VIDYASAGAR UNIVERSITY

BIOTECHNOLOGY

(Honours)

Under Graduate Syllabus

(3 Tier Examination Pattern)

w.e.f. 2014-2015

REVISED

Vidyasagar University

Midnapore 721 102

West Bengal

BIOTECHNOLOGY

(Honours)

Part I	200
Part II	300
Part III	300
Total marks : 800	

Biotechnology Honours (B.Sc)

Part-I

Paper 1

Group A: Biochemistry	30 marks
Group B: Cell Biology	30 marks
Group C: Biophysics & Molecular Biology	30 marks

Paper 2

Group A: Microbiology	30 marks
Group B: Genetics	30 marks
Group C: Computer application & Bioinstrumentation	30 marks

Part-II

Paper 3

Group A: Genetic Engineering	35 marks
Group B: Immunology	30 marks
Group C: Animal Cell culture	25 marks

Paper 4

Group A: Plant Physiology and Plant tissue culture	30 marks
Group B: Ecology and Environmental Biotechnology	30 marks
Group C: Industrial Biotechnology	30 marks
Paper 5 Practical	100 Marks

Part-III

Paper 6

Group A: Bioinformatics & Biostatistics	45marks
Group B: Genomics and Proteomics	20 marks
Group C: Rural Biotechnology	15 marks
Group D: IPR and Management of Biotechnology	10 marks

Paper 7-Practical	100 Marks
Paper 8- Practical	100 Marks

Each theoretical paper consisting of 100 marks of which 90 marks for University written examination and 10 marks for internal assessment from college

Syllabus- Biotechnology

Part-I

Paper I *Full marks-90*

Gr. A: Biochemistry-30 marks 30 lectures

Carbohydrate-Structure, Classification, Nomenclature, Function of carbohydrate.

Protein-Amino acid, peptide bond, Classification, Structure; Primary structure, Secondary structure, Ramchandan plot, Membrane protein, Glycoprotein, Collagen structure.

Lipid-Classification, structure, Function, Saturated and unsaturated Fatty acids, liposome, micelles, lipoprotein structure and function.

Nucleotides-Structure, Chemistry and physical properties of DNA (A, B, C and Z, RNA; tertiary structure.

Enzyme-Classification, Coenzyme, Enzyme kinetics, Inhibitor, Michelis-Menten equation, Properties of Enzyme, Function of lysozyme. Trypsin, pepsin, Chymotrypsin, Isoenzyme.

Metabolic pathway – Glycolysis and TCA cycle and its regulation. Electron transport cycle, Oxidative phosphorylation and photosynthetic phosphorylation.

Hormone-Chemical nature of Hormone, Molecular mechanism of Hormone action, Function of trophic Hormone (FSH,TSH, ACTH, Gh), Insulin, testosterone ,Estrogen, progesterone, hCG, Disease related to hormone –Diabetes mellitus, diabetes incipidus.

Biosynthesis-Purine and Pyrimidine biosynthesis, cholesterol, Fattyacid and Phospholipid

Suggested reading

- Analytical Biochemistry 3rd Ed. by Holme, D. J. & Peck, H.
- Basic Concepts in Biochemistry A Student's Survival Guide by Gilbert, H. F.
- Biochemistry (3rd ed. 1994) by Rawn J. D.
- Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.
- Biochemistry by Todd, W.B., Mason, M., Bruggen, R.V. & Macmillan.
- Biochemistry by Voet & Voet
- Biochemistry by Mathews 3rd Ed.
- Biochemistry The Chemical Reactions of Living Cells 2d Ed Vols 1 & 2 by Metzler, D. E.
- Biochemistry: (3rd ed. Vol.1, 2, 3, 1993) by Zubay, J.
- Biochemistry2ed by Stryer

Gr.-B Cell Biology-30 marks 50 lectures

Cell-Basic structure of Cell, Cell organelles, microbodies and their function. Difference between Prokaryotic and Eukaryotic cell.

Tissue- Animal epithelial tissue, Connective tissue, Muscle tissue and Nervous tissue and their function Plasma Membrane-Membrane Structure, Fluid Mosaic Model, Membrane Transport, Membrane protein. Integral and peripheral protein, membrane lipid and its role in membrane fluidity.

