VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. MICROBIOLOGY

Teaching and Evaluation Scheme

(Effective from 2014-15)

Semester – I

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-101	Taxonomy,Virology & Cytology	4	-	70	30	100	**4**
MB-102	Molecular Biology & rDNA Technology	4	-	70	30	100	**4**
MB-103	Microbial Physiology	4	-	70	30	100	**4**
MB-104	Bioanalytical techniques and Instrumentation	4	-	70	30	100	**4**
Practicals		-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

Semester – II

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-201	Molecular Microbial Physiology And Enzymology	4	-	70	30	100	**4**
MB-202	Molecular diagnosis and molecular pathogenesis	4	-	70	30	100	**4**
MB-203	Advances in Immunology and Immunotechnology	4	-	70	30	100	**4**
MB-204	Microbial Ecology & Environmental Microbiology	4	-	70	30	100	**4**
Practicals		-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

Semester – III

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-301	Fermentation Technology	4	-	70	30	100	**4**
MB-302	Bioprocess Engineering	4	-	70	30	100	**4**
MB-303	Industrial Microbiology	4	-	70	30	100	**4**
MB-304	Pharmaceutical Microbiology	4	-	70	30	100	**4**
Practicals		-	16	140	60	200	**8**
Total		**16**	16	420	180	600	**24**

Semester – IV

Paper No.	Paper Title	Theory (Hrs/Wk)	Practical (Hrs/Wk)	External	Internal	Total	Credit
MB-401	Research methodology ,Biostatistics and IPR	4	-	70	30	100	**4**
MB-402	Bioinformatics & "OMICS"	4	-	70	30	100	**4**
	PRACTICAL: MB 401 & 402		08	70	30	100	**4**
	PROJECT/DISSERTATION	-	24	210	90	300	**12**
Total		**8**	16	420	180	600	**24**
Total credit of the course							**96**

M.Sc. Microbiology Syllabus

(Effective from 2014 -15)

MB 101: TAXONOMY, VIROLOGY AND CYTOLOGY

OBJECTIVES: 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.

UNIT: 1Taxonomy and classification of bacteria and virus.

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

UNIT: 2 Fundamentals of virology [Ref. Shors]

2.1 Virus properties
2.2 Viruses that challenge the definition of a virus
2.3 Virus structure and morphology
2.4 Virus replication cycles
2.5 Molecular biology of prion proteins [Ref.Fields]
2.6 Prion replication [Ref Fields]
2.7 Genetic research and the function of PRP^{C}
2.8 Chronic Wasting Diseases (CWD).
2.9 New Viruses and Viruses that are reemerging.

UNIT: 3 Bacteriophages [Ref.Fields]

3.1Virulent Phages
3.1.1 Phage T_4
3.1.2 Ø x174

3.1.3 MS2

3.2 Temperate phages

3.2.1 Phage λ.

3.2.2 Phage Mu-1 as a Model Transposon.

3.2.3 Phage P 1 as a Model plasmid.

3.3 Evolution and natural biology of Phages

UNIT: 4 Cytology

4.1 The nucleus (Ref: Cooper)

4.1.1 Protein sorting

4.1.2 The endoplasmic reticulum

4.1.3 The Golgi apparatus

4.1.4 Lysosomes

4.2 Bioenergetics and metabolism

4.2.1 mitochondria

4.2.2 Chloroplast and other plastids

4.3 Peroxisomes

4.4 The cytoskeleton

4.5 Actin filaments

4.6 Intermediate filaments

4.7 Microtubules

4.8 The plasma membrane

4.9 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. Manual of clinical microbiology, 8th Edition, Vol. 2, Murray, Barron, Jorgenson, Pfaller, Yolken. ASM Press: ISBN: 1-55581-255-4.
3. Basic virology, 3rd Edition, Blackwell publishers, Wagner, Hewlett, Bloom & Camerini, 2008. ISBN-13:978-1-4051-4715-6.
4. Principals of molecular virology, 4th Edition. Alan. J. Cann, Elservier academic press, 2005. ISBN: 0-12-088787-8.
5. Fields virology, 5th Edition Vol. 1 David. M. Knipe, Peter M. Howley, 2007, LWW, ISBN-13: 978-0-7817-6060-7.
6. Fields virology, 5th Edition Vol. 2 David. M. Knipe, Peter M. Howley, 2007, LWW, ISBN-13: 978-0-7817-6060-7.
7. The cell, 4 edition,Geoffrey M. Cooper,Robert E.Hausman,2007,ASM press, ISBN-13:978-0-87893-220-7.
8. Desk encyclopedia of microbiology, Moselio Schaechter,Elsevier Academic Press ,2004, ISBN 0-12-621361-5
9. Shors, T., (2013), Understanding viruses, 2nd edition, Jones and Bartlett, ISBN: 978-1-4496-4892-3

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MB 102: MOLECULAR BIOLOGY & rDNA technology

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

UNIT 1: GENOME ORGANIZATION, REPLICATION & REPAIR (Ref. Watson and Baker)

1.1 The Structures of DNA and RNA
1.2 Chromosomes, Chromatin and Nucleosomes
1.3 Model organisms
  1.3.1Bacteriophage
  1.3.2 Bacteria
  1.3.3 Baker's Yeast
  1.3.4 *Caenorhabditis elegans(*Nematode)
1.4 The replicon Ref.: B.Lewin
1.5 DNA replication Ref.: B.Lewin
1.6 Recombination and repair Ref.: B.Lewin

UNIT 2: GENE EXPRESSION & REGULATION **Ref. Watson and Baker**

2.1 Mechanisms of Transcription
2.2 RNA splicing
2.3 Translation
2.4 Genetic code
2.5 Gene regulation in Prokaryotes

Unit 3: TOOLS OF RECOMBINANT DNA TECHNOLOGY

3.1 Blotting procedures:
  3.1.1 Southern Blotting [Primrose]
  3.1.2 Northern Blotting [Primrose; Watson]
  3.1.3 Western Blotting [Primrose]
3.2 Cloning in Eukaryotic Microorganisms:
  3.2.1 Types of cloning vector
  3.2.2 Cloning in Yeast and other fungi [Primrose]
  3.2.3 *Saccharomyces cerevisiae* Expression systems [Glick]
  3.2.4 *Pichia pastoris* and other Yeast Expression systems [Glick]
3.3 Polymerase Chain Reaction [Primrose]
  3.3.1 Starting material and enzymes for PCR
  3.3.2 Factors influencing PCR
  3.3.3 Quantitative PCR: TaqMan system, Molecular beacons and Scorpion probes
3.4 Genomic libraries:
  3.4.1 Making a Gene Library [Glick]
  3.4.2 cDNA Library [Primrose]
  3.4.3 Screening of clones

