MB 101: Taxonomy, Virology and Cytology

Objective: The main aspects of this paper includes Taxonomy and classification of Bacteria & Virus, fundamentals of virology along with concepts of new emergent virus, it also includes molecular aspects of phage and different organelle studies.

	No. of Lectures.
UNIT 1: Taxonomy and classification of bacteria and viruses.	12
UNIT 2: Fundamentals of virology	13
UNIT 3: Bacteriophages	09
UNIT 4: Cytology	12

UNIT: 1 Taxonomy and classification of bacteria and virus.

1. Taxonomy and classification of bacteria. **Ref. Bergey's manual, 2nd ed., Vol 1.**
   1.1 Procaryotic domains
   1.2 Classification of Procaryotic organisms and the concept of bacterial species
   1.3 Identification of procaryotes
   1.4 Numeric Taxonomy
   1.5 Polyphasic Taxonomy
   1.6 Bacterial nomenclature
   1.7 Etymology in nomenclature of procaryotes
   1.8 Culture Collections
   1.9 Intellectual Property of Procaryotes
   1.10 Virus taxonomy **Ref. Fields**
   1.11 The Baltimore scheme of virus classification **Ref. Wagner**
   1.12 Banking diverse data in ICTVdB **Ref. Murray**

UNIT: 2 Fundamentals of Virology

1. Particles **Ref. Cann**
2. Genomes **Ref. Cann**
3. Molecular biology of prion proteins **Ref. Fields**
4. Prion replication **Ref. Fields**
5. New and emergent viruses **Ref. Cann**
6. General features of virus induced cell transformation and oncogenesis **Ref. Fields**

UNIT: 3 Bacteriophages **Ref. Fields**

1. Temperate phages
   1.1 Phage λ.
   1.2 Phage Mu-1 as a Model Transposon.
   1.3 Phage P 1 as a Model plasmid.
2. Phage – borne genes for bacterial toxins and other proteins affecting host phenotype.
   2.1 Gene acquisition.
   2.2 Selection value for the phage.
   2.3 Relation to phage biology.
3. Virulent phage.
   3.1 Large DNA phage.
   3.2 Small DNA phage.
   3.3 RNA phage.

UNIT: 4 Cytology

1. The nucleus **Ref: Cooper**
2. Protein sorting
   2.1 The endoplasmic reticulum
   2.2 The Golgi apparatus
   2.3 Lysosomes
3. Bioenergetics and metabolism
   3.1 mitochondria
   3.2 Chloroplast and other plastids
   3.3 Peroxisomes
4. The cytoskeleton
   4.1 Actin filaments
   4.2 Intermediate filaments
   4.3 Microtubules
5. The plasma membrane
6. Cell structure of *The Archaea* **Ref. Schaechter**

References:

1. Bergey's manual of systematic bacteriology, 2nd Edition, Vol. 1, Springer, ISBN: 0-387-98771-1.
2. Murray *et. al.*: *Manual of clinical microbiology,* Vol. 2, ASM Press, 8th Ed.
3. Wagner *et. al.*: *Basic virology*, Blackwell publishers, 3rd Ed.
4. Cann A J (2005): *Principals of molecular virology*, Elservier academic press, 4th Ed.
5. Knipe D M and Howley P M: *Fields virology*, Vol. 1, 5th Ed.
6. Knipe D M and Howley P M: *Fields virology*, Vol. 2, 5th Ed.
7. Copper G M and Hausman R E (2007): *The cell*, ASM press 4th Ed.
8. Schaechter M (2004): *Desk encyclopedia of microbiology*, Elsevier Academic Press.

MB 102: MOLECULAR BIOLOGY

Objective: The paper intends to deal basic reactions of molecular biology at its most advanced level.

UNIT 1: GENOME ORGANIZATION

1.1 The Content of the Genome
1.2 Genome Sequences and Gene Numbers
1.3 Chromosomes
1.4 Nucleosomes

Key Research / Review Articles:

1. Gall, J.G. (1981). Chromosome Structure and C-value paradox. *The Journal of Cell Biology, 91* (3), 3s to 14s.
2. Luger, K. *et al* (1997). Crystal structure of the nucleosome core particle at 2.8 A° resolution. *Nature, 389,* 251-260.
3. Bentley, S. D. and Parkhill, J. (2004). Comparative genomic structure of Prokaryotes. *Annual Reviews of Genetics, 38,* 771-91.
4. Sherratt, D. J. (2003). Bacterial Chromosome Dynamics. *Science, 301,* 780-785.

UNIT 2: DNA REPLICATION AND TRANSPOSONS

2.1 The Replication of DNA **Ref.: Watson**
2.2 Transposons
2.3 Retroviruses and Retroposons

Key Research / Review Articles:

1. McInerney, P. *et al* (2007). Characterization of a Triple DNA Polymerase Replisome. *Molecular Cell, 27,* 527-538.
2. Hubscher, U. *et al* (2002). Eukaryotic DNA Polymerases. *Annual Reviews of Biochemistry, 71,* 133-63.
3. Bell, S. P. and Dutta, A. (2002). DNA Replication in Eukaryotic Cells. *Annual Reviews of Biochemistry, 71,* 333-74
4. Ostertag, E. M. and Kazazian, H. H. (2001). Biology of Mammalian L1 Retrotransposons. *Annual Reviews of Genetics, 35,* 501-38.

