RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR
SYLLABUS PRESCRIBED FOR THE
DEGREE OF THE MASTER OF SCIENCE IN BIOTECHNOLOGY
[UNDER SEMESTER EXAMINATION AT PG LEVEL Ordinance No. 118]
(Academic Session 2011-12 onwards)

This brochure of the programme of the study in Biotechnology in broadly divided into three parts: (A) General Information, (B) Scheme of Examination, and (C) Course of Study.

(A) General Information:

1. Duration of the Course: This will be a full time programme to be covered in four semesters in two academic sessions. Each academic session will have one year duration with the following composition:

First Academic Session:	First and Second Semesters
Second Academic Session:	Third and Fourth Semesters

2. Admission to the Course: The number of seats will be 25. Number of seats can be increased from time to time on the approval of the Vice-Chancellor. Admission to the course will be done through a National Written Entrance Test followed by personal interview and counseling to be conducted at Jabalpur by the University preferably in the month of May-June each year. A candidate who after having passed the Bachelor of Science examination with a minimum of 50% marks from a recognized University with at least one subject of Life Science/ Biological Science/ Biotechnology shall be eligible for the entrance test. Admission will be given purely on the basis of merit in the entrance test. Reservation rules of Govt. of M.P. would be followed in the admission. After completion of one semester, students will be provisionally admitted to the next semester, which will commence after a gap of not more than 15 days from the completion of semester examination.

3. Tuition and other Fees: This course will be totally operated under Self-Finance Scheme of the University. Candidates admitted to this course will pay for his/her seats Rs 20,000 (twenty thousand) along with other fees of the University every semester. Fee may be increased as and when required after due consideration. No concession will be made in the fee structure for the candidate of any category in this course.

4. Scope of students (Structure of Programme): There will be four papers along with practical in each semester, except in the fourth semester. Every student of the fourth semester will submit a dissertation *in lieu* of four theory papers. The course of the studies in different papers and in practicals will be as per syllabus prescribed by the Board of Studies in Biotechnology, Rani Durgavati Vishwavidyalaya, Jabalpur.

5. Internal (Continuous) Assessment: Apart from the semester (term) examination, every student of first, second and third semesters will be assessed in (i) Seminars (ii) Written tests.

(i) **Seminars:** Students in I, II and III semesters will be required to deliver one seminar of 30 minute duration followed by discussion. The performance of the student will be judged by two teachers of the department. The credit for seminar in each semester shall be 20 marks.

(ii) **Written Tests:** In I, II & III semesters, every student will have to appear in one written test each in all four papers. The duration of test will be one hour and credit will be 20 marks. The test will be conducted by the concerned teacher and result will be declared within a week. The average marks of all the four papers in each semester will be credited to the students.

Students Participation in the Course (Attendance) : The students whose average attendance is less than 60% will not be allowed to appear in the term examination and will be declared failed in that subject / course / semester.

6. Term (Semester) Examination: There shall be term (semester) examination at the end of each semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the Department / University. A student seeking admission to a semester examination will submit through the Head of the Department his / her application on prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and one combined practical examination of 6-hour duration in every semester except for the fourth semester. In the fourth semester, every student will be allotted dissertation work in lieu of 4 theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Reader of the Department by rotation according to seniority. The students can be permitted to pursue their dissertation work out of the Department / University at the institutions / Universities duly recognized by a statutory body. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

7. Condition for Pass: For passing the examination in each semester, a candidate must have secured a minimum of 45% marks in aggregate in theory, practical and internal assessment separately. The students who do not pass a semester examination shall get an opportunity in the subsequent examination of that semester in the papers in which they have failed. Provided any student who fails in two consecutive semesters will not be given privileges of this clause. Meanwhile, they will be allowed to keep term (ATKT) in next semester.

8. Result: The result of the candidate will be declared on the basis of aggregate marks obtained by him / her in all the semester examinations taken together. The division shall be awarded on the following basis *viz*.

(i) First Division: 60% and above,
(ii) Second Division: 50% and above but less than 60%,
(iii) Third Division: 45% and above but less than 50%.