3.4.3.1 Screening by DNA Hybridization [Glick]
3.4.3.2 Immunological Screening [Primrose]
3.4.3.3 Functional Cloning [Primrose]

Unit 4: APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY

4.1 DNA Fingerprinting & DNA Forensics [Watson]
4.2 Gene Therapy
4.2.1 Human Gene Therapy [Glick]
4.2.2 DNA Vaccines [Primrose]
4.2.3 Gene Augmentation [Primrose]
4.2.4 Gene Therapy for Cancer Cells [Primrose]
4.3 Regulation of Gene Action by RNA Interference [Watson]
4.4 Transfection of Plants
4.4.1 Gene transfer to plants [Primrose]
4.4.2 Manipulation of Gene Expression in Plants [Glick]
4.4.3 Plants as Bioreactors [Primrose; Glick]
4.5 Methods of Transgenesis in Animals
4.5.1 Retroviral Vector Method [Glick]
4.5.2 DNA Microinjection Method [Glick]
4.5.3 Engineered Embryonic Stem Cell Method [Glick]
4.5.4 Use of High Capacity Vectors [Glick]
4.5.5 Cre-*loxP* Recombination System [Glick]

Reference:

Lewin, B., (2004). *Genes VIII*. Pearson.
Watson, J. D. *et al* (2008). *Molecular Biology of the Gene.* 5th Edition, Pearson

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MB 103: MICROBIAL PHYSIOLOGY

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

UNIT-1: Inorganic Nitrogen and Sulfur Metabolism. [Albert G. Moat, 4th Edition]

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 Regulation of Nitrogen fixation (Kim & Gadd)
1.7 General Reactions of Amino Acids.
    1.7.1 Amino Acid Decarboxylases.
    1.7.2. Amino Acid Deaminases.
    1.7.3. Amino Acid Transaminases (Aminotransferases)
    1.7.4. Amino Acid Racemases.
    1.7.5. Role of pyridoxal-5'-Phosphate in Enzymatic Reactions with Amino Acids.
1.8 The Stickland Reaction
1.9 Sulfate assimilation
1.10 Sulfide formation and sulphide consumption by bacteria (Encyclopedia of Microbiology)
1.11 Dissilmilatory sulfate reduction
1.12 Microbial sulphur oxidation.

UNIT- 2: Energy Production. [David White and Moat, 4th Edition]

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
2.5 Energy efficiency in C_1 metabolism (Kim & Gadd)
2.6 Chemolithotrophic bacteria.

UNIT-3: Photosynthesis [David White, 2nd Edition]

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
    3.6.1 Light harvesting pigments

3.6.2. Structures of Chlorophylls, bacteriochlorophylls and carotenoids
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 [David White, 2nd Edition]

4.1 Carbon dioxide fixations systems
4.2 Cell wall and capsule biosynthesis

REFERENCES:

1. The Physiology and Biochemistry of Prokaryotes, 2nd Edition, David White, Oxford University Press 2003, ISBN: 0-19-512579-7
2. Microbial Physiology, 4th Edition, 2009, Albert G. Moat, John W. Foster, Michael P. Spector, Wiley, ISBN: 978-81-265-2106-7
3. Rutger de Wit., Sulfide-Containing environments, Encyclopedia of Microbiology Vol-.4, 2ndEdition.Academic Press.
4. Byung Hong Kim and Geoffrey Michael Gadd. Bacterial Physiology and Metabolism, Cambridge University Press 2008, ISBN 13 978-0-511-39322-8. (e-book). ISBN 13 978-0-521-84636-3 (hard back).

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MB 104: BIOANALYTICAL TECHNIQUES AND INSTRUMENTATION

OBJECTIVE:
The objective of the course is to introduce the students to the concepts of physical principles of detection and measurement systems. Emphasis will also be given to understand the principles of major experimental techniques applied to understand these physical problems. The course will cover theoretical aspects and applications of modern analytical techniques in Modern Biology.

Unit 1: Basic principles and fundamentals of instrumentation

1.1Analytical Measurements **(Currel)**
- 1.1. 1 Analytical Procedure
- 1.1.2 Analytical Instrument
- 1.1.3 Data output
- 1.1.4 Error, Uncertainty and Reliability
- 1.1.5 Analytical Method characteristics.

1.2. pH meters **(Khandpur**)
- 1.2.1 Principle of pH measurement
- 1.2.2 Electrodes for pH easurement

1.3. Radiochemical Instruments**(Khandpur**)
- 1.3.1 Fundamentals of radiochemical methods
- 1.3.2 Radiation detectors
- 1.3.3 Liquid scintillation counters

1.4. Biosensors**(Khandpur**)

Unit 2: Chromatographic and centrifugation techniques **Ref: Wilson, Currell**

2.1 Chromatographic techniques
- 2.1.1 Principle of chromatogrqaphy.
- 2.1.2 Chromatographic performance parameters
- 2.1.3 High-Performance Liquid chromatography
- 2.1.4 Thin layer chromatography
- 2.1.5 Adsorption chromatography
- 2.1.6 Partition chromatography
- 2.1.7 Gel permeation chromatography
- 2.1.8 Ion exchange chromatography
- 2.1.9 Affinity chromatography
- 2.1.10 Gas chromatography

2.2 Centrifugation
- 2.2.1 Basic principles, sedimentation
- 2.2.2 Types care and safety aspect of centrifuges
- 2.2.3 Preparative and analytical centrifugation

Unit 3: Spectroscopic and X-ray diffraction techniques (Ref: Walker, Khandpur)

3.1 Electromagnetic radiation, Interaction of radiation with matter, Beer-Lambert's law.
3.2 single beam and double beam photometers
3.3 Principles, Instrumentation and applications of
- 3.2.1 UV-VIS spectroscopy
- 3.2.2 Infrared spectroscopy
- 3.2.3 Nuclear Magnetic Resonance spectroscopy.
- 3.2.4 Electron spin resonance spectroscopy
- 3.2.5 Mass spectrometer
  - 3.2.5.1 Basic mass spectrometer
  - 3.2.5.2 Principle of operation
  - 3.2.5.3 Types of mass spectrometers
  - 3.2.5.4 Components of a mass spectrometer
  - 3.2.5.5 Application of mass spectrometry