UNIT 3: GENE EXPRESSION

3.1 Messenger RNA
3.2 Transcription
3.3 Promoters and Enhancers
3.4 Using the genetic code
3.5 Protein synthesis

Key Research / Review Articles:

1. Noller, H. F. (2005). RNA Structure: Reading the Ribosome. *Science, 309,* 1508-1514.
2. McClure, W. R. (1985). Mechanism and Control of Transcription Initiation in Prokaryotes. *Annual Reviews of Biochemistry, 54,* 171-204.

3. Shilatifard, A. *et al* (2003). The RNA Polymerase II Elongation Complex. *Annual Reviews of Biochemistry, 72,* 693-715.
4. Woychik, N. A. *et al* (2002). RNA Polymerase II Machinery: Structure Illuminates Function. *Cell, 108,* 453-463.
5. Smale, S. T. and Kadonaga, J. T. (2003). The RNA Polymerase II Core Promoter. *Annual Reviews of Biochemistry, 72,* 449-479.
6. Ramakrishnan, V. (2002). Ribosome Structure and the Mechanism of Translation. *Cell, 108,* 557-572.

UNIT 4: GENE REGULATION

4.1 The Operon
4.2 Activating Transcription
4.3 Regulatory RNA

Key Research / Review Articles:

1. Harrison, S. C. (1991). A Structural Taxonomy of DNA Binding Domains. *Nature, 353,* 715-719.
2. Botsford, J. L. and Harman, J. G. (1992). Cyclic AMP in Prokaryotes. *Microbiological Reviews, 56(1),* 100-122.
3. Gottesman, S. (2002). Stealth Regulation: Biological Circuits with Small RNA Switches. *Genes and Development, 16,* 2829-2842.
4. Yanofsky, C. *et al* (1979). Attenuation in the *Escherichia coli* Tryptophan Operon: Role of RNA Secondary Structure Involving Tryptophan Codon Region. *Proceedings of the National Academy of Sciences of the USA, 76(11),* 5524-5528.
5. Sharp, P. A. (2001). RNA Interference-2001. *Genes and Development, 15,* 485-490.

Text Reference:

Lewin, B., (2008). *Genes IX*. Jones and Bartlett Publishers, Sudbury.

Supplementary Reference:

Watson, J. D. *et al* (2004). *Molecular Biology of the Gene.* 5th Edition, Benjamin Cummings, San Francisco.

MB 103: Microbial Physiology

Objective: The main aspect of this paper includes Inorganic metabolism of nitrogen and sulfur, electron transport and C_1 metabolism, Photosynthesis in prokaryotes. This also includes Carbon dioxide fixations systems and Cell wall and capsule biosynthesis.

	No. of Lectures.
UNIT-1: Inorganic Nitrogen and Sulfur Metabolism.	13
UNIT- 2: Energy Production.	10
UNIT-3: Photosynthesis	09
UNIT-4: Biosynthesis	09

UNIT-1: Inorganic Nitrogen and Sulfur Metabolism. **Ref. Albert G. Moat**

1.1 Biological Nitrogen fixation.
1.2 The Nitrogen Fixation process
1.3 Symbiotic Nitrogen Fixation.
1.4. Inorganic Nitrogen Metabolism.
1.5 Assimilation of Inorganic Nitrogen.
1.6. General Reactions of Amino Acids.
  1.6.1. Amino Acid Decarboxylases.
  1.6.2. Amino Acid Deaminases.
  1.6.3. Amino Acid Transaminases (Aminotransferases)
  1.6.4. Amino Acid Racemases.
  1.6.5. Role of pyridoxal-5'-Phosphate in Enzymatic Reactions with Amino Acids.
1.7. The Stickland Reaction
1.8. Sulfate assimilation
1.9. Dissilmilatory sulfate reduction

UNIT- 2: Energy Production. **Ref. David White and Moat**

2.1 Membrane bioenergetics: the proton potential
2.2 Electron transport
2.3 Metabolism of substrates other than glucose
2.3 Catabolism of Aliphatic hydrocarbons
2.4 Growth on C_1 compounds other than CO_2: The methylotrophs.

UNIT-3: Photosynthesis **Ref. David White**

3.1 The phototrophic prokaryotes
3.2 The purple photosynthetic bacteria

3.3 The green sulfur bacteria
3.4 Cyanobacteria and chloroplast
3.5 Efficiency of photosynthesis
3.6 Photosynthetic pigments
3.7 The transfer of energy from light harvesting pigments to the reaction centre
3.8 The structure of photosynthetic membranes in bacteria

UNIT-4: Biosynthesis **Ref. David White**

4.1 Carbon dioxide fixations systems

4.2 Cell wall and capsule biosynthesis

References:

1. White D (2003) : *The Physiology and Biochemistry of Prokaryotes*, Oxford University Press 2nd Ed.
2. Moat A G *et. al* (2009).: *Microbial Physiology*, Wiley-Liss, Inc, New york 4th Ed.