Membrane transport-Passive diffusion, carrier mediated transport, Active transport, Ion channel and voltage gated channel, Exocytosis, pinocytosis.

Protein transport- Protein transport from Nucleus to Golgi complex, ER.

Cell Signal-General principle of cell signaling, Ligand – receptor interaction, G protein linked receptor, second messenger (cAMP, cGMP).

Cell division - Mitosis and Meiosis.

Cell cycle- Cell cycle control, Cell cycle check point, Cyclin and CDK protein, Regulation of cell cycle, Apoptosis and necrosis.

Suggested reading

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

Gr. C Molecular Biology-30 marks 50 lectures

DNA and RNA -Structure and properties of Nucleic acids; Watson and Crick Model of DNA structure, RNA; mRNA, tRNA, rRNA

Chromosome- Chromosome structure, Chromatin, Telomere, Histone, Non Histone, Nucleosome organization.

DNA replication – Models of prokaryotic DNA replication, Replication process.

Transcription-Components of transcription machinery in prokaryotes, and Eukaryotes, Transcription process, Post transcriptional modification (Capping, Polyadenylation, Splicing etc), editing.

Translation-Genetic code, Wobble hypothesis, Translation process, tRNA, Post translational modification of protein. Signaling peptide, Protein transport.

Gene regulation-Regulation of gene expression in Prokaryote (lactose operon and Trypophan operon)

DNA repair pathway-DNA repair pathway of Prokaryote and Eukaryotes, DNA Repair defect disease-*Xeroderma Pigmentosum* in Human, SOS repair pathway in *E coli*.

Cancer genetics-Causes of cancer, Benign and malignant tumor, carcinogenesis, Carcinogen, Proto-oncogene, Viral oncogene, Tumor suppressor gene, Regulation of gene expression by oncoprotein.

Suggested reading

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

Paper II *Full marks-90*

Gr-A: Microbiology-30 marks 40 lectures

Type of micro-organism, brief history of microbiology,

Bacteria –Morphology and structure of bacteria: Cell wall structure of Gram Positive structure and Gram negative Bacteria, Endospore, Cytoplasmic membrane, cilia, flagella etc.

Bacterial classification-Biochemical, serological and DNA/RNA based classification of bacteria.

Microbial metabolism-Oxidation reduction reaction, the respiratory chain, energy production by glycolysis, pentose phosphate pathway, Enter-Doudoroff pathway, TCA, Glyoxylate cycle.

Bacterial growth-Microbial growth, culture media, Pure culture, growth kinetics.

Virus-Classification of Virus, Structure, Multiplication of virus: Lysogenic and lytic phage,

Viruses of animal-Yellow fever virus, influenza virus, HIV

Antibiotics –Antimicrobial agents, Sulfa drugs, penicillin, Broad spectrum antibiotics, antifungal antibiotics, mode of action, semi synthetic antibiotics, chemotherapeutic effect of antibiotics.

Suggested readings

- Powar C. B. and H. F. Daginawala (2003).General Microbiology Vol. II; Himalaya Publishing House.

- Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S. Chand and Company Ltd.
- H.C. Dube (2005) A Textbook of Fungi, Vikas Publishing House.
- A Textbook of Fungi- Vashistha (2003) S. Chand and Company Ltd.
- Davis and Harper, General Microbiology
- Alexopoulos C. J. and C. W. Mims (1996). Introductory Mycology, 4th Edition; John Wiley and Sons, Inc. USA.
- Stanier, R.Y., J.L. Ingraham, M.L. Wheelis and P.R. Painter (1987) Vth edition. General Microbiology, Macmillan Press Ltd.
- Wiestrich G. A. and M. D. Lechtman (1988). Microbiology, 5th Edition; Macmillan Pulishing Company, New York.
- Trivedi, P.C. (2004) 1st Edition. Microbial Biotechnology, Aavishkar Publisher.
- Sharma, P.D. (2005) 2nd Edition. Microbiology, Rastogi Publications.
- Pelczar M. J., E. C. S. Chan and N. R. Krieg (2003) Microbiology, 5th Edition; Tata McGraw Hill Publishing Company , New Delhi

Gr.-B Genetics -30 marks 30 lectures

Discovery of DNA as genetic material (Griffiths experiment), Nuclear genome, organelles (Mitochondria and chloroplast) genome, transposable element.