3.4 X-ray Diffraction
- 3.4.1 Principle, X-ray diffraction, Applications

Unit 4: Electrophoretic techniques (Ref: Walker)

4.1 General principles
4.2 Support media
4.3 Electrophoresis of proteins
4.4 Electrophoresis of nucleic acids
4.5 Capillary electrophoresis
4.6 Microchip electrophoresis

Reference:

1) Wilson K and Walker J: *Principles and Techniques of Biochemistry and Molecular Biology*. Cambrige University Press (Low price edition), New York, 6th ed.
2) Khandpur R S (2008): *Handbook of analytical instruments*. Tata McGraw-Hill Publishing Company Limited (New Delhi), 2nd ed.
3) Webster J G (2009): *Bioinstrumentation*.Wiley India (P) Ltd. New Delhi. (Student ed.)
4) Upadhyay A., Upadhyay K and Nath N. (2003): *Biophysical Chemistry (Principles and Techniques)*. Himalaya Publishing House, 8th ed.
5) Khopkar S M (2008): *Basic concepts of Analytical Chemistry*. New age international publishers (New Delhi), 3rd ed.
6) Sharma B K (2005): *Instrumental methods of chemical analysis*. GOEL publishing house, Meerut, 24th ed.

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M.SC. MICROBIOLOGY PRACTICALS

SEMESTER 1

1. Demonstration Of Lysogeny in *E.coli***.**
2. One-step growth curve.
3. Digesting DNA with Restriction Endonuclease.
4. Ligation of DNA fragments.
5. Amplification of gene by PCR.
6. To study RFLP.
7. Isolation of casein from milk by isoelectric precipitation and its quantification by dry weight estimation.
8. Estimation of Calcium ions present in sporulating bacteria by EDTA Method
9. Ultraviolet irradiation survival curve.
10. Demonstration Chemical mutagenesis
11. Isolation of mutants: Antibiotic resistant, Respiratory deficient, Thymine requiring.
12. Determination of melting temperature (*Tm*) and estimation of GC content
13. Extraction & purification of RNA from Yeast
14. DNA isolation from filamentous fungi
15. Demonstration HPLC and GC
16. Thin layer chromatography of fatty acids, sugars, amino acids.
17. Extraction of plasmid DNA from bacterial cell
18. Extraction of bacterial DNA and purification by spin column technique
19. Fractionation of egg proteins and quantification by SDS-PAGE.
20. Study of root nodules (Detection and separation of leghaemoglobin)

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M.SC. MICROBIOLOGY SEMESTER - II

MB 201: MOLECULAR MICROBIAL PHYSIOLOGY AND ENZYMOLOGY

Objective: The main aspect of this paper includes physiology of the bacteria in molecular context. It also includes Enzyme structure and kinetic properties of an enzyme.

Unit-1 MOLECULAR TOOLS FOR STUDYING MICROBIAL PHYSIOLOGY

Ref: A. G. Moat

1.1 Mutant hunts
1.2 Reporter gene
1.3 PCR
1.4 DNA Mobility Shift [Gel Shift and Super Shift]
1.5 Primer extension
1.6 Southern blots
1.7 Northern blots
1.8 Western blots
1.9 Southwestern blots
1.10 Two hybrid analysis

Unit-2 MOLECULAR ADAPTATION PHYSIOLOGY

2.1 Introduction to two component signaling system: **Ref. U. N. Streips**
- 2.1.1 Prototypical two component signaling
- 2.1.2 Spectrum of functions

2.2 Physiology, biochemistry and genetic aspects of oxidative stress response and regulation.(**A.G. Moat**)
2.3 Heat shock response **Ref: D. White**
2.4 Nutritional stress and Starvation stress response **Ref: A. G. Moat**
2.5 Biochemistry and Physiology of Adaptation in… **Ref: M. Schaechter**
- 2.5.1 Hyperthermophiles,
- 2.5.2 Extremeacidophiles,
- 2.5.3 Halophiles,
- 2.5.4 Alkalophioles,
- 2.5.5 Radiation resistant microorganisms

2.6 Sporulation in *Bacillus subtilis* **Ref: D. White**

Unit-3 STRUCTURE OF ENZYME

3.1 Protein Structure **Ref: T. Palmer**
- 3.1.1 Determination of primary structures,
- 3.1.2 Determination of secondary and tertiary structures,
- 3.1.3 Determination of protein structure by X-ray crystallography,
- 3.1.4 Investigation of protein structure in solution,

3.2 Mechanism of enzyme actions **Ref: L. Stevens**
- 3.2.1 Proximity and orientation effect,
- 3.2.2 Acid-Base Catalysis,

3.2.3 Covalent catalysis,
3.2.4 Metalloenzymes **Ref: T. Palmer**
3.2.5 Electrostatic catalysis
3.3 Investigation of active site structure **Ref: T. Palmer**

Unit-4 ENZYME KINETICS Ref: T. Palmer

4.1 Kinetics of uncatalyzed chemical reaction
4.2 Kinetics of Enzyme catalyzed reactions
4.3 Methods use for investigating kinetics of enzyme catalyzed reaction:
4.3.1 Initial velocity studies
4.3.2 Rapid enzyme catalysis
4.4 Kinetics of single substrate enzyme catalyzed reaction:
4.4.1 Michaelis-Menten equation, its modification and its importance
4.4.2 *Vmax* and *Km*
4.4.3 Lineweaver-Burk plot, Eadie-Hofstee plot, Hans plot, Dixan plots
4.5 Enzyme inhibition kinetics:
4.5.1 Reversible inhibition:
4.5.1.1 Competitive inhibition
4.5.1.2 Non Competitive inhibition
4.5.1.3 Un Competitive inhibition
4.5.1.4 Allosteric inhibition
4.5.1.5 Substrate inhibition
4.5.1.6 Partial inhibition
4.5.2 Irreversible inhibition
4.6 Kinetics of multi-substrate enzyme catalyzed reaction:
4.6.1 Ping-pong reaction
4.6.2 Random-order reactions
4.6.3 Compulsory order reactions

References:

1. White D (2007): *The Physiology and Biochemistry of Prokaryotes*, 3rd Ed. Oxford University Press, New York.
2. Streips U N and Yasbin R E (2002): *Modern Microbial Genetics*, 2nd Ed, Wiley-Liss, A John wiley and sons Inc., publication, New York.
3. Schaechter M (2004): *The Desk Encyclopedia of Microbiology*. Elsevier Academic Press, California USA.
4. Wheelis M (2008): *Principles of Modern Microbiology*. John and Bartlett Publishers, Sudbury, Massachusetts, USA.
5. Moat A G, Foster J W and Spector M P (2009): *Microbial* Physiology, 4th Ed. Wiley-India, New Delhi.
6. Palmer T (2004): *Enzymology*. East-West Press Pvt. Ltd., New Delhi.
7. Price N C and Stevens L (1999) *Fundamental of Enzymology* , 3rd Ed. Oxford University Press, New York.