The result of an examination shall be published as per the provisions of the concerned Ordinance.

9. For any other matter not contained in this Ordinance, revised Ordinance no. 79 would be followed.

(B) Scheme of Examination:

As and when required, the Board of Studies in Biotechnology, Rani Durgavati Vishwavidyalaya, Jabalpur, will be empowered to change the Scheme of Examination.

(C) Course of Study: The courses of the studies in different papers and in practicals will be as per syllabus prescribed by the Board of Studies in Biotechnology, Rani Durgavati Vishwavidyalaya, Jabalpur

(B) Scheme of Examination

FIRST SEMESTER

Number & Title of the Courses	Max. marks	Mini. Marks	Min. Aggr. for passing
(A) Theory Papers			
I Cell Biology	40	14	
II Biomolecules	40	14	72
III Microbial Physiology & Genetics	40	14	
IV Animal Cell Science & Technique	40	14	
(B) Practical & Viva Voca	100	45	45
(C) Internal Assessment			
Seminars	20	18	18
Written Tests	20		
TOTAL	**300**		

SECOND SEMESTER

Number & Total of the Courses	Max. Marks	Min. Marks	Min. Aggr. for Passing
(A) Theory Papers			
V Molecular Biology	40	14	
VI Macromolecules & Basic Enzymology	40	14	72
VII Biology of the Immune System	40	14	
VIII Biostatistics & Computer Application	40	14	
(B) Practical & Viva voce	100	45	45
(C) Internal Assessment			
Seminars	20	18	18
Written Tests	20		
TOTAL	**300**		

Approved by
Board of Studies in Biotechnology on 25/01/11, Faculty of Life Science on 25/02/11
Standing Committee on 04/05/11, Executive Council on 16/06/11

THIRD SEMESTER

Number & Title of the courses	Max. Marks	Min. marks	Min. Aggr. for Passing
(A) Theory Papers			
IX Environmental Biotechnology	40	14	
X Genetic Engineering	40	14	72
XI Plant Biotechnology	40	14	
XII Bioprocess Engineering & Technology	40	14	
(B) Practical & Viva voce	100	45	45
(C) Internal assessment			
Seminars	20	18	18
Written Tests	20		
TOTAL	**300**		

FOURTH SEMESTER

DISSERTATION	**Max. Marks**	**Min. Aggr. Marks For Passing**
A. Valuation		
(i) Language & Presentation	50	90
(ii) Review of Literature	50	
(iii) Methodology	50	
(iv) Analysis & interpretation of Result	50	
B. Viva-Voce	100	45
TOTAL	**300**	

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COURSES OF STUDY (M. Sc. in Biotechnology)
FIRST – SEMESTER

Course No. I: Cell Biology

Unit -1
Diversity of cell size and shape, cell theory, structure of prokaryotic and eukaryotic cells, isolation of cells, microscopic techniques for study of cells.

Unit-II
Sub cellular fractionation and criteria of function integrity, cellular organelles, plasma membrane, mitochondria, chloroplast, nucleus and other organelles and their structural organization; transport of nutrients, ions and macromolecules across membranes.

Unit-III
Cellular energy transactions- role of mitochondria and chloroplast; cell cycle- molecular events and model systems; cellular responses to environmental signals in plants and animals-mechanisms of signal transduction.

Unit-IV
Cell motility – cilia & flagella of eukaryotes & prokaryotes; biology of cancer, metabolite pathways and their regulation.

Unit-V
Biosynthesis of proteins in eukaryotic cell; co and post-translational modifications, intracellular protein traffic; cellular basis of differentiation and development mitosis, gametogenesis and fertilization; development in *Drosophila and Arabidopsis;* spatial and temporal regulation of gene expression; brief introduction to the life cycle and molecular biology of some important pathogen of AIDS, malaria, hepatitis, tuberculosis, filaria, kalazar.

Practicals
1. Microscopy: bright field, phase contrast fluorescence.
2. Microtomy.
3. Instrumental methods for cell biology
4. Sub-cellular fractionation and marker enzymes.
5. Histochemical techniques.
6. Mitosis & meiosis.

