

SYLLABUS UNDER AUTONOMY

TYBSc MICROBIOLOGY (2013-14)

INDUSTRIAL BIOTECHNOLOGY AND GENETICS

S.MIC. 5.01

OVERALL LEARNING OBJECTIVES

- Understand the basic concepts of downstream processing in fermentation technology
 - Study various microbial biotechnological processes
 - Understand basic concepts of mutations and DNA repair
 - Understand the regulatory mechanisms of gene expression in prokaryotes, eukaryotes and bacteriophages
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UNIT – 1 DOWNSTREAM PROCESSING OF FERMENTATION PRODUCTS 15 LECTURES

LEARNING OBJECTIVES

- Understand the principles involved in downstream processing
 - Understand the steps of fermentation product recovery
 - Understand the principles underlying detection of the recovered products
 - Apply learnt concepts to study different fermentation processes
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1. Overview of fermentation process **1L**
2. General overview & Principles of - Criteria for choice of recovery process **1L**
3. Biomass separation from fermentation media (Biomass as a fermentation product – Bakers yeast) **1L**
4. Cell Disruption for intracellular products (Growth factors or dietary supplements as a fermentation product - Vitamin B₁₂) **1L**
5. Whole broth processing **1L**
6. Solvent extraction (Penicillin fermentation) **1L**
7. Detection & Assay methods of the fermentation products **1L**
8. Microbiological assay of penicillin & vitamin B₁₂ **3L**
9. Fermentation Process (Flow charts) **5L**
 - Penicillin fermentation
 - Vitamin B₁₂
 - Amylase production
 - Beer making
 - Acetone Butanol Fermentation

UNIT – 2 MICROBIAL BIOTECHNOLOGY
LEARNING OBJECTIVES

15 LECTURES

- Understand significance of biosensors and nanotechnology
 - Understand applied biotechnological processes
 - Introduce concepts of Intellectual property rights & Good manufacturing practices
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1. Introduction to biosensors, biochips & nanotechnology **2L**
 - Definitions, Examples, Applications
2. Biofuel production from biomass **3L**
 - Bioethanol, Biogas, Biohydrogen
3. Microbial enhanced oil recovery (MEOR) process **1L**
4. Microbial ore leaching **2L**
5. Biopesticides & Biofertilizers **3L**
6. Social & ethical issues of biotechnology **1L**
7. Biowarfare (self study) **1L**
8. Intellectual property rights - patents, trade secrets, copyrights and trademarks, GMP, Quality Assurance, Biosafety **2L**

UNIT 3: MUTATIONS & DNA REPAIR IN PROKARYOTES

15 LECTURES

LEARNING OBJECTIVES

- Understand the basic concept of forward & reverse mutations
 - Understand the consequences of mutations
 - Understand the various DNA repair mechanisms
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MUTATIONS IN PROKARYOTES

10 LECTURES

1. Forward Mutations:

- **Types of mutations:** macrolesions, microlesions
- a. Genotypic consequences of point mutations
 - i. Base pair substitutions – transitions & transversions
 - ii. Insertions & deletions
 - b. Phenotypic consequences of point mutations
 - i. missense mutations, nonsense mutations, silent mutations, neutral mutations
 - ii. frameshift mutations
 - iii. pleiotropic mutations, cryptic mutations
- Definitions - alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, prototrophs & auxotrophs

- **Causes of Mutations:**

- i. Natural/spontaneous mutation - replication error, depurination, deamination, oxidative damage, hotspots, Fluctuation test
- ii. Induced mutation: principle and mechanism with illustrative diagrams for
 - a. Chemical mutagens- base analogues, base modifying agents like nitrous acid, hydroxyl amine, alkylating agents and intercalating agents
 - b. Physical mutagen – ultra violet radiations, X- rays
 - c. Biological mutagen – plasmids & transposons

2. Reverse Mutations:

Suppressor mutation types – intragenic & extragenic, conditional remedial mutations
Ames test

3. Detection of mutants:

- i. Selection based on relative growth – direct selection
- ii. Selection based on relative survival - indirect selection – penicillin enrichment, phenotypic lag, sib selection
- iii. Selection based on visual detection

4. Mutations in bacteriophages

- i. Complementation test – intergenic & intragenic
- ii. Phenotypic mixing of phages

DNA REPAIR IN PROKARYOTES

5 LECTURES

1. Light repair – direct reversal of DNA damage - Photoreactivation

2. Dark repair

- a. Excision repair
 - Mismatch repair
 - Base excision repair
 - Nucleotide excision repair
- b. Tolerance to DNA damage
 - Recombination repair – Post dimer synthesis
 - Error Prone / SOS repair – Trans dimer synthesis
- c. Repair of alkylated DNA – direct reversal

UNIT 4: REGULATION OF GENE EXPRESSION 15 LECTURES

LEARNING OBJECTIVES

- Understand the basic concept of regulation
 - Understand the significance of regulation in prokaryotes, eukaryotes and bacteriophages
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Regulation of gene expression in prokaryotes, eukaryotes and bacteriophages