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MB 202: MOLECULAR DIAGNOSIS AND MOLECULAR PATHOGENESIS

Objectives:

Infectious diseases are thriving. In the case of smallpox (and soon polio), the disease can be eliminated from the earth before details of it pathogenesis have been unraveled. Nevertheless, we need to keep studying pathogenesis, because understanding it lends a helping hand to therapy, control of transmission, vaccine development and to the science of immunology. It is no accident that the recent Nobel laureates, Peter Doherty and Rolf Zinkernagel, made their discovery of the MHC restriction of cytotoxic T-cells in the course of studies on the pathogenesis of a virus infection of mice.

It has been said that the gene sequence of a microbe is like the Rosetta stone- impressive to see, but to have value it must be translated. It will be an immense help if we can become better at predicting protein function from sequence and understand the pathogenesis at molecular level. Keeping in mind, therefore, this paper is planned to acknowledge the students regarding molecular pathogenesis, including most of the advanced molecular diagnostic technology.

UNIT: 1 Molecular Detection and Identification of microorganisms

1.1 Non amplified nucleic acid probes **Ref: Murray**
1.2 Amplified nucleic acid technique
1.3 Target Amplification technique
1.4 Probe Amplification technique
1.5 Post amplification detection and Analysis
1.6 Current Application

Unit: 2 Molecular pathosgenesis-1 Ref: MIMS

2.1 Attachment to and Entry of microorganisms in to the body
- 2.1.1 Enteropathogenic *E. coli*
- 2.1.2 *Shigella*

2.2 The encounter with the phagocytic cell
- 2.2.1 Phagocytosis in polymorhonuclear leucocytes
- 2.2.2 Phagocytosis in macrophages
- 2. 2.3 Growth in the phagocytic cell
- 2.2.4 Killing the phagocyte
- 2.2.5 Entry into the host cell other than by phagocytosis
- 2.2.6 Consequences of defects in the phagocytic cell

Unit: 3 Molecular pathogenesis-2 Ref: MIMS

3.1 The spread of microbes through the body
- 3.1.1 Direct spread
- 3.1.2 Microbial factors promoting spread
- 3.1.3 Spread via lymphatics
- 3.1.4 Spread via the blood
- 3.1.5 Spread via other pathways

3.2 Microbial strategies in relation to the immune response
- 3.2.1 Induction of immunological tolerance
- 3.2.2 Immunosuppresion
- 3.2.3 Absence of a suitable target for the immune response
- 3.2.4 Microbial presence in bodily sites inaccessible to the immune response
- 3.2.5 Antibodies mopped by soluble microbial antigens
- 3.2.6 Local interference with immune forces
- 3.2.7 Antigenic variation
- 3.2.8 Microorganisms that avoid induction of an immune response

3.3 Mechanisms of tissue and cell damage
- 3.3.1 Direct damage by microorganisms
- 3.3.2 Microbial toxins

3.4 Host and Microbial factors Influencing Susceptibility
- 3.4.1 Genetic Factors in the Microorganisms
- 3.4.2 Genetic Factors in the Host

3.5 Host and virus factors involved in pathogenesis
- 3.5.1 Patterns of infection and pathogenic effect of viruses
- 3.5.2 Pathogenesis of animal viruses (Adenovirus, Hepatitis virus)
- 3.5.3 Pathogenesis of plant virus (TMV)

Unit: 4 Molecular Plant Pathology

4.1 Host pathogen interaction Ref. Mehrotra and Agarios

4.2 Genetics of virulence in pathogens and of resistance in host plant. Horizontal and vertical resistance, Disease Escape Ref. Agario

4.3 Examples of molecular genetics of selected plant diseases Powdery mildew and Rice blast Ref. Agarios

4.4 Compatible and incompatible reactions

4.5 Recognition of host and gene for gene concept Ref. Flor and Agarios

4.6 Resistance genes of plants, Signal transduction between pathogenicity and resistance genes, Signaling and regulation of programmed cell death Ref. Agarios

References:

1. Murray, P. (2003). *Manual of Clinical Microbiology Vol-1*, 8th Ed. ASM Press.
2. Mims, C. A. *et al* (2000).*MIMS' Molecular pathogenesis of Infectious Disease,5th Ed.* Academic Press.
3. Pandey, B. P. (2005) *Plant Pathology: Pathogen and Plant disease*, S. Chand & Company Ltd. New Delhi.
4. Mehrotra, R. S. and Aggarwal, A. (2007) *Plant Pathology*, 2nd Ed., Tata McGraw-Hill Publishing Company Limited New Delhi.
5. Agarios, G. N. (2005). *Plant Pathology*, 5th ed. Elsevier.
6. Flor, H. H. (1971). Current status of the gene-for-gene concept. *Ann. Rev. Phytopath.*, 9:275-296.
7. Mitra, S. (2007). *Genetic Engineering-Principles and Practise*. Macmillan India Ltd, New Delhi.

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MB 203: ADVANCES IN IMMUNOLOGY AND IMMUNOTECHNOLOGY

Objectives: This paper focuses on principles behind current immunological research. It also explains some basic techniques for the same. It also throws light on its use in the field of therapeutics.

