Model Curriculum, Course Structure and Scheme of Instructions for the B.Sc Biotechnology, 3-Year Course

III Year B.Sc

Paper III – Molecular Biology, Genetic Engineering and Immunology

Unit I Gene and Genome organization 24 Hours

1.1 Organization of nuclear genome – Genes and gene numbers – essential and non essential genes
1.2 Denaturation and renaturation of DNA - Tm values and Cot curves
1.3 Kinetic classes of DNA - Single copy sequences, and repeated sequences. Inverted, tandem and palindromic repeats
1.4 Satellite DNA
1.5 Mitochondrial genome organization (eg: Human)
1.6 Chloroplast genome organization in plants
1.7 Organization of eukaryotic genes - Exons, introns, promoters and terminators
1.8 Gene families and clusters – eg. Globin gene, histones and ribosomal genes.

Unit-II Gene expression and Gene Regulation 22 Hours

2.1. Prokaryotic and Eukaryotic Transcription
Post-transcriptional modifications (Capping, polyadenylation, splicing and alternate splicing)
2.2 Translation
Genetic code and its features, Wobble Hypothesis

Synthesis of polypeptides - initiation, elongation and termination in prokaryotes and eukaryotes
2.3 Regulation of gene expression in prokaryotes and eukaryotes
Operon concept in bacteria – Lac operon

Unit III Recombinant DNA Technology 22 Hours

3.1. Enzymes used in gene cloning : Restriction endonucleases, Ligases, Phosphatases, Methylases, Kinases
3.2. Cloning vehicles – Plasmids, Cosmids, Phage vectors, Shuttle vectors,
3.3. Baculovirus vector system, Expression vectors - expression cassettes
3.4. Construction of genomic and cDNA libraries
3.5. Identification of cloned genes

3.6. Principles involved in Blotting Techniques – Souther, Northern and Western
3.7. Principles and Applications of PCR Technology
3.8. DNA Finger printing technique and its applications

Unit IV Basics of Immunology 22 Hours

2.1 Introduction to immune system – Organs and cells of the immune system
2.2 Antigens, Haptens – physico-chemical characteristics
2.3 Structure of different immunoglobulins and their functions – Primary and secondary antibody responses
2.4 Antigen - Antibody Reaction
2.5 The Major Histocompatibility gene complex and its role in organ transplantation, Generation of antibody diversity
2.6 Hypersensitivity – Coombs classification, Types of hypersensitivity
2.7 Autoimmune diseases – mechanisms of auto immunity

Practicals

1. Isolation of DNA from plant/animal/bacterial cells
2. Analysis of DNA by agarose gel electrophoresis
3. Restriction digestion of DNA
4. Immuno-diffusion test
5. ELISA Test
6. Microagglutination using microtiter plates (eg. ABO and Rh Blood grouping)
7. Viability tests of cells/bacteria (Evans blue test or Trypan blue test)
8. Coomb's test
9. Preparation of competent cells of Bacteria
10. Bacterial transformation and selection of transformants under pressure (antibiotic).

Recommended Books

1. Concepts in Biotechnology - By D. Balasubramanian, C.F.A. Bryce, K. Dharmalingam, J. Green and Kunthala Jayaraman
2. Essential Immunology - By I. Roitt, Publ: Blackwell
3. Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)
4. Cell and Molecular Biology - By Robertis & Robertis, Publ: Waverly
5. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
6. Gene Structure & Expression - By J.D. Howkins, Publ: Cambridge
7. Genetic Engineering - By R. Williamson, Publ: Academic Press
8. Test Book of Molecular Biology - By K.S. Sastry, G. Padmanabhan & C. Subramanyan, Publ: Macmillan India
9. Microbial Genetics - By S.R. Maloy, J.E. Cronan & D. Freifelder, Publ: Jones & Barlett
10. Principles of Gene Manipulation - By R.W. Old & S.B. Primrose, Publ: Blackwell
11. Genes - By B. Lewin - Oxford Univ. Press
12. Molecular Biology & Biotechnol. - By H.D. Kumar, Publ: Vikas
13. Immunology - By G. Reever & I. Todd, Publ: Blackwell
14. From Genes to Clones - By E.L. Winnacker, Publ: Panima, New Delhi
15. Methods for General & Molecular Bacteriology - By P. Gerhardf et al., Publ: ASM
16. Molecular Biotechnology - By G.R. Click and J.J. Pasternak, Publ: Panima
17. Recombinant DNA - By J.D. Watson et al., Publ: Scikentific American Books
18. Immuno diagnostics - By S.C. Rastogi, Publ: New Age
19. Molecular Biology - By D. Freifelder, Publ: Narosa
20. Genes and Genomes – By Maxine Singer and Paul Berg