Books
1. Molecular Biology of Cell, Alberts, B. et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic Press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and Inheritance, EB Wilson, MacMilan NewYork.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall.
8. Molecular Biology of Steroid and Nuclear Hormone Receptors, LP Freedman, Birkhuser

Course No. II: Biomolecules

UNIT-I

Structure of water and its solvent properties, acid, base, pH and buffer-mono, bi and poly protic buffer, free energy and spontaneity of reactions. ATP and other phosphorylated compound with their free energy of hydrolysis, phosphoryl group transfer, biological oxidation-reductions reaction, coupled reaction and oxidative phosphorylation; inhibitors and uncouplers.

UNIT-II

Enzyme classification, specificity, active site. Enzyme kinetics-Michealis-Menton equation, determination of kinetic parameters, bi-substrate reaction and their kinetics, enzyme inhibition and kinetics, allosteric enzyme, kinetics, and allosteric regulation of phosphofructokinase.

UNIT-III

Structure and chemistry of macromolecules: proteins, carbohydrates and lipids, protein folding, structure and chemistry of biomolecules such as antibiotics; pigments, vitamins as coenzymes, lipid analysis by GLC and mass spectrometry, oligosaccharide and polysaccharide analysis.

UNIT-IV

Biosignaling-Molecular mechanism of signal transduction, Gated ion channels, the nicotinic-acetylcholine receptor, receptor enzyme-the insulin receptor, G-proteins and cyclic AMP. Membrane transport: biomembrane, nutrient transport across membranes, active and passive diffusion, symport, antiport and uniport, Na^+-K^+ pumps and their metabolic significance.

UNIT-V

Chromatographic technique-paper and TLC, gel filtration, ion-exchange, affinity, HPLC SDS-PAGE, isoelectric focusing, Western blotting, protein sequencing, mass-spectrometry, MALDI-TOF-MS.

Practicals

1. Titration of amino acids.
2. Colorimetric determination of pK.
3. Model building using space filling/ ball and stick models.
4. Reactions of amino acids, sugars and lipids.
5. Isolation, purity determination and quantitation of cholesterol, DNA and RNA
6. Quantitation of proteins and sugars.
7. Analysis of oils- iodine number, saponification value, acid number.
8. UV, visible, fluorescence and IR spectroscopy, absorption spectra.
9. Separation techniques- centrifugation, chromatography (gel permeation, ion exchange TLC etc.) and electrophoresis

Books

1. Biochemical Calculations, Irwin H. Segal, John Wiley and Sons Inc.
2. General Chemistry. Linus Pauing, W.H. Freeman & Company
3. Organic Chemistry. DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry. D Voc and JG Voe, J Wiley and Sons.
5. Physical Biochemistry. D. Freitilder, W.H. Freeman & Company.
6. Laboratory Techniques in Biochemistry and Molecular Biology. Work and Work.
7. Understanding Chemistry CNR Rao, Universities. Press Hyderabad (1999).
8. A Biologist's Guide to Principals and Techniques of Practical Biochemistry. K Wilson & KH Goulding, ELBS Edition, 1986.
9. Tools of Biochemistry by T.O. Cooper.

Course No. III: Microbial Physiology and Genetics

UNIT-I

The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; synchronous growth; growth as affected by environmental factors like temperature, acidity, water availability and oxygen; storage and maintenance of cultures, continuous culture.

UNIT-II

Metabolic diversity among microorganisms, photosynthesis in microorganisms; role of chlorophylls, carotenoids and phycobilins: Calvin cycle; chemolithotrophy; hydrogen-iron-nitrite oxidizing bacteria; nitrate and sulfate reduction; Methane fermentation-diversity, syntrophy, role of anoxic decomposition, methanogenesis and acetogenesis; nitrogen fixation; hydrocarbon transformation.

UNIT-III

Structural diversity of bacteria: purple and green bacteria, cyanobacteria, homoacotogenic bacteria, acetic acid bacteria, budding and appendaged bacteria, spirilla, spriochaetes, gliding and sheathed bacteria, pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasms methanogens;
Structural diversity of viruses: bacterial, plant, animal and tumor viruses examples of herpes, pox, adenoviruses, retroviruses, viroids and prions.
Prokaryotic cells structure and functions: cell walls of eubacteria; peptidoglycan and related molecules; outer-membrane of gram negative bacteria; cell membrane synthesis; cell inclusions like endospores, gas vesicles etc.

