

# **Jodhpur National University**

## **M.Phil. Microbiology Syllabus**

### **First Semester**

#### **PAPER- I : Microbial Biotechnology**

Unit – I: Historical development of Microbial technology

Introduction – Contribution of Louis Pasteur, Robert Koch, Alexander Fleming, S.A. Wakesman and others in the development of microbiology and the early discoveries. Industrially important microorganisms. Products obtained from microorganism. Isolation, purification and preservation of microbes. Cell culture techniques – aseptic transfer.

Unit – II: Microbes in Medicine

Clinically important microorganisms and their effects on infection and immunity. Production of toxins by microorganism. Disease caused by pathogens and their control. Production of medicinally important substances by microbes. Production of useful nonmicrobial products produced through recombinant microbes – insulin, vaccines, and antibiotics. Production of antibodies in E. coli.

Unit – III: Microbial Products and their bioprocesses

Single cell protein – Chlorella, Spirullina, Yeasts, Mushrooms – SCP from wastes. Economic implications of SCP. Production of wine, vinegar and alcohol. Biofertilizers – cyanobacteria, Azospirillum, VAM and Azolla. Strategies applied for drug discoveries.

Unit – IV: Biodegradation and Bioremediation

Microbes involved in biodegradation of organic wastes and xenobiotic compounds – heavy metals, pesticides, insecticides. Bioinsecticides – BT toxin. Biofuels, Microbial hydrogen production. biodegradation of oils and petroleum products.

Unit – V: IPR, Biosafety and bioethics

World Trade Organization (WTO) with reference to biotechnology affairs – Basic requirement of patentability, process of patenting, patenting biological materials. National & International patent laws. Biosafety protocols – Biological weapons. Principles of bioethics – ethical conflicts in biotechnology.

References:

1. Raledge C and Kristiansen B Eds (2001) Basic Biotechnology, 2<sup>nd</sup> edition, Cambridge University Press.
2. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, Jayaraman K. (1996). Concepts in Biotechnology, University Press, India.
3. Baxevanis AD and BFF Ouellette, Wiley O. (ed) (2001) Bioinformatics – A practical guide to the analysis of genes and proteins. Interscience, New York,
4. Borowitzka MA, Borowitzka LJ (1989) Microalgal Biotechnology, Cambridge University Press.
5. Alan T. Bull. Microbial Diversity and Bioprospecting. ASM press. Washington, D.C
6. Brenden Wren and Nick Dorrell, Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press

7. Alexander Hillisch and Rolf Hilgenfeld. Modern Methods of Drug Discovery, Birkhauser, Switzerland
8. Doolittle RF. (1990). Molecular evolution. Computer Analysis of Protein and Nucleic acid Sequences Methods in Enzymology. Academic Press, New York.
9. Gerbardt P, Murray RG, Wood WA, Kreig NR. (1994) Methods for General and Molecular Bacteriology – American Society for Microbiology Washington D.C.
10. Glick BR, Pasternak JJ (1998) Molecular Biotechnology - Principles and Applications of Recombinant DNA, ASM Press, Washington DC.
11. Higgins D, Taylor W. (2000). Bioinformatics, sequence, structure and databanks A practical approach. Oxford University Press.
12. Glazer AN, Nikaido H. (1994) Microbial Biotechnology – Fundamentals of Applied Microbiology WH Freeman and Company, New York.
13. Glick BR, Pasternak JJ. (1994) Molecular Biotechnology, ASM Press, Washington DC.
14. Miyamoto MM, Cracraft JL. Phylogenetic Analysis of DNA sequences. Oxford University Press. Oxford.
15. Pnoella P (1998) Introduction to Molecular Biology, WCB Mc Graw Hill, Boston, Massacheutts.

## **Paper - II – Microbial Biodiversity and Molecular Taxonomy**

### Unit – I: Biodiversity

Prokaryotic and eukaryotic microbial diversity – bacteria, cyanobacteria, prochlorales, cyanelles, microalgae, microfungi, zooplankton & protozoans. Habitats, nutrition, ultrastructure and mode of reproduction. Isolation, cultivation and preservation of microorganisms.

### Unit – II: Symbiosis

Microbial symbiosis - bacterial – Rhizobium & Frankia. Cyanobacterial symbiosis with Bryophytes (Anthoceros), Pteridophytes (Azolla), Gymnosperms (Cycas), Angiosperms (Gunnera). Lichens, VAM. Structure, nutrition and mode of reproduction of symbiotic microorganisms.

### Unit – III: Classification

Introduction, Haeckel's three kingdom concept. Whittaker's five kingdom concept. Three domine concept of Carl Woese. Criteria for classification and identification of microorganisms – morphological, physiological & biochemical. Numerical taxonomy. Phage typing. Nomenclature – bacteriological code.

