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UNIVERSITY OF MUMBAI

No.UG 112 of 2004

CIRCULAR :-

A reference is invited to the scheme of papers of the B.Sc. degree course under the revised pattern vide pamphlet No.141 and to this office Circular No.UG/167 of 2003, dated 3rd May, 2003 and the Principals of the affiliated college in Faculty of Science are hereby informed that recommendation made by the Board of Studies in Microbiology at its meeting held on 9th July, 2003 has been approved by the Academic Council at its meeting held on 3rd January, 2004 vide item No.4.12 and that in accordance therewith the syllabus for papers, I, II and III in the subject of Microbiology at the S.Y.B.Sc. examination has been revised as per Appendix and that the same will be brought into force with effect from the academic year 2004-2005.

MUMBAI-400 032

19th March, 2004

for REGISTRAR

To,

The Principals of the Affiliated Colleges in Science

AC.4.12/03.01.2004

No.UG/112-A 2004

MUMBAI-400 032,

18th March 2004

Copy forwarded with compliments for information to :-

1. The Dean Faculty of Science
2. The Chairman, Board of Studies in Microbiology

for REGISTRAR

Copy to :-

The Director, Board of College and University Development, the Controller of Examination, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information.

The Controller of Examinations (10 copies), Finance and Accounts Officer (2 copies), Record Section (5 copies), Publication Section (5 copies), Deputy Registrar, Enrolment, Eligibility and Migration (3 copies), Deputy Registrar, Statistical Unit (2 copies), Deputy Registrar, Accounts Section, Vidyanagari (2 copies), Deputy Registrar, Affiliation Section, (2 copies), The Director, University Computer Center (IDE Building), Vidyanagari, Assistant Registrar, Academic Authorities Unit (2 copies) He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that no separate Action Taken Report will be sent in this connection. . Assistant Registrar, Constituent Colleges Unit (2 copies), BUCTU (1 copy), Deputy Accountant, Unit V (1 copy), In-charge Centralized Computing Facility (1 copy), Receptionist (1 copy), Telephone Operator (1 copy), Secretary MUASA (1 copy), Superintendent, Post-Graduate Section (2 copies).

UNIVERSITY OF MUMBAI



Syllabus for S.Y.B.Sc Microbiology

(with effect from the academic year 2004-2005)

Papers offered at S.Y.B.Sc level.

	<u>Marks.</u>	
	<u>Theory</u>	<u>Practical</u>
Paper-I General Microbiology	60	40
Paper-II Microbial Physiology & Molecular Biology	60	40
Paper-III Microbial Technology	60	40

Paper	Term-I		Term-II	
	Unit	Topics	Unit	Topics
I	I	Biomolecules-20	I	Taxonomy-10
	II	Microbial Growth.-10	II	Ecology-10,Aquatic
	III	Soil Microbiology-14 Air Microbiology-6.	III	Microbiology-10 Microbiology of Waste Water-10
II	I	Microbial Virulence factors-6 Clinical Infections-4 and Epidemiology-10.	I	Innate Immunity-10
	II	Clinical Diagnosis-10 Enzymology Topics-a and b-5	II	Enzymology- Topics c to f-15
	III	Bioenergetics-15	III	Introduction to Metabolism.-15
III	I	Antigens-8 Biotechnology-10	I	Immunoglobulins-12
	II	Macromolecules and genetic Informations-12	II	Mendelian Genetics-8
	III	Industrial Microbiology-20	III	DNA techniques and applications-10 Food Microbiology-10

UNIT-I Bio-molecules and taxonomy.

1. Estimation of biomolecules

(20)

- A. Macromolecular composition of a microbial cell (*E. coli*)
- B. Methods for elemental analysis
 - Carbon by Van Slyke's method
 - Nitrogen by MicroKjeldahl method
 - Phosphorus by Fiske-Subbarow's method
- C. Methods for molecular analysis
 - Carbohydrates
 - Estimation of carbohydrates by Phenol and anthrone method
 - Estimation of reducing sugars by DNSA method
 - Detection of sugars by aniline diphenylamine reagent
 - Proteins and amino acids
 - Estimation of proteins by Biuret and UV absorption
 - Estimation of amino acids by Ninhydrin method
 - Lipids
 - Soxhlet method
 - Nucleic acids
 - Extraction of nucleic acid by modified Schneider's process
 - Estimation of nucleic acid - DNA by DPA method and RNA by Orcinol method
 - Principle techniques used in above estimations (only the principle, working, applications, merits and demerits)
- D. Colorimetry
- E. Chromatography - General principles
 - Low pressure column chromatography
 - Paper chromatography
 - TLC, GLC, HPLC
 - Absorption chromatography
 - Ion exchange chromatography
 - Gel filtration
 - Affinity chromatography