UNIT-IV

Host-parasite relationship: entry of pathogens into the host; colonization types of toxins: exo-endo- and entero-toxins and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agents, sulfa drugs, antibiotics, penicillins and cephalosporins, broad spectrum antibiotics, mode of action, resistance to antibiotics.

UNIT-V

Genes, mutation and mutagenesis; UV and chemical mutagens; types of mutation; Ames test for mutagenesis, complementation test, Bacterial genetic system: transformation, conjugation, transduction, recombination, plasmids and transposons; bacterial genetics map with reference to *E. coli.*

Practicals

1. Preparation of liquid and solid media for growth of micro – organisms.
2. Isolation and maintenance of micro-organisms by plating, streaking and serial dilution methods of slants and stab cultures, storage of microorganisms
3. Isolation of pure cultures from soil and water.
4. Growth curve; measurement of bacterial population by turbidometry and serial dilution methods; effects of temperature, pH, carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria and yeast study of micro – organisms by gram staining, acid fast staining and staining for spores.
6. Study of mutations by Ames test.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for portability and determination of MPN.
9. Bacterial transformation.
10. Biochemical characterization of selected microbes.

11. Transduction.
12. One step growth curve of coliphage.
13. Isolation of plasmids.

Books

1. General Microbiology, Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan press Ltd.
2. Brock Biology of Microogranisms, Madigan M.T. Martinko, J.M. and Parker, J. Prentice- Hall.
3. Microbiology, Pelczar, M.J. Jr. Chan E.C.S. and Kreig , N.R. Tata McGraw Hill.
4. Microbial Genetics Maloy, S.R.C Cronan , J.E.Jr. and Frelfelder ,D. Johnos Bartlett Publishers.
5. Microbiology- A Laboratory Manual, Cappuccino, J.G. and Sherman N. Addison Wesley.
6. Microbiological Application: A Laboratory Manual in General Microbiology Benson, H.J, WCB: Wm C. Brown publishers.

Course No. IV: Animal Cell Science and Techniques

UNIT-I

Structure and organization of animal cell; equipments and materials for animal cell culture technology; primary and established cell lines cultures; introduction to the balanced salt solutions and simple growth medium; brief account of chemical, physical and metabolic functions of different constituents of culture medium; role of carbon dioxide, serum and supplements.

UNIT-II

Serum and protein free defined media and their application, measurement of viability and cytotoxicity; biology and characterization of the cultured cells, measuring parameters of growth; basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.

UNIT-III

Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.

UNIT-IV

Application of animal cell cultures, stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, somatic cell genetics.

UNIT-V

Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering.

Practicals

1. Preparation of tissue culture medium, and membrane filtration.
2. Preparation of single cell suspension from spleen and thymus.
3. Cell counting and cell viability.
4. Macrophage monolayer from PEC, and measurement of phagocytic activity.
5. Trypsinization of monolayer and sub-culturing.
6. Cryopreservation and thawing.
7. Measurement of doubling time.
8. Role of serum in cell culture.
9. Preparation of metaphase chromosomes form cultured cells.
10. Isolation of DNA and demonstration of apoptosis of DNA laddering.
11. MTT assay for cell viability and growth.
12. Cell fusion with PEG.

Books

1. *Culture of Animal Cells* (3rd Edition), R. lan Freshmney. Wiley-Liss.
2. *Animal Cell Culture-Practical Approach*, (Ed) John R.W. Masters, Oxford.
3. *Cell Growth and Division'* A Practical Approach. (Ed.) R. Basega, IRL Press.
4. *Cell Culture Lab Fax*. (Eds). M. Buller & M. Dawson, Bios Scientific Publication Ltd. Oxford.
5. *Animal Cell Culture Techniques*. (Ed.) Martin Clynes, Springer.
6. *Methods in Cell Biology*, Vol. 57, Animal Cell Culture Methods, (Ed.) Jenni P. Mather and David Barnes, Academic Press.