### Unit – IV: Molecular Taxonomy

Introduction - DNA finger printing – RFLP, Plasmid profiles, G+C content. Importance of 16S rRNA in taxonomy & phylogeny. PCR based finger printing – RT PCR, 16S rDNA amplification, cloning, transformation, DNA sequencing.

### Unit – V: Bioinformatics for genomics

Genome sequence comparison, alignment and data base searching. GenBank – NCBI, EMBL & DDBJ – retrieving sequences. RNA structure prediction, Restriction enzyme patterns. Designing primers & probes. DNA barcoding. Submission of rDNA sequences – Bankit & Sequin guidelines.

## Reference Books

1. Groombridge, B (Ed.) 1992. Global Biodiversity – Status of the Earth's Living Resources. Chapman & Hall, London.
2. UNEP, 1995, Global Biodiversity Assessment , Cambridge Univ. Press, Cambridge.
3. Virchow, D. 1998. Conservation & Genetic Resources , Springer – Verlag, Berlin.
4. Gary K.Meffe & .Ronald Carroll ,C.1994. Principles of Conservation Biology, Sinauer Associates, Inc., Massachusetts.
5. Danial Lim ,1998, Microbiology, McGrawHill Companies , New York.
6. Edward A. Birge ,1992, Modern Microbiology – Principles and application. Wm.C. Brown Publishers , Inc. U.S.A.
7. HH Rashidi & LK Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London
8. Gibas, C and P. Jambeck (2000). Developing bioinformatics Computer skills. Shroff Publishers and Distributors Pvt. Ltd., Calcutta
9. Brige EA (1992) Modern Microbiology, WmC, Brown Publishers, Dubugue, USA.
10. Bryant DA (1994) The Molecular Biology of Cyanobacteria, Kluwer Academic Publishers, London.
11. Gerherdt P, Murray RG, Wood WH. Kreig NR (1994) Methods for General and Molecular Bacteriology, American Society for Microbiology, Washington DC.
12. Landecker EM (1996) Fundamentals of Fungi –Prentice Hall International Inc.
13. Pelczar Jr. MJ, Chan ECS, Krieg NR (1993). Microbiology – Mc Graw Hill. Inc, New York.
14. Des Higgins & Willie Taylor (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Press
15. Baxevanis AD & Ouellette BEF (2001) Bioinformatics: A practical guide to the analysis of genes and proteins, Wiley Interscience – New York

## **Paper - III – Microbial Genomics**

### UNIT – I: Genome Mapping

Genome – size-complexity- structure and function of prokaryotic and eukaryotic genome. Physical mapping of genome-Sequencing whole genome- Restriction mapping – FISH – STS mapping - Hybridization assays - Physical mapping without cloning- Mapping by genetic techniques – DNA markers - RFLPs, SSLPs, SNPs – Linkage analysis – Cross breeding and pedigree analysis.

### UNIT- II: Sequencing methods and Strategies

Basic DNA sequencing - Modifications of chain-terminator sequences- Automated DNA sequencing- DNA sequencing by capillary array electrophoresis- shotgun sequencing – Overlapping clone contigs - High throughput sequencing- sequencing strategies- Alternative DNA sequencing – EST sequencing and sequence skimming.

### UNIT – III: Genome Analysis

Overview of sequence analysis- Gene prediction- Tools for genome analysis. Detecting open-reading frames-using homology to find genes- software programs for finding genes- Identifying the function of a new gene- Analyses not based on homology-Genome annotation- Molecular phylogenetics.

#### UNIT- IV: Comparative Genomics

Comparative genomics of prokaryotes, organelles, Eukaryotes and other aspects. Representational difference Analysis of cDNA and Genome Comparisons-Gene Expression during Host-pathogen interactions- genomics of Mycobacterium tuberculosis- Helicobacter pylori-Approaches to bacterial mRNA extraction and labeling for microarray Analysis.

#### UNIT-V: Functional Genomics

DNA micro array – Construction and Design- Application of DNA micro array for comparative and Evolutionary Genomics. Gene silencing, RNAi, SiRNA, SHRNA-Proteome analysis – Protein-protein Interactions. Application of Microbial Genomics – Reverse Vaccinology: from genome to vaccine- Microbial genomics for Antibiotic Target Discovery.