2) Taxonomy

(10)

Introduction

Purpose of classification systems, detailing some of the fundamental concepts in classification of living systems

Classification, nomenclature and identification as distinct but interrelated activities, their scope

Role of reference culture collections in taxonomy, type strains

Presence of multiple classification systems

Overview of classification of prokaryote organism - 19 parts

New approaches to bacterial taxonomy

Identification of bacteria

Nature of identification scheme

Approach to identification of an isolate, use of Bergey's Manual of Determinative/Systematic Bacteriology or Prokaryotes for this purpose

Illustrative example of identification of a new isolate

UNIT-II MICROBIAL ECOLOGY-I.

1) Microbial growth

(10)

A. Calculation of generation time

B. Continuous culture and maintenance energy; uses of continuous culture

C. Synchronous culture

D. Arithmetic growth

E. Catabolite repression; Diauxy phenomenon (Lactose)

F. Efficiency of growth and growth yield; molar growth yield

G. Microbial life in extreme environments

H. Survival curve

2) Ecology:

(10)

A. Microorganisms in nature, Methods of study in Microbial

B. Ecology, Identification and quantification, Microbial activity measurements

3) Aquatic Microbiology.

(10)

A. Aquatic Microbiology: Distribution of microorganisms in fresh and marine water, estuaries, Methods to study aquatic microorganisms : sampling, qualitative quantitative study

(4)

B. Microbiology of potable water: Definition of potable water, standards for potability, Municipal water purification process, Microorganisms as bioindicators of fecal pollution, routine analysis of water

(6)

UNIT-III MICROBIAL ECOLOGY-II.

1. Microbiology of waste water:

10

Types of waste water, Characteristics of waste water,
Analysis of waste water (Physical, Chemical, biological),
Effect of waste water on environment,
Monitoring bodies (small and large scale),
Treatment of small and large scale waste water and disposal of treated water.

2. Soil Microbiology:

14.

Soil as habitat for different types of organisms in soil,
Qualitative and quantitative methods to study soil fertility,
Decomposition of organic matter (including pesticides and hydrocarbons),
Methanogenesis, Nitrogen fixation, Nitrification, Denitrification, Hydrogen sulphide
and sulphate reduction, Elemental sulphur and sulphate oxidation, Iron oxidation and
reduction, Interactions between microorganisms and metals.

3. Air Microbiology:

6

Distribution of microorganisms on air- launching, transport and deposition of
aerosols, survival of microorganisms in air,
Significance of microorganisms in air (extramural and intramural), Methods to study
airborne microorganisms – List of airborne diseases.
Sampling, qualitative and quantitative methods,
Bio-aerosol control (ventilation, filtration, biocidal control - UV, gaseous,
Quarantine).

PRACTICAL FOR PAPER-I

- 1) Production of Biomass for chemical analysis (bacterial/fungal /yeast as applicable)
- 2) Determination of dry and wet weight of microb~s (yeast/fungi)
- 3) Determination of Nitrogen content by MicroKjeldahlmethod (Demonstration)
- 4) Verification of Beer-Lambert' s Law (5% CUS04)
- 5) Preparation of cell fractions for macromolecular analysis
- 6) Estimation of Proteins by Biuret method
- 7) Estimation of DNA (DPA method)
- 8) Estimation of RNA (Orcinol method)
- 9) Estimation of reducing sugar (DNSA method)
- 10) Estimation of amino acid (Ninhydrin method)
- 11) Paper chromatography of amino acids

- 12) TLC of sugars
- 13) Column chromatography (spinach)
- 14) Isolation and identification of a bacterial isolate
- 15) Determination of generation time (up to exponential phase)
- 16) Study of Diauxy growth curve
- 17) Study of growth yield! molar growth yield
- 18) Assignment on growth of microorganisms in extreme environments
- 19) Setting up Winogradsky's Column and study of various types of groups
- 20) Study of Eutrophication
- 21) Study of air flora: Qualitative and quantitative, Liquid impingement and Gravity sedimentation methods
- 22) Study of Fresh water flora: Qualitative and quantitative, Isolation of agar digesters, Study of haloduric and halophilic bacteria
- 23) Analysis of potable water: Presumptive, confirmed and completed test, Detection of fecal Stretococci and Clostridium species, determination of coliform count in water by MPN
- 24) Waste water analysis: Physical (total solids), Chemical (COD), Biological (BOD), Quantitative study of raw and treated sewage (Nutrient agar and MacConkey's agar)
- 25) Soil Microbiology: isolation of organisms from soil (bacteria, fungi and actinomycetes), Enrichment/isolation of-Cellulose degraders, Starch hydrolyzers, Ureolytic, Saccharolytic organisms, Nitrosifiers , Nitrifiers and Sulphate reducers

REFERENCES.