Genome Complexity- C value Paradox, Cot curve, Repetitive DNA, Satellite DNA, Pseudogene, overlapping gene, gene family and Gene Cluster.

Heredity- Mendel's Experiment (Mono hybrid and dihybrid cross), Gene interaction, Chromosomal theory of inheritance, Multiple allele, Linkage, Crossing over, Sex linked inheritance, Maternal inheritance, nondisjunction, Klinefelter Syndrome and Turner Syndrome.

Biochemical genetics- Inborn error of Metabolism, one gene one polypeptide concept, Alkaptoneuria, Sickle cell anaemia.

Microbial genetics- Conjugation, transformation, transduction, chromosome mapping, Extrachromosomal genetic material of bacteria.

Mutation – Chromosomal aberration, Mutation in molecular level; Somatic vs. Gametic mutation, Mutagenic agent.

Population genetics- Hardy-Wienberg low, Gene frequency, gene pool.

Suggested reading

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
- Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.

- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology - Principles and Applications of recombinant, DNA. ASM Press, Washington.
- Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.
- Epigenetics- http://www.nature.com/nrg/focus/epigenetics/index.html, Tetrad Analysis in fungi, Centromere Mapping, Cytogenetic Mapping

Gr-C: Computer application and Bioinstrumentation- 30 marks
30 lectures

Computer application

Generation of computer:-1st to 4th generation with their characteristics.

Basic concept of computer: Introduction , different components of computer, basic design of computer.

Introduction to operating system

Introduction to OS, different management (processor, memory, device, file),

Processor management-Process concept, Threads, CPU Scheduling

Process scheduling, Deadlocks, Process synchronization.

Memory management – Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory.

Device management, File management.

Windows operation :

Customizing the interface, windows explorer, computer upkeep & utilities

Office operation

Microsoft word:- concept of toolbar, character, paragraph& document formatting, drawing tool bar, header, footer, document editing, page setup, short cut keys, text & graphics.

Microsoft excel:- concept of spread sheets, creating worksheet, well formatted documents, concept of row, column, cell &formula bar, using function, using shortcuts, chart, conditional formatting, goal seek, validation rule.

Microsoft power point:- slide presentation, slide layout & design, custom animation, image importing, slide transition.

C Programming

Introduction, data type, operators & expression, program control, case control structure, function, array, structure & union, character & string, pointer, file handling, pre-processor & library function. Digital logic Number systems (binary, octal, hexadecimal), logic gates, Boolean algebra, logic diagram.

Suggested reading

• V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.

• Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.

Reference manual for Open Office available at: http://www.openffice.org

Reference manual for Star Office available at: http://www.sun.com/ software/staroffice

Bioinstrumentation

1. **Separation & Identification of Materials** - concept of Chromatography (Partition

Chromatography, Paper Chromatography, Adsorption Chromatography, TLC, GLC, Ion

Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography);

Electrophoresis (Gel Electrophoresis, Paper Electrophoresis).

2. **Centrifugation** – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation.

3. **Microscopy** – Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, TEM, SEM.

4. **X-Ray Crystallography** – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal

structure, determination of crystal structure [concept of rotating crystal method, powder method].

5. **Spectroscopy**: Raman Spectroscopy – What is Raman effect, Quantum mechanical reason of Raman effect, Molecular Polarizability, Polarizability ellipsoid, Experimental technique of Raman effect, Basic concept of Pure Rotational & Vibrational, Raman spectra of simple molecule (linear molecule).

6. **NMR Spectroscopy** – Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, Hyperfine splitting, Relaxation process.

7. **Absorption Spectroscopy** – Simple theory of the absorption of light by molecules, Beer-Lambert law, Instrumentation for measuring the absorbance of visible light, Factors affecting the absorption properties of a Chromophore.

