETIC ENGINEERING PRACTICALS

1. Preparation of competent cells
2. Calcium Chloride mediated transformation of *E. coli*
3. Shot- gun cloning in plasmid or phagemid vectors

4. Southern blotting
5. Northern blotting
6. PCR
7. Repoter gene assay(Gus/CAT/b-GAL)

BIOPROCESS TECHNOLOGY PRACTICALS

1 Isolation of industrially important microorganisms for microbial processes
2. Comparative studies of ethanol production using different substrates
3. Microbial production of citric acid using *Aspergillus niger*
4. Microbial production of antibiotics(penicillin)
5. Production and estimation of Protease
6. Use of alginate for cell immobilization

PLANT BIOTECHNOLOGY PRACTICALS

1. Preparation and sterilization of glasswares, explant.
2. Preparation stock solution for and media.
3. Large scale isolation of mesophyll cells from leaves.
4. Initiation and maintenance of callus.
5. Organogenesis from callus
6. Somatic embryogenesis from root cultures.
7. Induction of haploids from anther and pollen cultures
8. Cultures.Isolation and culture of protoplasts from leaf/callus by
9. Quantitation of tissue culture procedures: Determination of fresh and dry weights, cell culture density, PCV and MI

IMMUNOLOGY PRACTICALS

1. Blood film preparation and identification of cells, ABO Blood grouping.
2. Lymphoid organs and their microscopic organization.
3. Immunization and collection of Serum.
4. Antibody titration.
5. Double immunodiffusion, Radial Immunodiffusion and immunoelectrophoresis.
6. Western Blotting.
7. ELISA.
8. Separation of mononuclear cells by Ficoll – Hypaque and its cell culture by mitogen induction.
9. Widal and VDRL tests

IV Semester (Elective Course)

THEORY

GB4E3. Industrial & Food Biotechnology

Unit I Industrial and Food Biotechnology; Indroduction; History; Importance; Applications of Bioprocess and Biotechnology in food processing; Significant advances; Risk factors; Safety regulations.

Unit II
Bioprocessing-Industrial use of micro organism; Microbes exploited commercially-Saccharromyces, Lactobacillus; Penicillium, Acetobactor, Bifidobacterium, Lactococcus, Streptococcus. Fermentation-process, media and syste3ms; Upstream and down stream processing; Product development; Dairy fermentationand fermented products.

Unit III
Microbial enzymes in food processing; Industrial production of enzymes – proteases amylase, invertase, pectinase and cellulases; High Fructose Corn Syrup (HFCS). Food and beverage fermentation-alcholic and non alcoholic beverages; Food additives and supplements – probiotics, health care products, Neutraceuticals, vitamins and antibiotics, Fuels and industrial chemicals-Alkanes, industrial ethanol.

Unit IV
Modification of microbes/enzymes – Strain improvement, enzymes/cofactors recombinant enzymes, Applications in product development/improvement.

Unit V
Cells and enzymes immobilization. Product enhancement – Classic examples; Biosensors and Bioprocess monitoring; Basic components and the utility and applications.
Texts/References

1. Gautam, N.C., Food Biotechnology in Comprehensive Biotechnology, Vol.6., Shree Publishers,
2. Gutierrez – Lopez, G.F. et. Al., Food Science and Foos Biotechnology. CRC Publishers, Washington, 2003
3. Maheshwari, D.K. et. Al., Biotyechnological applications of microorganisms, IK. International, New Delhi, 2006
4. Stanbury, P.F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995.
5. Waites, M.J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.
6. Food Microbiology, William C. Fraizer & Deniss C Westhoff, Tata MaGraw-Hill, 2008.
7. Industrial Microbiology Casida L. E., Wiley, 2007

GB4E4. Nanobiotechnology

Unit I

Introduction to Nano-Biotechnology; Nanotechnology definition and concepts; Cellular Nanostructures; Nanoprocess; Biomolecular motors; Criteria for suitability of nanostructures for biological applications

Unit II
Molecular nanotechnology; Nanopowders and nanomaterials: Sol-gels and their use, Use of natural nanoparticles, Nanobiometrics, Lipids as nano-bricks, Proteins as nanomolecules, DNA in nanotechnology, Present and future of nanotechnlogy applications in Molecular biology and Medicine

Unit. III
Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation sepectroscopy, Thin films; Colloidal nanostructures; Nanovesicles; Nanospheres; Nanocapsules

Unit IV
Nanostructures for drug delivery, concepts, targeting, routes of delivery and advantages

Unit V
Nanostructures for diagnostics and biosensors; Nanopartcles for diagnostics and imaging; Nanodevices for sensor development.

Texts/References

1. Multilayer Thin Films, Editors(s): Gero Decher, Joseph B. Schlenoff, Multilayer Thin Films, Wiley-VCH Verlag, GmbH & Co. KGaA ISBN: 3527304401
2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss ISBN: 047141719X.
3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-8247-2579-4
4. Gero Decher, Joseph B. Schlenoff, Multilayer Thin Films, Wiley-VCD Verlag, GmbH & Co.KGaA, 2003.
5. David S. Goodsell, Bionanotechnology: Lessons from Nature, 1st Edition, Wiley-Liss, 2004.
6. Neelina H. Malsch, Biomedical Nanotechnology, 1st Edition, CRC Press, 2005.

GB4E5 Stem Cell Biology

Unit. I

Introduction to stem cells, classification, Sources, programming and reprogramming, tissue specific stem cells Embryonic hematopoietic and neural stem cells, Classification and Sources

Unit II
Embryonic Stem Cells Blastoyst and inner cell mass cells; Organogenesis; Mammalian Nuclear Transfer Technology; Stem cell differentiation; Stem cells cryopreservation

Unit III
Application of stem Cells Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's Alzheimer, Spinal Code Injuries and other Brain Syndromes; Tissue systems failures; Diabetes; Cardiomyopathy; Kidney failure; Liver Failure; Cancer; Hemophilia.

Unit IV
Human Embryonic Stem Cells and society. Human stem cells research : Ethical considerations; Stem cell religion consideration; Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy.

Unit V
Various model organisms. Stem cell isolation & charecterisation techniques

Texts/References

1. Ann A Kiessling, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, jones and Bartett, 2003.
2. Peter J. Quesenberry, Stem Cell Biology and Gene therapy, 1st Edition, Willy-Less, 1998.
3. Robert Lanja, Essential of stem cell Biology, 2nd Edition, Academic Press, 2006.
4. A.D. Ho., R. Hoffiman, Stem Cell Transplantation Biology Processes Therapy, Willy-VCH, 2006.
5. C.S. Potten, Stem Cells, Elsevier, 2006.

CSS – General Pattern of Question Paper for Core and Elective courses in General Biotechnology

I/II/III/IV Semester M.Sc. Degree Examination – (year),
(CSS – M.Sc. Programme in General Biotechnology)
(Course code and Title)

Time : 3 hours Total weightage = 36

Section A

(very short answer type)
(Answer ALL questions, each with weightage 1)

Question Number 1 to 10 total weightage 1 x 10 = 10

Section B

(Paragraph type/ short answer type)
(Answer any seven questions, each with weightage 2)

Question Numbers 11 to 20 total weightage 7 x 2 = 14

Section C

(Essay Type)
(Answer ANY two questions, each with weightage 6)

Question numbers 21 to 23 total weightage 2 x 6 = 12