Unit 1: Receptor Biology

1.1 The Major Histocompatibility Complex **Ref. Abbas**
- 1.1.1 Discovery of the MHC and its role in immune responses
- 1.1.2 Structure of MHC molecules
- 1.1.3 Genomic organization of MHC
- 1.1.4 Expression of MHC molecules

1.2 T-cell receptor **Ref. Kuby**
- 1.2.1 T cell receptor complex: TCR-CD3
- 1.2.2 T cell accessory membrane molecules
- 1.2.3 T cell activation

1.3 B-cell receptor **Ref. Abbas**
- 1.3.1 The B cell receptor
- 1.3.2 Signal transduction by BCR
- 1.3.3 Second signals for B cells provided by complement receptors
- 1.3.4 Presentation of protein antigens by B lymphocytes to helper T cells
- 1.3.5 Helper Tcell mediated activation of B lymphocytes

Unit 2: Transplantation and Tumor Immunology

2.1 Responses to alloantigens and transplant rejection **Ref. Janeway**

2.2 Cancer and immune system **Ref. Kuby**
- 2.2.1 Cancer: Origin and Terminology
- 2.2.2 Malignant transformation of cells
- 2.2.3 Oncogenes and cancer induction
- 2.2.4 Tumors of immune system
- 2.2.5 Tumor antigens
- 2.2.6 Tumor evasion of immune system

Unit 3: Immunotechnology Ref. Janeway

3.1 Detection, measurement and characterization of antibodies and their use
3.2 Isolation of lymphocytes
3.3 Characterization of lymphocyte specificity, frequency and function
3.4 Detection of immunity *in vivo*
3.5 Manipulation of immune system

Unit 4: Immunotherapy Ref. Paul

4.1 Introduction
4.2 A major goal for immunotherapy - Immunotolerance.

4.3 Cellular therapeutics
4.4 Antibody therapeutics
4.5 Engineered antibodies for therapy
4.6 Engineering antibodies for cancer therapy
4.7 The clinical applications of antibodies

References:

1. Kindt, T; Osborne, B.& Goldsby, R.(2006) *Kuby Immunology 6Ed.* W. H. Freeman.
2. Janeway, C. *et al*. (2004) *Immunobiology 6 Ed.* Garland Science.
3. Lichtman, A. & Abbas, A.(2003) *Cellular and Molecular Immunology 5Ed.*Saunders.
4. Paul, W. (1999) *Fundamental Immunology 4Ed.* Lippincott Williams & Wilkins.

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MB 204: MICROBIAL ECOLOGY AND APPLIED ENVIRONMENTAL MICROBIOLOGY

Objectives: 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 Biodivdersity 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 Ref: M. Alexander

3.1 Fundamentals of Biodegradation
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	Microbial transformation of heavy metals	Ref: Mohapatra
4.2	Microbial transformations of Pesticides	Ref: Mohapatra
4.3	Biodesulfurization	Ref: Doble&Anilkumar
4.4	Bioleaching and biomining for recovery of resources	Ref: Mohapatra
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)*WastewaterEngineering: 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.

9**.** Mohapatra, Environment Biotechnology

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M.SC. MICROBIOLOGY PRACTICALS

SEMESTER 2

1. Find out the cellulase activity by using CMC as substrate.
2. To check the Invertase enzyme activity …
    a. By varying the substrate concentration and Data analysis.
    b. By varying enzyme concentration.
3. Find out the effect of inhibitor and type of inhibition on invertase enzyme.
4. ELISA detection of anti-HIV sera.
5. ELISA detection of HBsAg.
6. Isolation of Bacteriocin producers.
7. Immobilization studies:Preparation of urease/Amylase entrapped in alginate beads and determination of percent entrapment
8. Analysis of domestic water and waste water
    8.1 Physical
        - Acidity
        - Alkalinity
        - Hardness –EDTA titrimetric method
        - Chlorine demand
        - Solids : TDS and TSS
    8.2 Inorganic non-metallic constituents
        - Residual chlorine
        - Chloride
        - Oxygen (Dissolved)
    8.3 Aggregate organic constituents
        - Biological oxygen demand
        - Chemical oxygen demand
9. Bioremediation of heavy metals : Biosorption
10. Detection of fecal pollutant bacteria by Membrane Filtration Technique.

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M.SC. MICROBIOLOGY SEMESTER - III

MB 301: FERMENTATION TECHNOLOGY

Objective: This paper provides the knowledge of basic principle of fermentation process. Which help students to design, develop and operate industrial level fermentation process. This fundamental knowledge is essential for the students to make their career in industry based on bioprocess.

Unit – 1 Screening and strain improvement.

1.1 Introduction to fermentation process – stanbury
1.2 Important characteristics of microbes used in industrial microbiology. – okafor
1.3 Screening for new metabolites – Crueger.
1.4 Over production of metabolite of industrial microorganisms. – okafor
1.5 Strain improvement of industrially important microorganism. – Bailey , crueger
1.6 Preservation of cultures after strain improvement programme. - Moo young

Unit - 2 Fermentation media and sterilization

2.1 Medium design. – Moo young
2.2 Media for industrial fermentation. – stanbury
2.3 Media for cell culture. – Rehm
2.4 Industrial sterilization. – stanbury

Unit – 3 Fermentation processes

3.1 Types of fermentation processes
3.2 Fermentation kinetics. – El-mansi
3.3 System for fermentation process control. - Moo young

Unit – 4 Upstream and downstream processing. Stanbury

4.1 Development of inoculum for industrial fermentation.
4.2 Downstream processing of fermentation product
4.3 Fermentation economics

Reference:

1. Rehm H.J., Reed G., Puhler A and Stadler P., (1993) *Biotechnology*, 2nd ED, VCH Publishers Inc., New York, USA.
2. Stanbury P.F., Whitaker A., Hall S.J.,(1997) *Principles of fermentation technology.* 2nd ED, Aditya books(P) Ltd, New Delhi.
3. El-mansi E.M.T., Bryce C.F.A., Demain A.L., Allman A.R., (2009) *Fermentation microbiology and biotechnology*, 2nd ED,CRC Press.
4. Crueger W. and Crueger A. (2003) *Biotechnology: A textbook of industrial microbiology*, 2nd ED, Panima publishing corporation, New delhi.

5. Okafor N. (2007) *Modern industrial microbiology and biotechnology*, Science publishers, USA.
6. Moo-Young M. (2004) Comprehensive biotechnology, Vol- 1 to 4, Pergamon press Ltd, England.
7. Bailey J. S. and Bhatia S.C. (2009) Biochemical engineering. Vol – 1&2. CBS publishers & distributors, India.

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MB 302: BIOPROCESS ENGINEERING

Objective: This course is designed to impart the knowledge of basic engineering principles, rheological behavior of fluids and mass transfer. Further the students are enriched to apply these principles to bioprocessing units.