Suggested reading

- Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
- Bioinstrumentation, Webster
- Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
- Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press
- Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.

- NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.
- Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.

Part- II

Paper III Full marks-90

Gr.-A: Genetic Engineering-35 marks 50 lectures

Basic principle of genetic engineering

Tools of genetic engineering-Restriction Endonuclease, Cloning Vector, Plasmids, cosmids, Bacteriopage, Ti plasmids, Yeast artificial chromosome, Yeast Two Hybrid system, transformation, Promoter; caMV,SV40,Selection marker; LacZ gene, Luciferase, CAT, NPTII, Expression Vector system.

Molecular technique- PCR ; Assymetric PCR , RAPD, RFLP,AFLP, Southern blot, Western blot and Northern blot analysis, dot and slot blot analysis. DNA fingerprinting, DNA foot printing, cDNA and genomic DNA library, Sequencing of DNA and protein, DNA microarray, protein Micro array.

Application of Genetic Engineering –DNA vaccine, Gene therapy, Stem cell therapy, Genetically Modified food (Golden rice),Recombinant Pharmaceutical product (Insulin, Growth Hormone, Blood clotting factor VIII, Interferon,), Drug designing ,Transgenic animal ;Transgenic mice, Knockout mice, Anti sense therapy, Ribozyme therapy ,Protein Engineering.

Suggested readings

- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)
- Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.
- Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
- Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
- Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.
- Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
- Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

Gr.-B: Immunology-30 marks 30 lectures

Introduction to Immunology-Properties of Immune response, Innate and acquired immunity, Active and Passive immunity

Immune system-Primary and Secondary immune system; Bone marrow, Thymus, lymph node, Spleen ,Antigen presenting cell, NK cells, Mast cells, Dendritic cells, Macrophage, Phagocytosis.

Antibody-Structure, function, Classification of Antibody, Isotopes, Allotype, isotype, idiotype, Antibody diversity.

Antigen-Nature of antigen, Adjuven, Hapten, Antigen – antibody interaction.

MHC-Structure, function, Cytokine and lymphokines.

Tolerance-Autoimmunity, Autoimmune disease (Reumatoid arthrities, Mysthesia gravies)

Vaccine-Principle, Methods of vaccination, Heat killed, attenuated vaccine, Synthetic vaccine, DNA vaccine, Vector vaccine Immunological techniques- Ag-Ab reaction, Immuno-diffussion, Immuno-electrophoresis, ELISA, RIA.

Hybridoma Technology-Monoclonal Antibody; Therapeutic application, disease detection kit, Hybrid antibody

Suggested reading

- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
- Peakman M., and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Gr.C: Animal Cell culture-25 marks 50 lectures

Animal cell culture-Basic animal cell culture laboratory, Culture condition, maintenance, Limitation, equipment, Media, Basic salt solution, Physicochemical properties, Advantage and dis-advantage of Serum free media

Cell cycle, Cell differentiation, Cell dedifferentiation, Extracellular matrix,

Primary culture-Establishment of Cell line, primary cell culture, Subculture, Routine maintenance, designation.

Characterization of Cell -Cell count and cell viability test, plating efficiency, labeling index, growth curve of cell.

Cancer cell - Morphology, characterization; tumorigenecity, antigenic marker, immortality etc.

Cryopreservation –Methods of cryopreservation, Cell count and cell viability test.

Cytotoxicity assay-Colony Forming assay, MTT assay, XTT assay, FACS analysis, Apoptosis study by tunnel assay and DNA fragmentation assay.

Transfection methods- Calcium Phosphate methods of transfection.

Stem cell –Embryonic stem cell, Haematopoitic stem cell, liver stem cell, Fate map, Totipotency and pluripotency of cell.

Suggested reading

- Culture of Animal Cells, R.I Freshney, Wiley-Leiss.
- Animal Cell Culture – A Practical approach, J.R.W. Masters, Oxford.
- Animal Cell Culture Techniques, M. Clynes, Springer Verlag.
- Cell Culture Lab Fax, M. Butler and M. Dawson, Bios scientific Publications Ltd.
- Cell Growth and Division – A Practical approach, R. Basega, IRL Press.
- Comprehensive Biotechnology, Moo-Young, Alan T. Bullm Howard Dalton, Panima Publication.