15 LECTURES

1. Prokaryotes

i. Operon model – criteria for negative /positive types & inducible / repressible types

ii. Examples

- Lac operon regulation, types of lac mutants, isolation of lac mutants, Positive control: Catabolite repression of lac operon
- Trp operon regulation - repressor control & attenuator control

2. Phages

Regulation of lytic & lysogenic life cycle in bacteriophage λ

3. Eukaryotes

- Cell signaling-an introduction to signaling molecules and their receptors, functions of cell surface receptors, pathways of intracellular signal transduction, signaling networks
- Cell cycle-regulators of eukaryotic cell cycle progression
- Cell Death-programmed cell death- events of apoptosis, caspases, central regulators of apoptosis
- Molecular mechanisms of activation of proto-oncogenes

CIA: Quiz and Assignment

References: -

1. Industrial Microbiology 2009 Reprint, Casida L. E., New Age International (P) Ltd, Publishers, New Delhi
2. Principles of Fermentation Technology Stanbury P. F., Whitaker A. & HaII--S. J., 1997, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Industrial Microbiology, A. H. Patel, Macmillan Publishers India Limited
4. A Textbook of Biotechnology, R.C. Dubey, 2010, S. Chand and Co Ltd.
5. Advances in Biotechnology, S. N. Jogdand, 2007, 2nd edition
6. Genetics – a molecular approach, Peter Russell, 3rd edition, Pearson Publications
7. Molecular Biology of the gene, JD Watson, Baker, Bell, 4th / 5th edition, Pearson Education Publications
8. Concepts of Genetics 7th edition, Klug & Cummings, Pearson Education Publications
9. Genes IX, Lewin, Oxford Publications
10. Lehninger's Principles of Biochemistry, D. Nelson & M. Cox, 5th edition, Macmillan Worth Publications
11. Brock Biology of microorganisms, M. Madigan, J. Martinko, J. Parkar, (2009), 12th ed., Pearson Education International
12. The Cell: A Molecular Approach, Geoffrey Cooper, Robert Hausman, 5th edition, ASM Press

MEDICAL MICROBIOLOGY AND IMMUNOLOGY: I
60 LECTURES

COURSE: S.MIC.5.02

OVERALL LEARNING OBJECTIVES

- Understand the principles underlying the field of chemotherapy
 - Get an overview of clinical microbiology
 - Study significant microbial pathogens with respect to the respiratory tract and the infections caused by them
 - To understand basic principles of Immunology
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UNIT 1: CLINICAL MICROBIOLOGY (DIAGNOSTICS) AND RESPIRATORY TRACT INFECTIONS
15 LECTURES

LEARNING OBJECTIVES:

- Get an overview of the diagnostic methods used in a Clinical Microbiology lab and understand the principles underlying them
 - Understand with respect to the respiratory tract :
 - The anatomy and function of the system and its defenses against microorganisms
 - The clinical syndromes that characterize the tract related infections
 - The modes of transmission, pathogenesis, diagnosis, prophylaxis and treatment with respect to some significant microbial pathogens that infect the system
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Note: All infections labeled **ii.** to be covered with respect to all details - emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, Treatment.

All infections labeled **iii.** to be covered with respect to General Aspects

1. Introduction to Medical Microbiology 1L

2. Clinical Microbiology (Diagnostics) 2L

- Specimens : Collection, Handling, Transport
- Identification of Microorganisms from Specimens:
- Microscopy
- Growth and Biochemical Characteristics
- Rapid Methods of Identification
- Immunologic Techniques
- Bacteriophage Typing
- Molecular Methods and Analysis of Metabolic Products

- Computers in Clinical Microbiology
- Concepts of Quality Assurance in Diagnostics

3. Respiratory tract Infections 12L

- Upper respiratory tract:
 - i The anatomy and function of the upper respiratory tract and host defenses
 - ii Streptococcal Pharyngitis, Diphtheria
 - iii Common Cold , Oral Candidiasis , Measles- Rubeola, Rubella, Mumps , Chicken pox, Shingles
- Lower Respiratory tract:
 - i The anatomy and function of the lower respiratory tract and host defenses
 - ii. Tuberculosis , Influenza , H1N1, Avian Influenza
 - iii Bacterial pneumonia , Whooping cough , SARS

UNIT 2: ANTIMICROBIAL CHEMOTHERAPY

15 LECTURES

LEARNING OBJECTIVES

- Understand the characteristics of an ideal chemotherapeutic agent
 - Get an overview of the principal groups of antibacterial agents, their modes of action and examples
 - Get familiar with the range of antimicrobial agents
 - Understand drug resistance
 - Know the methods of testing presently being used
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1. Basics of Chemotherapy 3L

- History and Development of Chemotherapy
- General Properties of antimicrobial agents
- Attributes of an ideal antimicrobial agent

2. Drug Resistance: Origin, Mechanisms and Transmission 3L

3. Selection & Testing 2L

4. Principal Groups of Antibacterial Agents and Mechanism of Action 4L

- Cell Wall Inhibitors
- Inhibitors of Protein Synthesis
- Inhibitors of Nucleic Acid Synthesis
- Cell Membrane Disruptors
- Antimetabolites