SECOND – SEMESTER

Course No. - V: Molecular Biology

UNIT-I

DNA replication: prokaryotic and eukaryotic DNA replication, mechanics of DNA replication enzymes and accessory proteins involved in DNA replication.

UNIT-II

DNA repair and recombination – methyl directed mismatch repair, very short patch repair nucleotide and base excision repair, SOS system. Holliday junction, gene targeting and gene knock-outs, FLP/ FRT Cre/Lox recombination, RecA and other recombinases.

UNIT-III

Transcription and modification in RNA/ protein; prokaryotic and eukaryotic transcription, RNA polymerases, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, 5- Cap formation transcription termination, 3' – end processing and polyadenylation, splicing, editing, stability and nuclear export of mRNA; post- transcriptional gene silencing, Protein localization; synthesis of secretary and membrane proteins.

UNIT-IV

Oncogenes and tumor suppressor genes: viral and cellular oncogenes, tumor suppressor genes from humans; structure function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and ribozyme technology, molecular mechanism of anti- sense molecules, disruption of RNA structure. Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

UNIT-V

Molecular mapping of genome: genetic and physical maps, physical mapping and map- based cloning. Southern and fluorescence in situ hybridization for genome analysis; chromosome micro-cloning; molecular markers in genome analysis: RFLP and RAPD analysis, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal and germplasm maintenance. Genome sequencing and genomic libraries, YAC, BAC libraries, strategies for sequencing genome, packaging, transfection and recovery of clones.

Practicals

1. Isolation of genomic DNA.
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of poly A+ RNA
6. Northern blotting
7. Preparation of probes
8. In vitro transcription
9. In vitro translation
10. Metabolic labeling of protein and immunoprecipitation.

Books

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. New York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. *Molecular Cell Biology* (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. *Molecular Biology of the Cell* (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. *Gene VI* (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. *Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995*
9. *Genomes, T.S. Brown----*

Course No. VI: Macromolecules & Basic Enzymology

UNIT-I

Physical techniques in protein, nucleic acids and polysaccharide: structural analysis (UV,IR, NMR, LASER Mass spectroscopy, fluorescence spectroscopy); differential colorimetry, X-ray crystallography, ultra centrifugation, electron cryo-microscopy; scanning, tunneling microscopy.

UNIT-II

Sequencing of proteins and nucleic acids, protein-protein and protein-ligand interactions, physical and chemical methods for their study; conformational properties of polynucleotides and polysaccharides secondary and tertiary structural features and their analysis-theoretical and experimental; protein folding-biophysical and cellular aspects.

UNIT-III

Protein and nucleic acid databases: structural comparison at secondary and tertiary levels; enzyme catalysis in solution- kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences; physical and chemical methods for immobilization of small and macromolecules.

UNIT-IV

Glyco and lipoproteins- structure and function; organization of macromolecular complexes-chromatin and ribosomes; protein denaturation. Macromolecules and supra molecular assemblies-types of macromolecules in biological systems, molecular assemblies like membranes, ribosomes, extra-cellular matrix.

UNIT-V

Nucleic acid hybridization-structural analysis and biological studies; ribozymes and catalytic antibodies: functional proteins-structure and drug targets (enzymes and receptors). Computer aided drug designing, computational techniques in structural analysis, nanoparticles.

Course No. - VII: Biology of the Immune System

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells.

Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Practicals

1. Blood film preparation and identification of cells.
2. Lymphoid organs and their microscopic organization.
3. Immunization, collection of serum.
4. Double diffusion and immuno-electrophoresis.
5. Radial immuno-electrophoresis.
6. Purification of IgG from serum.
7. Separation of mononuclear cells by Ficoll-Hypaque.
8. Con-A induced proliferation of thymocytes by MTT method.
9. Western-blotting.
10. ELISA
11. Hapten conjugation and quantitation.
12. immunodiagnostics (demonstration using commercial kits).

Books

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A. Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

Course No.-VIII: Biostatistics & Computer Applications

UNIT-I

Importance and scope of statistics in biochemical experimentation; Elements of Probability-Mathematical and Statistical definitions; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal; Area under normal distribution curve.