Paper- IV **Full marks-90**

A. Plant physiology and Plant Tissue culture- 30 marks

50 lectures

Plant Nutrition-Photosynthesis, C3, C4, CAM pathway of Plant. Plant growth substances-Auxin, Cytokines, Gibberellins, ABA

Artificial propagation-Cutting, Grafting, Budding, layering.

Plant breeding-Selfing, crossing technique, male sterility, polyploidy and hybrid vigour.

Plant reproduction-Sexual reproduction; pollination, fertilization, double fertilization, embryo and seed formation, Vernalization and germination.

Plant tissue culture-Description of Tissue culture lab, Culture media, Culture condition

Haploid culture; Anther, pollen culture, Protoplast culture and fusion, Single cell suspension culture , Somatic hybridization- Hybrid, cybrid plant.

Transgenic plant-Gene transfer methods; Agrobacterium mediated gene transfer, Electroporation ballistic gun Herbicides resistant and insect resistant transgenic plant.

Genetically modified Food-Golden rice, Bt cotton

Cryopreservation, Gene bank, Seed Bank, Artificial Seed.

Suggested reading

- An Introduction to Plant Tissue Culture, M.K. Razdan, Oxford and IBH Publishing

- Experiments in Plant Tissue Culture, J.H. Dodds and L.K. Roberts, Cambridge University Press
- Plant Biotechnology and Transgenic Plants, K.M.O. Caldenty, W.H. Barz and H.L. Wills, Marcel Dekker
- Plant Biotechnology, J. Hammond, P. McGarvy and V. Yusibov, Springer Verlag.
- Plant Cell & Tissue Culture for the production of Food Ingredients, T-J Fu, G. Singh and W.R. Curtis, Kluwer Academic/Plenum Press
- Plant Tissue Culture: Theory & Practice, S.S. Bhojwani and M.K. Razdan, Elsevier Health Sciences

B. Ecology and Environmental Biotechnology 30 marks

50 lectures

Ecology-Definition, level of organization, Energy flow in ecosystem, Population, Biotic community, Biodiversity (Ex situ and In situ Conservation), Pollution and Biomonitoring

Bioremediation-In situ and Ex situ Bioremediation, bioremediation of industrial waste (Paper and Pulp Industry), Bioremediation of Heavy metal, phytoremediation.

Bioconversion-Biomass conversion by Non-Biological processes and Biological process.

Environmental genetics- Biodegradation of Xenobiotics and Pseudomonas putida-oil degrading bacteria.

Bioleaching-Metal recovery and Microbial desulfurization of Coal.

Sewage and Waste water system-Aerobic and anaerobic treatment, Conventional and advanced treatment technology, emerging biotechnological processes in waste water treatment.

Biosensor; Type of Biosensor, Environmental industrial and clinical application

Suggested reading

- Environmental Science, S.C. Santra
- Environmental Biotechnology, Pradipta Kumar Mohapatra
- Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter.
- Waste Water Engineering, Metcalf and Eddy, Tata McGraw Hill.
- Agricultural Biotechnology, S.S. Purohit.
- Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer.
- Introduction to Environmental Biotechnology, Milton Wainwright.
- Principles of Environmental Engineering, Gilbert Masters.
- Principles of fermentation Technology, Salisbury, Whitaker and Hall.
- Industrial Microbiology – Cassida.
- Agricultural Biotechnology – S.S. Purohit.
- Wastewater Engineering – Metcalf & Eddy.

C. Industrial biotechnology 30 marks

20 lectures

Process Biotechnology: Bioprocess technology for the production of cell biomass and primary/secondary metabolites, such as baker's yeast, ethanol, citric acid, amino acids, exo-polysacharides, antibiotics and pigments etc.

Microbial production, purification and bioprocess application(s) of industrial enzymes; Production and purification of recombinant proteins on a large scale; Use of microbes in Industrial biotechnology. Kinetics of microbial growth, substrate utilization and product formation.