- 1) Principles of Biochemistry, Lehninger, Nelson and Cox, 2nd Ed.
- 2) Biochemistry, Conn and Stumpf, 5th Ed.
- 3) Practical Biochemistry, Keith Wilson and John Walker, 4th Ed.
- 4) Bacterial Metabolism, Gottschalk. G. 2nd Ed.
- 5) Methods in Microbiology, I. R. Norris and D. W. Ribbons- Vol 5-B
- 6) An Introduction to Biochemistry, David Plummer, 3rd Ed.
- 7) Lab manual in Biochemistry, J. Jayaraman, 3rd Ed.
- 8) Fundamentals in Microbiology, Frobisher, 9th Ed.
- 9) General Microbiology, Stanier et al., 5th Ed.
- 10) Brock - Biology of Microorganisms, Parker, Madigan, 9th Ed.
- 11) Bergey's Manual of Systematic Bacteriology, 9th Ed.
- 12) Microbiology, Prescott and Harley, 5th Ed.
- 13) Chemical Microbiology, A. H. Rose, 3rd Ed.

- 14) Advances in Biotechnology, S. N. Jogdand
- 15) Textbook of Biotechnology, R. C. Dubey
- 16) Fundamentals of Ecology, Odum
- 17) Microbial Ecology-Fundamentals and Application, Atlas and Bartha
- 18) Fundamentals of Microbiology, A. 1. Salle
- 19) Microbiology-Dynamics and Diversity, Perry and Staley
- 20) Soil Microbiology, Subba Rao
- 21) Soil Microbiology, Alexander and Martin, 1999

PAPER II-MICROBIAL PHYSIOLOGY AND MOLECULAR BIOLOGY. (90)

UNIT-I HOST PARASITE RELATIONSHIP. 30.

1. Host-Parasite Interaction (30)

A. MICROBIAL VIRULENCE FACTORS (06)

4. Enzymes : Hyaluronidase, Collagenase, Streptokinase & Coagulase
5. Exotoxins: Cytolytic toxins, Diphtheria, Tetanus & Botulinum toxins
6. Enterotoxins :Cholera, other enterotoxins
7. Endotoxins :Structure and function, Limulus Assay for Endotoxin
8. Eggs of Virulent organisms: Salmonella Species & its virulence factors
9. Measuring Virulence,LD50

B. CLINICAL INFECTIONS IN THE HOST (04)

10. Establishment, Spread & Pathologic Effects
11. Patterns of Infection
12. Signs & Symptoms- Warning Signals of Disease
13. Portal of Exit, Persistence of Microbe & Pathologic conditions

C. EPIDEMIOLOGY OF INFECTIOUS DISEASES (10)

14. Epidemiological Terminology
15. Measuring Frequency: The Epidemiologist's Tools
16. Infectious Disease Epidemiology
17. Recognition of an Infectious Disease in a population/ of an Epidemic
18. The Infectious Disease Cycle: Story of a Disease
19. Virulence and the mode of Transmission
20. Emerging & Reemerging Infectious Diseases and Pathogens
21. Control of Epidemics
22. The Emerging Threat of Bioterrorism
23. Global Travel and Health Considerations
24. Nosocomial Infections

D. Innate Immunity/Nonspecific host resistance (10)

- i. Overview of host resistance.
- ii. Nonspecific Host Resistance
 - a. Natural Host Resistance- Age,Stress,Diet etc
 - b. Physical and Mechanical Barrier (Skin, Mucous Membranes)
 - c. Respiratory System,Gastrointestinal Tract, Genitourinary Tract, Eye)
 - d. Chemical Barriers (Basic Proteins, Bacteriocins, Beta-Lysin and other Polypeptides)
- iii. Cells, Tissues and Organs of the Immune System