UNIT-II

Measures of central tendency: Arithmetic, geometric & harmonic means; Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means (equal & unequal variance), equality of 2 means (paired samples).

UNIT-III

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way analysis (one observation per cell), randomized block design; multiple comparisons: least significant difference, Duncan's new multiple range test.

UNIT-IV

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients; Non parametric tests: Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation.

UNIT-V

Introduction to Computers**:** Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet-LAN, MAN, WAN, Concept of bioinformatics; application of bioinformatics in microbiology.

THIRD SEMESTER

Course No.-IX: Environmental Biotechnology

UNIT-I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management.

UNIT-II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

UNIT-III

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processes-anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment.

UNIT-IV

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V

Biological N_2 fixation, H_2 production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (*Spirulina*, yeast, mushroom); global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

Practicals

1. Detection of coliforms 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 the efficiency of removal of air pollutant by using fibrous air filter/Air sampler.
5. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
6. Test for the degradation of aromatic hydrocarbons by bacteria.
7. Survey of degradative of aromatic hydrocarbons by bacteria.
8. Estimation of nitrate, nitrite, and ammonium in drinking water.
9. To study the impact of heavy metals on growth & survival of microbes.
10. To study the impact of pesticides on the growth and survival of microbes.
11. To study the impact of salt and osmotic stress on the growth survival of microbes.
12. To study the biology of N_2- fixing microbes/SCP producing microbes.

Books

1. *Wastewater Engineering- Treatment, disposal and Reuse*. Metcalf and Eddy, Inc,.
2. Tata McGraw Hill, New Delhi.
3. *Comprehensive Biotechnology*. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
4. *Environmental Chemistry*, A.K. De. Wiley Eastern Ltd. New Delhi.
5. *Introduction to Biodeterioration*. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

Course No.-X: Genetic Engineering

UNIT-I

Scope of genetic engineering, milestones in genetic engineering; isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separations, cloning, gene expression; cloning and patenting of life forms; genetic engineering guidelines; molecular tools and their applications; restriction enzymes, modification enzymes, DNA and RNA markers; nucleic acid purification, yield analysis.

UNIT-II

Nucleic acid amplification and its applications, gene cloning vectors-plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes; restriction mapping of DNA fragments and map construction; nucleic acid sequencing; cDNA synthesis and cloning; mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; library construction and screening.

UNIT-III

Alternative strategies of gene cloning; cloning interacting genes-two-and three hybrid systems, cloning differentially expressed genes, nucleic acid micro array; site-directed mutagenesis and protein engineering; gene regulation-DNA transfection, Northern blot, primer extension, S1 mapping, RNase protection assay, reporter assays.

UNIT-IV

Expression strategies for heterologous genes; vector engineering and codon optimization, host engineering; *in vitro* transcription and translation, expression in bacteria, yeast, insects and insect cells, mammalian cells, plants; processing of recombinant proteins-purification and refolding, characterization of recombinant proteins, stabilization of proteins; phage display.

UNIT-V

T-DNA and transposon tagging; role of gene tagging in gene analysis, identification and isolation of genes through T-DNA or transposon; transgenic and gene knockout technologies-targeted gene replacement, chromosome engineering; gene therapy-vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Practicals

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda Phage DNA.
4. Quantitation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/ phagemid vectors.
8. Preparation of helper phage and its titration.
9. Preparation of single stranded DNA template.
10. Gene expression in *E.Coli* and analysis of gene product.
11. PCR
12. Reporter gene assay (Gus/CAT/b-GAL)

Books

1. *Molecular cloning*: A Laboratory Manual, J. Sambrook , E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. *DNA Cloning*: A practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