21. Cell and Molecular Biology - By S.C. Rastogi
22. Genetic Engineering and Biotechnology - By V. Kumar Gera
23. Essentials of Biotechnology – By P.K. Gupta
24. Introduction to Applied Biology and Biotechnology – By K. Vaidyanath, K. Pratap Reddy and K. Satya Prasad
25. Laboratory Experiments in Microbiology – By M. Gopal Reddy, M.N. Reddy, D.V.R. Sai Gopal and K.V. Mallaiah
26. Immunology - By Kubey
27. Gene Biotechnology - By Jogdand
28. Genome - T.A. Brown
29. Gene Cloning - T.A. Brown
30. Biotechnology, IPRs and Biodiversity - By M.B. Rao and Manjula Guru (Pearson Education)
31. Introduction to Biotechnology - By W.J. Thieman and M.A. Palladino (Pearson Education)
30. Genetic Engineering - By Boylan (Pearson Education)
31. Basic Concepts of Biotechnology - By Irfan Ali Khan and Atiya Khanum (Ukaaz Publications)
32. Advances in Biotechnology - By Irfan Ali Khan and Atiya Khanum (Ukaaz Publications)
34. Genetic Engineering - By Sandhya Mitra.

A.P. State Council of Higher Education, Hyderabad

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III Year B.Sc

Paper IV – Applications of Biotechnology

Unit I Animal Biotechnology 24 Hours

1.1 Introduction to animal biotechnology
1.2 Principles of animal cell culture – culture vessels
1.3 Cell culture media preparation, sterilization, types of cultures
1.4 Establishment and preservation of cell lines
1.5 Explants and cell disaggregation
1.6 Culture of cells and tissues (including Stem cells and their application)
1.7 *In vitro* fertilization and embryo transfer technology
1.8 Methods of gene transfer – Microinjection and viral mediated gene transfer techniques Production of transgenic animals and molecular pharming
1.9 Principles of *Ex vivo* and *In vivo* gene therapy

Unit II Plant Biotechnology 20 Hours

2.1. Composition of media (Murashige and Skoog's and Gamborg's only) Preparation of media and methods of sterilizations
2.2. Role of plant growth regulators in differentiation
2.3. Induction of callus
2.4. Meristem culture and production of virus free plants Clonal propagation of plants on a commercial scale (Somatic embryogenesis and organogenesis)
2.5. Mass cultivation of cell cultures and process engineering – batch and continuous cultures, Bioreactors
2.6. Production of commercially useful compounds by plant cell culture
2.7. Methods of gene transfer techniques (*Agrobacterium*, Microprojectile bombardment)
2.8. Applications of recombinant DNA technology in agriculture
2.9. Production of therapeutic proteins from transgenic plants

Unit III Industrial Biotechnology 23 Hours

3.1 Introduction to industrial biotechnology.

3.2 Primary and secondary metabolic products of microorganisms
3.3 Screening and isolation and preservation of industrial microorganisms
3.4 Principles of Fermentation technology
3.5 Commercial production of fuels and chemicals by microbial fermentations
3.6 Fermentative production of microbial enzymes (amylases, proteases), and antibiotics
3.7 Fermentative production of foods and dairy products
3.8 Animal cells as bioreactors; characteristics of bioreactors, expression and over production of targeted proteins – human growth hormones – production of α and β - interferons, monoclonal antibodies
3.9 Good manufacturing practices, Biosafety issues, Bioethics
3.10 Intellectual Property Rights and Patenting issues