Unit – 1 Bioreactor design and It's components

1.1 Bioreactor design
1.2 Component of bioprocess reactor. – Martin
- 1.2.1 Vessels.
- 1.2.2 Agitation system design.
- 1.2.3. Transfer lines.
- 1.2.4 Valves.
- 1.2.5 Pipes.
- 1.2.6 Gassing devices.
- 1.2.7 Mechanical foam separator.

Unit – 2 Fluid flows and mixing. - Doran

2.1 Classification of fluids.
2.2 Fluids in motion
2.3 Viscosity.
2.4 Momentum transfer
2.5 non-newtonian fluids
2.6 viscosity measurement
2.7 Rheological properties of fermentation broth.
2.8 Factors affecting broth viscosity.
2.9 Mixing.
2.10 Power requirement for mixing.
2.11 Scale-up of mixing system.

Unit – 3 Mass transfer Doran

3.1 Molecular diffusion.
3.2 Role of diffusion in bioprocessing.
3.3 Convection mass transfer.
3.4 Oxygen uptake in cell culture.
3.5 Mass transfer correlation.
3.6 Measurement of Kla.

Unit – 4 Bioprocess monitoring and control Ref:Bailey and Bhatia

4.1 Methods of measuring process variables
4.2 On-line analysis of other chemical factors
4.3 Control systems

Reference:

1. Shuler M. L. and Kargi F. (2003) *Bioprocess engineering Basic concepts*, 2nd ED, Pearson education Pvt Ltd, India.
2. Stanbury P.F., Whitaker A., Hall S.J.,(1997) *Principles of fermentation technology*. 2nd ED, Aditya books(P) Ltd, New Delhi.
3. El-mansi E.M.T.and Bryce C.F.A. (2004) *Fermentation microbiology and biotechnology*, Taylor & Francis Inc, USA.
4. Martin K. (2007) Ullmann's biotechnology and biochemical engineering. Vol-1&2. Wiley – VCH verlag gmbh and Co, Weinheim.
5. Bailey J. S. and Bhatia S.C. (2009) Biochemical engineering. CBS publishers & distributors, India.
6. Doran P.M. (2008) Bioprocess engineering principles, Academic press, California.

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MB 303: INDUSTRIAL MICROBIOLOGY

Objectives: This paper explains production and processes of various microbial metabolites at industrial scale by use of microbes.

Unit 1: Industrial production of Biomolecules Ref: Flickinger

1.1 Antibiotics: Cephalosporin and Streptomycin
1.2 Organic acids: Citric acid and Lactic acid Ref: Ratledge
1.3 Amino acids: Glutamic acid and L-Lysine
1.4 Enzymes: Amylase and Protease
1.5 Hormones: Erythropoietin and Human Insulin
1.6 Immuno therapeutic: Monoclonal Antibody production and Recovery
1.7 Anticancer agent: Anthracyclines

Unit 2: Modern trends in microbial production Ref: Flickinger

2.1 PHA: Sseparation, purification, and manufacturing Methods
2.2 Food grade pigments Ref: Dufossé L
2.3 Biosurfactant Ref: Lederberg J.
2.4 1, 2 pentane diols (Optically active 1,2 diols)
2.5 Nitrile Hydratase (Acrylamide)

Unit 3: Microbial production of Food and Beverages Ref: Prescott & Dunn

3.1 Fermented Milk Products
3.1.1 Cheese
3.1.2 Yogurt
3.1.3 Kefir
3.2 Fermented Soy Products Ref: Flickinger
3.2.1 Soy sauce
3.2.2Soy paste
3.2.3 Tempeh
3.2.4 Natto
3.2.5 Tofu
3.3 Production Of Beverages
3.3.1 Alcohol
3.3.2 Beer
3.3.3 Wine

Unit 4: Biotransformations Ref : Ratledge

4.1 Biocatalyst selection
4.2 Biocatalyst immobilization
4.3 Immobilized bioreactors
4.4 Biocatalyst in non-conventional media.

References:

1. Moo-Young, M. *et al* (1985) *Comprehensive Biotechnology: The Practice of Biotechnology: Current Commodity Products.* Pergamon.
2. Flickinger, M. & Drew, S.(1999) *Encyclopedia of Bioprocess Technology,(Volumes 1 - 5)* Wiley-Interscience.
3. Ratledge, C. & Kristiansen, B.(2006) *Basic Biotechnology 3Ed.* New Delhi: Cambridge University Press.
4. Lederberg, J. (2000) *Encyclopedia of Microbiology, 2Ed (Volumes 1 to 4).Academic Press.*
5. Reed, G.(1981) *Prescott and Dunn's Industrial Microbiology.* Chapman & Hall.
6. Dufossé, L.(2006): *Food Grade Pigments.* Food Technol. Biotechnol. 44 (3) 313–321.

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MB 304: PHARMACEUTICAL MICROBIOLOGY

OBJECTIVE: This paper give insight in microbiological analysis and quality control in pharmaceutical industries.

UNIT 1: MICROBIAL ASSAY FOR PHARMACEUTICAL ANALYSIS Ref.:W.Hewitt

1.1 Microbiological assay
1.2 The agar diffusion assay: Its quantitative basis
1.3 The theory and practice of Tube assays for growth promoting substances
1.4 The theory and practice of Tube assays for growth inhibiting substances
1.5 Standard Reference Materials

UNIT 2: MONITORING MICROBIOLOGICAL QUALITY Ref.:Denyer, S. P.

2.1 Good manufacturing practice (GMP) and good industrial large scale practice (GLSP) Ref.: Flickinger
2.2 Monitoring microbiological quality: Conventional testing methods
2.3 Monitoring microbiological quality: Application of rapid methods

UNIT 3: MICROBIOLOGICAL ASPECTS OF PHARMACEUTICAL PROCESSING Ref.:Hugo and Russell's

3.1 Sterile pharmaceutical products
3.2 Sterilization procedures and sterility assurance
3.3 The quality assurance and quality control of pharmaceutical products

UNIT 4: ADVANCES IN PHARMACEUTICAL MICROBIOLOGY

4.1 Pharmaceuticals, biologics and biopharmaceuticals **Ref.: G.Walsh**
4.2 Bioinformatics and Pharmacogenomics for Developing information-Based Medicine and Pharmacotyping in Health Care management **Ref.: Gad**
4.3 Microbiological Auditing **Ref.:Denyer, S. P.**
4.4 Law and regulations for Pharmaceutical manufacturing: Brief idea

Reference:

1. Denyer, S. P. and Baird, R. M. (2008). *Guide to microbiological control in pharmaceuticals and medical devices*. 2nd Edition, CRC Press, Boca Raton.
2. Flickinger, M. C. and Drew, S. W. (1999). *Encyclopedia of Bioprocess Technology*. Wiley-Interscience, New Jersey.
3. Barredo, J. L. (2005). *Microbial Processes and Products.* Humana Press, New Jersey.
4. Gad, S. C. (2007). *Handbook of Pharmaceutical Biotechnology.* Wiley-Interscience, New Jersey.
5. Hugo and Russell's(2007). *Pharmaceutical Microbiology*, Blackwell Publishing.
6. Walsh, G. (2007). *Pharmaceurcal Biotechnolog- Concepts and Applications*, Wiley.
7. Hewitt,W.(2004). *Microbiological Assays for Pharmaceutical Analysis-A rational approach*, Indian Edition, CRC.