Bioconversion- Biomass conversion by Non-Biological processes and Biological process

Bioprocess Engineering:Kinetics of microbial growth, substrate utilization and product formation; Simple structured models; Sterilization of air and media; Batch, fed-batch and continuous processes; Aeration and agitation; Mass transfer in bioreactors; Rheology of fermentation fluids; Scale-up concepts; Design of fermentation media; Various types of microbial and enzyme reactors; Instrumentation in bioreactors. Microbial biotransformation (Transformation of steroid and Sterol) Immobilization of enzymes and cells and their application for bioconversion processes.

Use of microbes in Industrial biotechnology.

Books

Industrial Microbiology – Cassida

Agricultural Biotechnology, S.S. Purohit

Industrial Microbiology-Prescott

Ecology- P.D.Sharma

Paper-V

Biochemistry lab 40 marks

Preparation of Buffer and detection of pH of solution.

Separation of amino acids and carbohydrate by Paper chromatography and Thin layer chromatography.

Estimation of protein by Lowry method.

Separation of Protein by PAGE and SDS-PAGE.

Enzyme assay; Amylase, Protease etc.

Microbiology lab 40 Marks

Media preparation and Bacterial culture preparation.

Staining methods-Gram staining, Endospore stain, Flagella stain, Capsule stain.

Determination of BOD and COD of a sample of Waste water.

Study of Bacterial growth kinetics by Spectrophotometer.

Bacterial characterization; IMVIC test, Sugar utilization by amylase assay, Protein utilization by casein hydrolyzed assay. Antibiotic sensitivity assay.

Isolation of bacteria from soil by serial dilution methods.

Lab Note Books 10 Marks

Viva-Voce-10 Marks

Part-III

Paper-VI Full marks-90

Group A: Bioinformatics & Biostatistics 45 marks

Bioinformatics

1. Introduction to Genomics - information flow in biology, DNA sequence data, Experimental approach to genome sequence data, genome information resources.
2. (8 Periods)
3. Functional Proteomics - protein sequence and structural data, protein information resources and secondary data bases. (8 Periods)
4. Computational Genomics - Internet basics, biological data analysis and application, sequence data bases, NCBI model, file format. (8 Periods)
5. 4. Sequence alignment & data base search - Protein primary sequence analysis, DNA sequence analysis, pair wise sequence alignment, FASTA algorithm, BLAST, multiple sequence alignment, DATA base searching using BLAST and FASTA.
   (10 Periods)
6. Structural data bases - Small molecules data bases, protein information resources, protein data bank.

Suggested reading

- Computer Science, J.G. Brookshear, Pearson, Addison Wesley

- Introduction to Bioinformation – T.Attawood
- A book on C by Kelley: Programming in C, Addison-Wesley Publishing
- Introduction to C++ for Engineers and Scientists, Prentice-Hall
- Schaum's Outline of Introduction of Computer Science, P. Cushman and R. Mata-Toledo, McGraw Hill Trade
- Bioinformatics – Managing Scientific Data, Zoe' Lacroix and Terence Critchlow
- Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor
- Structural Bioinformatics, Philip E. Bourne, Helge Weissig 2003
- Statistical Methods in Bioinformatics: An Introduction, G.R. Grant, W.J. Ewens, Springer

Biostatistics:

Probability calculation (classical & axiomatic definition of probability, theorem on

total and compound probability), standard distribution with important properties, simple

problems involving binomial, poisson and normal variables, methods of sampling, collection of data, primary and secondary data, classification & tabulation, confidence level, statistics , idea of sampling, distribution and standard error, large samples; normal tests, measurement of dispersion (measures of location and desperation).

Mean, median, mode and standard deviation, Random variables, Poisson, normal and binomial distributions, Correlation and regression analysis.

Group B: Genomics and Proteomics - 20 marks 20 lectures

Genomics

Genome evolution and phylogenetics.

The origin of genomes.

Acquisition of new genes.

DNA sequencing- chemical and enzymatic methods.

The origin of introns.

Restriction mapping.

DNA and RNA fingerprinting

The Human Genome.