5. Anti-mycobacterial, Antifungal, Antiviral, Antiprotozoal drugs 1L

- Tabulation of Examples

6. Principles of Ayurveda & other forms of alternative medicine 1L

7. Concepts of Drug Design, Clinical Research & Pharmacogenomics 1L

UNIT 3: FUNDAMENTALS OF IMMUNOLOGY

15 LECTURES

LEARNING OBJECTIVES

- Understand processes involved in immune cell development
 - Understand structure and function of MHC molecules
 - Understand Complement activation pathways, their significance and regulation
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1. Overview of the immune system 1L

2. Cells of the immune system- T-cells, B-cells, NK-cells 6L

- Development and Maturation of T cells- Receptors, structure and organization, positive and negative selection
- Development and Maturation of B cells -Receptors----structure & organization

3. Major Histocompatibility Complex 4L

- Organization of MHC genes
- Structure of class I and class II molecules
- Polymorphism and Polygenism
- T cell antigen receptors and MHC molecules.
- Tests for MHC specificity.

4. Complement system 4L

- Complement components and notations
- Complement activation (classical pathway, Alternate pathway, Lectin pathway)
- Biological consequences of complement activation.
- Regulation of complement pathways.

UNIT 4: ADAPTIVE IMMUNE RESPONSE

15 LECTURES

LEARNING OBJECTIVES

- Understand the significance of antigen presenting cells

- Understand cellular interactions and activation of immune cells in response to foreign antigen
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1. Antigen Presenting Cells 1L

2. Antigen presentation and processing pathways 2L

- Cytosolic pathway
- Endocytic pathway

3. Cytokines 2L

- Properties and Functions
- Cytokines secreted by Th1 and Th2 cells

4. T cell activation and differentiation 2L

- Generation of effector and memory cells.
- Cell death and T cell population.
- Functions of peripheral $\alpha\beta$ and $\gamma\delta$ cells

5. B cell activation & differentiation 2L

- Thymus dependent and independent antigens.
- B cell activating signals
- Role of T_H cells in humoral response, formation of T&B conjugates
- CD40/CD40L interaction, T_H cell cytokine signals.

6. Humoral response 3L

- Induction of Humoral response, Primary and secondary responses,
- Germinal centers and antigen induced B cell differentiation
- Affinity maturation and somatic hyper mutation, class switching
- Generation of plasma cells and memory cells, synthesis, assembly and secretion of immunoglobulins.
- Evaluation of humoral response.

7. Cell mediated effector response 3L

- Generation and target destruction by Cytotoxic T cells.
- Killing mechanism of NK cells.
- Antibody dependent cell cytotoxicity (ADCC)
- Experimental assessment of CM cytotoxicity.

CIA: Quiz

References:-

1. Textbook of Microbiology, Ananthanarayan and Paniker, (2009), 8th Edition. Universal Press
2. Medical Microbiology, Cedric Mims et al, 3rd Edition Mosby
3. Microbiology, Prescott, Harley, Klein, 6th Edition McGraw Hill
4. Diagnostic Microbiology, Koneman, 5th and 6th Edition. Lippincott
5. Understanding Viruses, Teri Shors Jones, Bartlett Publishers
6. Introduction to Microbiology, Ingraham and Ingraham, 2nd Edition, Thomas Learning Inc
7. Immunology, Richard A. Goldsby, Janis Kuby, 6th Edition. W. H. Freeman and Company.
8. The elements of Immunology, Fahim Halim Khan, Pearson Education.
9. Immunology, An Introduction Ian R. Tizard, 4th - Edition, Saunders College Publishing
10. Immunobiology, Janeway, C, 6th edition, Garland Science Publishers

SEMESTER 5

COURSE: S.MIC.5.PR

INDUSTRIAL MICROBIOLOGY AND GENETICS

1. UV survival curve and repair– determination of exposure time leading to 90% reduction
2. Isolation of mutants using UV mutagenesis-Viable Count
3. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant
4. Study of Diauxy
5. Paper chromatography, TLC & Column Chromatography
6. Bioassay of Penicillin & Vitamin B₁₂
7. Study of biofertilizers

CIA: Projects based on Industrial Microbiology

MEDICAL AND IMMUNOLOGY PART I

1. Kirby-Bauer method (antibacterial & antifungal activity) and Stokes method for AST
2. Study of antimicrobial effects of natural products
3. Synergistic activity of antibiotics.
4. Detection of β -lactamase producer by Acidometric/Iodometric method
5. Schematic /diagrammatic representation of Respiratory tract
6. Diagnostic Cycle of any one infection of the above system (viz., in upper respiratory tract: Pharyngitis)
7. Case study and problem solving for identification of the pathogen and antibiotic sensitivity with reference to each of the infections
8. Quality control tests of media, reagents, strains and equipment used in the syllabus.

CIA: Technique – Medical