M.Sc. MICROBIOLOGY PRACTICALS

SEMESTER 3

1. Screening of Citric acid / lactic acid producing microorganisms.
2. Screening of alkaline protease / alpha amylase producing microorganisms.
3. Microbial production of protease at lab scale
4. Partial purification of enzyme by ammonium sulphate precipitation.
5. Monitoring of dissolved oxygen during aerobic fermentation.
6. Determination of *KLa* of laboratory fermenter.
7. Sterility testing of pharmaceutical product.
8. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
9. Cell disruption by sonication and estimation of endoenzymes (Dehydrogenase).
10. Production of wine from grapes**:**
    a) Determination of pH, TSS (0Brix), titrable acidity of wine.
    b) Determination of alcohol (ethanol) percentage of wine by Ebulliometry.
    c) Tartarate and bitartrate stability test / Cold stability test of wine.
    d) Determination of Acetaldehyde content, phenol content of wine by titrametric method.
    e) Estimation of reducing & total sugar by copper reduction technique.
11. Microbial production of dextran by *Leuconostoc mesenteroides*

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MB 401: RESEARCH METHODOLOGY, BIOSTATISTICS AND IPR

Objectives: The overall aim of the course is to deepen knowledge regarding basic concepts of Biostatistics, the research process in occupational therapy from formulating a problem to presenting a proposal for a research project and IPR techniques.
Introduction to Biostatistics will teach the students to organize and summarize data and there by the idea how to reach decisions about a large body of data by examining only a small part of it.
Study of Research Methodology in this section of the course is to deepen knowledge and understanding of how to use a quantitative approach and quantitative research methods in occupational therapy research. Course content includes the research process in quantitative studies, formulating quantitative research questions relating to occupational therapy, statistics, and single case-methodology.
One of the most important issues, which has been raised due to the emergence of modern biotechnology, is the legal characterization and treatment of trade related biotechnological processes and products, is described as Intellectual Property, which definitely helpful for the students related to their research work.
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Unit:1 Research Methodology

1.1 Introduction to Research Methodology **Ref: Dr. Ranjit Kumar**
- 1.1.1 Applications of research
- 1.1.2 Definitions and Characteristics of Research
- 1.1.3 Types of Research

1.2 Formatting a Research Problem
- 1.2.1 Reviewing the literature
- 1.2.2 Formulating a research problem
- 1.2.3 Identifying variables &Constructing Hypothesis

1.3 Conceptualizing a Research Design
- 1.3.1 The Research Design
- 1.3.2 Selecting a study Design & a method for Data Collection
- 1.3.3 Selecting a Sample

1.4 Writing a Research Proposal
- 1.4.1 Collecting, Processing Data
- 1.4.2 Developing a Frame of Analysis
- 1.4.3 Analysis & Displaying Data

1.5 Writing a Research Paper

UNIT 2: Introduction to Biostatistics

2.1 Introduction to Biostatistics **Ref: Arora**
- 2.1.1 Definition of statistics and biostatistics
- 2.1.2 Development of biostatistics
- 2.1.3 Applications and role of biostatistics

2.2 Sources and Presentation of Data **Ref: Gurumani**
- 2.2.1 Types of data and Collection of data
- 2.2.2 Classification and tabulation

2.2.3 Diagram and Graph
2.2.4 Frequency distributions of data .

2.3 Sampling **Ref: Sundar Rao**

2.3.1 Introduction and Definition
2.3.2 Types of population
2.3.3 Sample, sampling variation and Bias
2.3.4 Listing of population and sample size

Unit-3 Tools and Techniques for data-analysis

3.1 Measures of central Tendency: **Ref: Sundar Rao**

3.1.1 Mean, Median and Mode
3.1.2 Position of averages
3.1.3 Selection of the appropriate measure of central Tendency
3.1.4 Geometric mean and Harmonic mean

3.2 Chi-Square Test **Ref: Sundar Rao**

3.2.1 The formula for Chi-Square Test
3.2.1.1 Distribution of Chi-Square Test and degree of freedom
3.2.1.2 Application of Chi-Square Test
3.2..1.3 Misuse of Chi-Square Test

3.2.2 Student t-test **Ref: Gurumani**

3.2.2.1 Introduction
3.2.2.2 Student's t-Distribution
3.2.2.3 Application of t-Distribution

3.2.3 Analysis of Variance (ANOVA) **Ref: Gurumani**

3.2.3.1 Principle of Anova
3.2.3.2 Partitioning of Anova
3.2.3.3 Comparison of pairs of Means
3.2.3.4 Assumption Underlying Anova
3.2.3.5 Application of Anova

Unit:4 Intellectual Property Rights and Protection (IPR and IPP) Ref:B.D.Singh

4.1 IPR: Patents, copyright, trade secrets, trademarks, Plant variety protection **Ref:R.C.Bubey**
4.2 The world Intellectual Property Organisation (WIPO) **Ref:R.C.Bubey**
4.3 International Harmonization of Patent laws **Ref:B.D.Singh**
4.3.1 Trips
4.3.2 India and Trips
4.4 Patenting of Genes and DNA sequences **Ref:B.D.Singh**
4.5 Gene Patenting and genetic resources **Ref:B.D.Singh**
4.4 Patenting of Life forms **Ref:B.D.Singh**
4.5 Plant Breeder's Rights (PBR) **Ref:B.D.Singh**
4.6 Choice of IPR protection
4.7 Management, Benefits and Problems of IPR
4.8 International Convention on Biological Diversity (ICBD)
4.9 Indian response to the IPR upheaval