Proteomics

Basic principles of protein structure.

Modeling of three-dimensional structure of a protein from amino acid sequence.

Modeling mutants.

Evaluating protein structure.

Designing protein.

Analysis of nucleic acid/protein sequence and structure data, genome and proteome data using web-based tools.

Intellectual property rights, patenting, product regulation, entrepreneurship development

Human genome project-Its application.

Suggested reading

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
- Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology-Principles and Applications of recombinant DNA. ASM Press, Washington
- Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.
- Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford

Group C: Rural Biotechnology

Kinetics of microbial growth, substrate utilization and product formation

Industrial Production of Antibiotics (Penicillin), Lactic acids, Vitamin B12 and ethanol, citric acid, amino acids, exo-polysacharides and pigments etc.;

Food Biotechnology

Food Biotechnology: Production and types of cheese, microorganisms as food – production of mushroom and spirulina, assessment of microbiological quality of various foods.

Industrial awareness: Quality control and quality assurance in food and pharamaceutical industry, concept of current good manufacturing practices in pharmaceutical industry

Food biotechnology- SCP from micro-organism, Algae, bacteria, mushroom.

Biofertilizer- Azolla, Rhizobea spp,Asymbiotic Nitrogen fixer, Mycorryza, Vermiculture.

Microbial biotransformation (Transformation of steroid and Sterol)

Immobilization of enzymes and cells and their application for bioconversion processes

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.

2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

Group D: Intellectual Property Right and Management of Biotechnology – 10 marks 15 lectures

IPR- IPP, Forms of Protection, Patenting strategy, Copy right, Plant variety protection, WIPO, GATT, WTO, Patent status international scenario Role of patent in Pharmaceutical Industry, Role and regulation of Indian Patent.

Biosafety and Bioethics-Risk for Human health, Biosafety guideline and regulation,

Marketing – Commercialization of Biotechnology, Research and Development of University-Industry agreement.

Suggested reading

- Entrepreneurship: New Venture Creation, David H. Holt
- Patterns of Entrepreneurship : Jack M. Kaplan
- Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.

Paper VII Full marks-100

Molecular Biology and rDNA technology lab 30 Marks

Isolation of genomic DNA from Bacteria , Plant leaf /Human Blood.

Isolation of Plasmid DNA from Bacteria.

Agarose gel electrophoresis.

Restriction Digestion of DNA by RE II

Polymerase Chain reaction

Preparation of Competence cell and transformation

Method of Plasmid mediated transfer of antibiotic resistant gene.

Fermentation technology lab 30 Marks

Induced mutation by UV light in enzyme producing bacteria.

Preparation of Inoculum and production of Ethanol from *S cerevisiae*.

Analysis of Ethanol by Sp.Gravity and colorimetric methods.

Phylogenetic analysis of unknown bacteria by PCR using universal primer.

Group project	20 Marks
Lab Note Books	10 Marks
Viva-Voce	10 Marks

Paper 8

Bio-Informatics Lab 20 marks

DNA sequence analysis by BLAST

Prediction of secondary structure of protein using EXPAsy, Swissport .

Phylogenetic analysis of unknown bacteria by PHYLIP/Megablast software

Plant Biotechnology 30marks

Media preparation –MS medium

Sterilization of Leaf and Explant

Embryo culture, Meristem Culture, Anther/pollen culture.

Grafting in rose plant.

Spawn preparation and Mushroom culture.

Spirulina culture

Production of Biofertilizer using agro based waste material by Vermicomposting or Microorganism.

Immunology and Medical Biotechnology 30 marks

Qualitative determination of Albumin, Bilirubin, Glucose, creatine, Occult blood and Amino Acids in Blood

Quantitative Estimation in Blood of Cholesterol, Urea, Glucose, Haemoglobin, HDL and LDL, Uric acids

TC/DC of WBC, ESR from Blood Sample.

Assay of SGPT, SGOT, LDH in Blood.

Counting of RBC by Haemocytometer.

Determination of Blood group and Rh factors

Estimation of Blood Pressure.

Lab Note Books-10 Marks

Viva-Voce-10 Marks