MB 104: Applied Environmental Microbiology

Objective: This paper is devoted to study of diversity of microbial habitats, processes taking place in environment and its application in solving environmental problems. It also involves exploiting these principles for economic purpose.

Unit 1: Biodiversity, Microbial ecology and it' s tools

1.1 What is Biodiversity? **Ref: Hawksworth**

1.2 Measurement of Biodiversity **Ref: Hawksworth**

- 1.2.1 Taxic measures
- 1.2.2 Molecular measures
- 1.2.3 Phylogenetic measures

1.3 Biodiversity at the molecular level: the domains, kingdoms and phyla of life **Ref: Hawksworth**

1.4 Theoretical and practical aspects of the quantification of biodiversity among microorganisms **Ref: Hawksworth**

1.5 Microbial ecology – New Directions, new importance **Ref: BMSB Ed. 2 Vol 1**

1.6 Nucleic acid probes and their application in environmental microbiology **Ref: BMSB Ed. 2 Vol 1**

1.7 Metagenomic libraries from uncultured microorganisms **Ref: Osborn**

Unit 2: Waste water engineering

2.1 Waste water **Ref: Metcalf and Eddy**

- 2.1.1 Physical characteristics of waste water
- 2.1.2 Inorganic non metallic constituents
- 2.1.3 Aggregate organic constituents
- 2.1.4 Microbial growth kinetics

2.2 Biotreatment of waste **Ref: Doble & Anilkumar**

- 2.2.1 Textile effluent
- 2.2.2 Food and Dairy industry
- 2.2.3 Sugar and Distillery waste
- 2.2.4 Pharmaceuticals
- 2.2.5 Hospital waste
- 2.2.6 Waste from nuclear plants

Unit 3: Biodegradation and Bioremediation

3.1 Fundamentals of Biodegradation **Ref: M. Alexander**

- 3.1.1 Growth linked biodegradation
- 3.1.2 Acclimation
- 3.1.3 Detoxication
- 3.1.4 Activation
- 3.1.5 Kinetics
- 3.1.6 Bioavailability
- 3.1.7 Cometabolism
- 3.1.8 Inoculation

3.2 Biodegradation of pesticides **Ref: Doble & Anilkumar**

3.3 Biodegradation of polymers **Ref: Doble & Anilkumar**

3.4 Biodegradation of dyes **Ref: Doble & Anilkumar**

3.5 Bioremediation technologies **Ref: M. Alexander**

Unit 4 : Environmental Biotechnology

4.1 Oil field microbiology **Ref: Hurst**

4.2 Bioreporter, Biosensor and microprobes **Ref: Hurst**

4.3 Biodesulfurization **Ref: Doble & Anilkumar**

4.4 Colonization, adhesion, aggregation and Biofilms **Ref: Hurst**

4.5 Bioprospecting

4.6 Investigative Biodeterioration **Ref: Allsopp**

4.7 The control of Biodeterioration **Ref: Allsopp**

References:

1. Hawksworth, D. L. (1995) *Biodiversity: Measurement and Estimation.* Chapman & Hall 1 Ed - The royal society.
2. Garrity, G. M. and Boone, D. R. (2001) *Bergey's Manual of Systematic Bacteriology Volume 1: The Archaea and the Deeply Branching and Phototrophic Bacteria*; *2 Ed.* Springer.
3. Metcalf & Eddy Inc. (2002) *Wastewater Engineering: Treatment and Reuse 4 Ed.* McGraw Hill Higher Education.
4. Doble, M. & Anil kumar (2005) *Biotreatment of Industrial Effluents.* Butterworth-Heinemann – An imprint of Elsevier.
5. Alexander, M. (1999) *Biodegradation and Bioremediation, 2Ed.* Academic Press.
6. Osborn, A. & Smith, C.(2005) *Molecular Microbial Ecology (Advanced methods)1Ed.* BIOS Scientific Publisher, Taylor & Francis group.
7. Hurst, C. (2007) *Manual of Environmental Microbiology, 3Ed.* ASM Press.
8. Allsopp, D.*et al*(2004) *Introduction to Biodeterioration, 2Ed.* Cambridge University Press

M.Sc. MICROBIOLOGY PRACTICALS

SEMESTER 1

1. One step growth curve of phage.
2. Extraction, characterization and quantification of genomic DNA from bacterial cell
3. Extraction of plasmid DNA from bacterial cell
4. Extraction of bacterial DNA using spin column technique
5. Detection siderophore production by *Pseudomonas*.
6. Study of nodulation of legumes by rhizobia.
7. Analysis of domestic water and waste water
   7.1 Physical
   - Acidity
   - Alkalinity
   - Hardness –EDTA titrimetric method
   - Chlorine demand
   - Solids : TDS and TSS

   7.2 Inorganic non-metallic constituents
   - Residual chlorine
   - Chloride
   - pH value
   - Oxygen (Dissolved)

   7.3 Agregate organic constituents
   - Biological oxygen demand
   - Chemical oxygen demand
8. Bioremediation of heavy metals : Biosorption
9. Biodegradation of dyes