Referances:

1. Arora, P. N. (2007). *Biostatistics*. Himalaya Publishing House.
2. Sundar Rao, P. S. S. (2006). *Introduction to Biostatistics and Research Methods*. 4th Edition. Prentice-Hall of India Private Limited, New Delhi.
3. Gurumani, N. (2005). *An Introduction to Biostastistics*. 2nd Edition. MJP Publishers, Chennai.
4. Kumar, R. (2005). *A Step-by-step Guide for Beginners*. Sage Publications.
5. Singh, B. D. (2011). *Biotechnology Expanding Horizons*,2nd revised Edition, Kalyani Publishers.
6. Dubey, R.C.(2012).A text book of Biotechnology, 4th edition, S.Chand & company

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MB 402: BIOINFORMATICS AND "OMICS"

OBJECTIVES: This paper describe a rapidly growing branches of highthroughput, large scale biology & maturing scientific discipline like Genomics, Proteomics, Transcriptomics and Metabolomics. This paper includes genome analysis, proteome analysis, and structural, functional & interactional proteomics. It also includes emerging trend of Metagenomics in the field of genomics.

UNIT 1: GENOME AND GENOMICS **Ref: Primrose**

1.1 Introduction to Genomics: Structural, Functional and Comparative
1.2 Genome Mapping: RFLPs, SNPs, AFLPs
1.3 Next generation sequencing method.
1.4 Genome assembling **Ref: Xiong**
1.5 Gene prediction: Introduction and Computational methods of Gene prediction
1.4 Genome Annotation **Ref:Xiong**
1.5 Comparative Genomics of Prokaryotes, Eukaryotes and Organelles

UNIT 2: PROTEOMICS AND OTHER "OMICS" **Ref:R.M.Twyman**

2.1 Interaction Proteomics: Methods of Protein-Protein Interaction
2.2 Expression proteomics
2.2.1 Basic techniques and approaches (2-DDifference gel electrophoresis)
2.2 Functional Proteomics:
3.2.1 Protein Microarray and its Application,
3.2.2 Types and Manufacture of protein chip
2.3 Application of Proteomics: In the field of Medical, Pharmaceutical and Plant Biotechnology
2.4 Transcriptomics:
RNA level Gene Expression: DNA Micro array Technology and its Application, Printing Technologies **Ref: Primrose**
2.5 Metabolomics: Introduction and different levels of metabolomics, Sample selection and Sample handling in metabolomics. **Ref: Primrose**
2.6 Metagenomics: **Ref: The Science of Metagenomics**
2.6.1 Metagenomics offer a way forward and Contribution in various fields.
2.6.2 Designing a Metagenomics Project: Sequence based and Function based analysis.

UNIT: 3 DATABASES: IN SILICO RESOURCE FOR THE INFORMATION. Ref: Ghosh

3.1 Biological Database and database design.
3.2 Nucleotide sequence database: EMBL, gene bank, DDBJ
3.3 Protein Database:
Protein sequence database:PIR, Swiss-Prot
Structure database: PDB, MMDB
Classification database: CATH, SCOPE
3.4 Sequence-based Database Searches: BLAST, PSI-BLAST, RPS-BLAST & FASTA

3.5 Metabolic pathway Database: KEGG

UNIT: 4 APPLIED BIOINFORMATICS **Ref: Ghosh**

4.1 **Sequence Analysis:**

Pairwise sequence Alignment: Dynamic programming Algorithm **Ref: Mount**

Multiple sequence alignments (MSA): **Ref: Mount**

4.1.1 Global Multiple sequence alignments and introduction to CLUSTALW and PileUp

Local Multiple sequence alignments and introduction to BLOCKS, eMOTIF, MEME, GIBBS, HMM

4.2 Phylogeny: Statistical methods to obtained phylogenetic tree, Software for phylogenetic analysis

4.3 Secondary structure prediction: Computation methods for secondary structure prediction: Chou Fasman, GOR and Softwares for Secondary structure prediction

4.4 Protein Modeling: methods of Protein Modeling, Homology Modeling; fold recognition and threading approaches, and Ab-initio structure prediction methods.

4.5 Molecular Interaction and Docking, Simulation Techniques,Softwares for Structure based drug design and molecular docking, Autodock and Drug Bank

REFERANCES:

a. Twyman R. (2008). Principles of Proteomics. Taylor & Francis Publisher, Oxon.
b. Primrose S. and Twyman R. (2006). Principles of Gene Manipulation & Genomics, 7th edition. Black well Publishing, Malden.
c. Humphery I. and Smith. (2006). Microbial Proteomics: Functional Biology of whole organism.WILEY-LISS Publisher, New Jersey.
d. Innis M., Gelfand D. and Sninsky J. (1999). PCR Applications: Protocols for functional genomics. Academic Press. California.
e. Board on Life Sciences. (2007). The Science of Metagenomics. Division of Earth and Life sciences, The Natonal Academies Press, washington DC.
f. The Human Genome Project and Beyond, (n.d.). Retrieved on January 27, 2010 from *www.ornl.gov/hgmis/publicat/primer/*
g. The International HapMap Consortium (2007). A second generation human haplotype map of over 3.1 million SNPs. *Nature, 449,* 851-862.

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M.SC. MICROBIOLOGY PRACTICALS

SEMESTER 4

1 Sequence retrival systems for Nucleic acid and Proteins
2 To Study the Structural databases revise pdb, ndb, ccsd
3 BLAST and FASTA analysis
4 Finding an ORF.
5 EMBOSS application in Genomics.
6 EMBOSS application in Proteomics.
7 Multiple sequences alignment analysis by CLUSTAL W, COBALT
8 Computer assisted oligonucleotide primer designing. (Primer3, Primer3^{+})
9 Rasmol and Jmol application
10 Protein Secondary structure prediction
11 Homology modeling: SwissModel and Modeller
12 To browse Genomic databases using MapViewer & Ensembl, viewing genetic, linkage maps for human and other model organisms.
13 To Browse Genomic Resources for Microbial and Viral genomes
14 To Browse Gene Prediction Algorithms for Prokaryotes.
15 To evaluate structure of proteins:Procheck, Ramachandran plot, ProsaII plot
16 To Browse and Search Derived Databases of Structures: DSSP, FSSP, CATH & SCOP
17 Write a Perl program to open NCBI database file by File handle.

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