#### References:

1. C. M. Fraser, T. D. Read and K. E. Nelson (Eds) Microbial Genomes, Humana Press, USA
2. Principles of Genome Analysis: A Guide to Mapping and Sequencing DNA from Different Organisms by S. B. Primrose (Paperback - Jan 1998)
3. Genome Mapping: A Practical Approach (Practical Approach Series) by Paul H. Dear , Medical Research Council Laboratory of Molecular Biology, Hills Road, Cambridge CB2.
4. Principles of Gene Manipulation and Genomics - Page xviii by Richard M. Twyman, Sandy Blackadder Primrose - Science - 2006 - 644 pages
5. Microbial Genome Methods by Kenneth W. Adolph (Hardcover - Oct 28, 1996)
6. Genome Mapping and Sequencing by Ian Dunham (Hardcover - Sep 1, 2003).
7. Brendan Wren (Editor), Nick Dorrell (2002) Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press, UK.
8. Sandy B. Primrose Richard M. Twyman (2005) Principles of Genome Analysis and Genomics, Blackwell Publishing, USA.

### **Paper - IV – ADVANCES IN MICROBIOLOGY**

#### **Objective**

This paper provides information about the latest and advanced knowledge of microbiology.

#### **UNIT – I:**

Microbial techniques: Confocal Microscopy, DNA Microarray for comparative and Evolutionary Genomics: Flow cytometry: Photo and video Micrography and Autoradiography. Atomic flame photometry, Plasma emission spectroscopy, Infra-red spectrophotometry. Tandem mass spectroscopy, Electron Spin Resonance spectroscopy, MOLDI-TOF mass spectrometry.

#### **UNIT- II**

Current trends: Exploration of bioactive compound from Extremophiles. Bio remediation, Bio sensors. Biofilms. Remote sensing microbiology, Microbial communication – Quorum Sensing. Bar coding of microbes – application in clinical and industrial fields.

### **UNIT – III**

Microbes and Health: GLP, Laboratory and hospital acquired infection. Emergence of MDR and XDR microbes. Harmful microbes and biological weapons. Automated diagnostic method. Recombinant vaccines. Environmental aspects of emerging diseases.

### **UNIT – IV**

Microbial Technology : Microbes in Nanotechnology, Applications in Tissue engineering and therapeutics. Biopolymers, Biosurfactants, Biofertilizers, Biopesticides, Bioluminescence, Genetically modified organisms. Gene therapy, Stem cell therapy. Carbon sequestration by microbes.

### **UNIT – V**

Microbial Pharmaceutics and Biotechniques: Drug discovery and design, British and Indian Pharmacopoeia, Marine microbial antibiotics, Microbial therapeutic enzymes, Microbial pigments, Single cell proteins. Microbial Products and their bioprocesses.

#### References:

1. Jawetz, E., J.L. Melnick and E.A. Adelberg, (1998). Review of Medical Microbiology (19th Edition). Lange Medical Publications, ELBS, London.
2. Chakraborty, P., (2003). A text book of Microbiology (2<sup>nd</sup> Edition). Published by New central book agency (P) Ltd., Kolkata.
3. Glick, B.R., (2003). Molecular Biotechnology. Principles and Applications of Recombinant DNA. (3<sup>rd</sup> Edition). ASM Press, Washington DC.
4. Jognand, S.N., (2004). Gene Biotechnology. Himalaya Publishing house, Mumbai.
5. Webster, J.G., (2004). Bioinstrumentation. Student edition, John Wiley and Sons Pvt. Ltd., University of Wisconsin.
6. Palanivelu, P., (2001). Analytical biochemistry and separation techniques – A Laboratory Manual (2<sup>nd</sup> Edition). Tulsi book centre (Publication), Madurai, Tamilnadu.
7. Purohit, S.S., (2003). Pharmaceutical microbiology.
8. Young, M.M. (Ed.), (2004). Comprehensive Biotechnology. The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Elsevier India Private Ltd, India.
9. Prave, P., U. Faust, W. Sittig and D.A. Sakatsch (Ed.), (2004). Fundamentals of Biotechnology. Panima Publishing Corporation, India.
10. Mansi, E.M.T.E.L. and C.F.A. Bryle, (2002). Fermentation Microbiology and Biotechnology. Taylor & Francis Ltd, U.K. ]
11. Crueger, W. and Crueger, A., (2000). Biotechnology: A Textbook of Industrial Microbiology. Panima Publishing Corporation, India.
12. Stanbury, P.F., A. Whitaker and S.J. Hall, (1997). Principles of Fermentation Technology. Aditya Books Pvt Ltd, India.

#### **Web References**

1. <http://gsbs.utmb.edu/microbook/toc.html>
2. <http://www.biosci.ohio-state.edu/~mgonzalez/micro521.html>
3. <http://bioweb.uwlax.edu/Genweb/Microbiology/General/general.html>
4. <http://www.medunich.edu/TAMC/LINKS/HTML>
5. <http://acs.ucalgary.ca/~browder/transgeni.html>

## **Second Semester**

### **DISSERTATION**

The candidate shall submit the dissertation on problem connected with any one disciplines of his papers.