3. *Molecular and Cellular Methods in Biology and Medicine*, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.
4. *Methods in Enzymology Vol*. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego,1998.
5. *Methods in Enzymology Vol*.185 Gene Expression Technology, D.V. Goeddel, Academic Press, Inc. San Diego, 1990.
6. *DNA Science*. *A First Course In Recombinant Technology*, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York,1990.
7. *Molecular Biotechnology* (2^{nd} Edn.) S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.
8. *Milestones in Biotechnology, Classic Papers in Genetic Engineering*, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
9. *Route Maps in Gene Technology*, M.R. Walker and R. Rapley, Blackwell Science Ltd. Oxford, 1997.
10. *Genetic Engineering; An Introduction to gene analysis and exploitation in eukaryotes,* S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.
11. Molecular Biotechnology-Glick.----------

Course No. XI: Plant Biotechnology

UNIT-I

Introduction to plant cell and tissue culture: tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture. Regeneration through organogenesis and somatic embryo genesis; transfer and establishment of whole plant in soil; embryo culture and embryo rescue; anther, pollen and ovary culture for production of haploid plants and homozygous diploid lines; cryopreservation for germplasm conservation; protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids; germplasm conservation, virus free plants.

UNIT-II

Cloning vector for higher plant transformation: *Agrobacterium tumefaciens* Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors and their application: direct gene transfer: particle bombardment, electro oration, microinjection: transformation of monocots; transgene stability and gene silencing, selection of clones. Expression of cloned genes: genetic markers, reporter genes, Gus assay.

UNIT-III

Application of plant transformation for productivity and performance: herbicide resistance (phosphnoinothricin, glyphosate, sulfonylurea, atrazine), insect resistance (Bt. endotoxin genes, Non-Bt like proteinase inhibitors alpha amylase inhibitor), virus resistance (Coat protein mediated protection (CPMP), nucleocapsid gene), disease resistance (anti fungal proteins chitinase, 1-3 beta glucanase, ribosome inactivating proteins (RIP), thionins, pathogenesis related (PR) proteins, nematode resistance, abiotic stress (salt tolerance); post harvest losses, long shelf life of fruits and flowers, use of ACC synthase. polygalacturanase. ACC oxidase, carbohydrate composition and concentration during storage. ADP glucose pyrophosphatase.

UNIT-IV

Chloroplast transformation: advantages, vectors, success with tobacco and potato; metabolic engineering and industrial products; plant secondary metabolites, control mechanism and manipulation of phenyl propanoid pathway, Shikimate pathway, alkaloids, industrial enzymes; biodegradable plastics. Polyhydroxybutyrate, therapeutic proteins; lysosomal enzymes, antibodies, edible vaccines purification strategies, oleosin partitioning technology.

UNIT-V

Molecular marker- aided breeding RFLP maps. Linkage analysis. RAPD markers. STS, microsatellites, SCAR (sequence characterized amplified region), AFLP, QTL. Molecular assisted selection; arid and semi- arid plant biotechnology, green house and green- home technology.

Practicals

1. Preparation of media.
2. Surface sterilization.
3. Organ culture.
4. Callus propagation, organogenesis, transfer of plant to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of haploids.
7. Cytological examination of regenerated plants.
8. *Agrobacterium* culture, selection of transformants, reporter gene (GUS) assays.
9. Developing RFLP and RAPD maps.

Books

1. J. Hammond, P. McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer Verlag, 2000.

2. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.
3. H.S. Chawla: Biotechnology in Group Improvement, International Book Distributing Company. 1998.
4. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.
5. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

Course No. XII: Bioprocess Engineering and Technology

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B_{12}, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: **s**ources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

Practicals

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. (a) Determination of growth curve of a supplied microorganism and also to determine substrate degradation profile.

(b) Computer specific growth rate (m), growth yield ($Y_{x/8}$) from the above experiment.

4. Comparative studies of ethanol production using different substrates.
5. Microbial production of citric acid using *Aspergillus niger.*
6. Microbial production of antibiotic (penicillin).
7. Production and estimation of alkaline protease.
8. Sauer Kraut fermentation.
9. Use of alginate for cell immobilization.

Books

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.
4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.
5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.
8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.
9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

FOURTH-SEMESTER

DISSERTATION	
A. Valuation	
(i)	Language & Presentation
(ii)	Review of Literature
(iii)	Methodology
(iv)	Analysis & interpretation of Result
B. Viva-Voce	
	TOTAL