Unit IV Environmental Biotechnology 23 Hours

4.1 Introduction to environmental biotechnology
4.2 Renewable and non-renewable energy resources
4.3 Conventional energy sources and their impact on environmental
4.4 Non-conventional fuels and their impact on environment (biogas, bioethanol, microbial hydrogen production)
4.5 Microbiological quality of milk, food and water
4.6 Microbiological treatment of municipal and industrial effluents
4.7 Microbial degradation of pesticides and toxic chemicals
4.8 Biopesticides and Biofertilizers (Nitrogen fixing, phosphate solubilizing microorganisms)
4.9 Microbial ore leaching
4.10 Introduction to Bioremediation

Practicals

1. Preparation of media, and initiation of callus from any one selected plant species
2. Micropropagation of plants (any one)
3. Preparation of synthetic seeds
4. Production of wine using common yeast
5. Production of hydrogen or biogas using cow/cattle dung
6. Isolation of microbes from soil or industrial effluents
7. Preparation of media and culture of animal cells/tissues
8. Cell disaggregation and cell counting
9. Cytotoxicity of the cells using the dye MTT method
10. Estimation of BOD in water samples
11. Production of alcohol by fermentation and Estimation of alcohol by colorimetry
12. Production of biofertilizers (*Azolla*)
13. Growth curves of bacteria, Measurement of growth in liquid cultures
14. Quality testing of milk by MBRT

Recommended Books

1. Strategies in Transgenic Animal Sciences - By Glemn M.M. and James M. Robl ASM Press 2000.
2. Practical Biotechnology – Methods and Protocols - By S. janarthanan and S. Vincent (Universities Press)
3. Animal Cells as Bioreactors - By Terence Gartoright, Cambridge Univ Press
4. Molecular Biotechnology - By Chinnarayappa (Universities Press)
5. Principles and Practice of Animal Tissue Culture - By Sudha Gangal (Universities Press)
6. Introduction to Veterinary Genetics - By F.W. Nicholas, Oxford University Press.

7. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
8. Biotechnology -By H.J. Rehm and G. Reed Vol-1-86 VIH Publications, Germany
9. Guide for the care and use of lab animals National Academy Press.
10. Biogas Technology - By b.T. Nijaguna
11. Biotechnology – I - By R.S. Setty and G.R. Veena
12. Biotechnology – II - By R.S. Setty and V. Sreekrishna
13. Introduction to Plant Tissue Culture - By M.K. Razdan (Oxford and IBH Publishing Company, New Delhi)
14. Introduction to Plant Biotechnology - By H.S. Chawla (Oxford and IBH Publishing Comp., New Delhi)
15. Biotechnology - By K. Trehan
16. Industrial Microbiology - By L.E. Casida
17. Food Microbiology - By M.R. Adams and M.O. Moss
18. Introduction to Biotechnology - By P.K. Gupta
19. Frontiers of Plant Tissue Culture - By T.A. Thorpe
20. Plant Tissue Culture – Theory and Practice - By S.S. Bhojwani and M.K. Razdan
21. Biotechnology – By U. Satyanarayana
22. Plant Biotechnology New Products and Applications - By J. Hammond, P. McGarvey, and V. Yusibov
23. Plant Tissue Culture – Basic and Applied - By Timir Baran Jha and B. Ghosh
24. Essentials of Biotechnology for Students - By Satya N. Das
21. Plant Tissue Culture - By Kalyan Kumar De
22. Bioethics – Readings and Cases - By B.A. Brody and H. T. Engelhardt. Jr. (Pearson Education)
23. Biotechnology, IPRs and Biodiversity - By M.B. Rao and Manjula Guru (Pearson Education)
24. Bioprocess Engineering - By Shuler (Pearson Education)
25. Essentials of Biotechnology - By Irfan Ali Khan and Atiya Khanum (Ukaaz Publications)
26. Gene, Genomics and Genetic Engineering - By Irfan Ali Khan and Atiya Khanum (Ukaaz Publications).