- a. Cells of the Immune System(Lymphoid cells, mononuclear cells, Granulocytes, Mast cells, Dendritic cells)
- b. Organs and tissues of the Immune System(Primary and secondary Lymphoid organs/tissues)
- E. Inflammation, Fever, Phagocytosis
- F. Natural Killer Cells
- G. Molecular Defence
- i. .The Complement System
- ii. Cytokines
- H. Integrated host defense
- I. Immuno Compromised host

UNIT-II. ENZYMOLOGY-

30

2. Clinical and Diagnostic Microbiology

(10)

- 25. Isolation of pathogens from clinical specimens
- 26. Specimens- blood, urine, feces, sputum, cerebrospinal fluid or pus, genital (collection, handling and transport) and cultures of anaerobes
- 27. Identification of conventional methods (growth dependent)
- 28. Rapid methods of identification/clinical diagnosis
- 29. Immunologic techniques
- 30. Molecular Methods and Analysis of Metabolic Products
- 31. Susceptibility testing
- 32. Computers in Clinical Microbiology

3. Enzymology

(20)

- (a) Concept checking
- (b) X-ray analysis -Important structural features
 - (a) Michaelis-Menton equation; derivation only
 - (b) Effect of enzyme concentration, substrate concentration, pH, temperature on enzyme activity. Multisubstrate reactions - Ordered, Random, Ping-pong (schematic with example)

©Inhibitors of enzymes:

Irreversible,Reversible - competitive, Non-competitive, Uncompetitive (schematic with examples).

Allosteric inhibition - Properties and mechanism

- (a) Koshland Nemethy and Filmer model
- (b) Monod Wyman and Changux model
- (d) Principles underlying enzyme purification
- (e)Vitamins and coenzymes
- 33. Water soluble vitamins

34. Fat soluble vitamins
 (f) Introduction to metals in enzymes
 Coenzymes of methanogenic bacteria

UNIT-III. MICROBIAL METABOLISM.

(15)

1. Bioenergetics

35. Scope of thermodynamics
 36. Concept of free energy; enthalpy; ΔG , standard free energy change of hydrolysis
 37. First and second law of thermodynamics
 38. Open and closed system (only outline)
 39. Structure, properties and functions of ATP, ATP-ADP cycle, Calculation of standard free energy change of hydrolysis of ATP
 40. Listing of other high energy compounds and their free energy change of hydrolysis
 41. Energy yielding mechanisms : Fermentation, Respiration and photosynthesis

(15)

2. Introduction to Metabolism

42. Concept of precursor, intermediate, end product
 43. Catabolism, anabolism, and link between catabolism-anabolism (outline); concept of amphibolism and anaplerotic reactions
 44. Biochemical Pathways: Linear, Branched and Cyclic
 45. Generation and utilization of reducing power: Role of flavin nucleotide and
 46. nicotinamide nucleotide

PRACTICAL II.

1. Virulence factors Enzymes - Streptokinase, coagulase, haemolysin, lecithinase, phagocytosis
2. Epidemiology
 - a) Case studies from Pelczar and Chan, Talaro, Prescott and Harley
 - b) Pyocin typing
 - c) Isolation of organisms from fomites
 - d) Identification of bacteria
 - a) Use of selective and differential solid media: SIBA, MacConkey's, SS Agar, TCBS, Hoyle's tellurite, SMA, Cetrimide, XLD, CLED
 - b) Use of biochemical media for identification of organisms
 Sugar fermentation, Casein hydrolysis, Catalase, Citrate utilization, Decarboxylase, Esculin hydrolysis, Gelatinase, H₂S production, Lipase, IMViC Nitrate reduction, Oxidase, PPA, TSI, Bile solubility, Bacitracin and Optochin

Sensitivity, etc.

- e) Diagnostic cycle (urinary tract infection)
- f) Rapid identification of pathogen using a kit
- 3. Effect of variables on enzyme activity (invertase from yeast)

- a) Temperature
- b) pH
- c) Substrate concentration
- d) Enzyme concentration

Determination of K_M of invertase (Lineweaver-Burke plot; Michaelis-Menton graph)

- e) Purification of enzyme (invertase from yeast) Ammonium sulfate precipitation and dialysis.

Measurement of enzyme activity before and after purification (DNSA method)

- f) Problems based on bioenergetics

Assignments on:

47. General scheme of catabolic and anabolic pathway

48. Diseases prevalent in India (any one)

Tuberculosis, AIDS, Malaria, Hepatitis, Campylobacter, Legionella infections

References

1. Biology of Microorganisms, Brock, 8th , 9th Ed.
2. Microbiology, Talaro 3rd Ed.
3. Microbiology, Prescott, Harley and Klein, 4th and 5th Ed.
4. Microbiology, Pelczar, 5th Ed
5. Diagnostic Microbiology, Bailey and Scott
6. Principles of Biochemistry, Lehninger, Nelson and Cox, 2nd Ed.
7. Biochemistry, Conn and Stumpf, 5th Ed.
8. Guide to principles and techniques of practical biochemistry, Wilson and Goulding, 3rd Ed.
9. Principles of Microbiology, Atlas
10. Bacterial Metabolism, Gottschalk, G. 2nd Ed
11. Chemical Microbiology, A. H. Rose, 3rd Ed.
12. Principles of Biostatistics, Mahajan

PAPER-III. MICROBIAL TECHNOLOGY.

90

UNIT-I IMMUNOLOGY AND BIOTECHNOLOGY.

1. IMMUNOLOGY

20

A. Antigens

(8)

1. Immunogenicity versus antigenicity
2. Factors that influence immunogenicity
 - a. Contribution of the immunogen to immunogenicity (foreignness, molecular size, chemical composition and heterogeneity, ability to be processed and presented)
 - b. Contribution of the biological system to immuno-genecity (genotype of the Recipient, animal, immunogen dosage, route of administration and adjuvants)
3. Epitopes/ antigenic determinants (not in detail)
4. Haptens and the study of antigenicity
5. immunogenicity of some natural substance (native globular proteins, polysaccharides, lipid, nucleic acids)
6. Types of antigens (heterophile antigens, isophile antigens, sequestered antigens, superantigens, bacterial and viral antigens)

B. Immunoglobulins

(12)

1. Immunoglobulin- basic structure, sequenceing studies and fine structure.
2. Immunoglobulin classes and biological activities
3. Antigenic determinants on immunoglobulins (isotype, allotype, idiotype)
4. The immunoglobulin receptors
5. antigen and antibody reactions

2. BIOTECHNOLOGY

(10)

1.Introduction; BT as an interdisciplinary science, historical developments, products and services based on biotechnology (medicines, energy, food and beverages, chemicals, materials, environments, agriculture)

(2)

2. Energy and Biotechnology: biological fuel generation, photosynthesis- an ultimate source of energy, sources of biomass, ethanol and methane from biomass, H₂ production, petroleum prospecting, enhanced oil recovery, biochips and bioelectrochemical devices, biogas technology.

(3)

3. Materials and Biotechnology: microbial leaching of ores, biobeneficiation, tanning of leather, retting of flax and hemp, coir retting, biodeterioration of materials and its prevention (foods, cellulosic products, animal products, surface coats, rubber and plastic, fuels and lubricants)

(3)

4. Social aspects of biotechnology: legal, social and ethical aspects of biotechnology, patent law, culture collection, problems of biological products based on biotechnology, GMP, quality assurance, biological warfare, Biotechnology-Indian scenario. (2)

UNIT-II MOLECULAR BIOLOGY.

30.

A. MENDELIAN GENETICS

(8)

- 1.Genetic terminology: Gamete, Cross, Zygote, Gene, Locus, Alleles, Genotype, Phenotype
- 2.Mendel's Experimental Design
- 3.Monohybrid Crosses and Mendel's Principle of Segregation
 - i The Principle of Segregation
 - ii Representing Crosses with a Branch Diagram
 - iii Confirming the Principle of Segregation: The Use of Testcrosses
- 4.Dihybrid Crosses and the Mendelian Principle of Independent Assortment
 - i The Principle of Independent Assortment
 - ii Branch Diagram of Dihybrid Crosses
 - iii Trihybrid Crosses

B.MACROMOLECULES AND GENETIC INFORMATION

(12)

- 1.Gene and its Function: The steps in Information Flow
- 2.Prokaryotic and Eukaryotic Genetics (Introduction)
- 3.DNA
 - i . DNA as a Double Helix
 - ii Different forms of DNA structure
 - iii Important Features of DNA Structure
 - iv The Effect of Temperature on DNA Structure
 - v Hybridization of Nucleic Acids
 - vi DNA Structure: Supercoiling, Topoisomerase
4. Genetic Elements
 - i The Chromosome
 - ii Nonchromosomal Genetic Elements
 - iii) Viruses and Plasmids
 - iv) Organelles and Transposable Elements

C. DNA TECHNIQUES AND APPLICATIONS

(10)

1. Extraction and Purification of DNA
2. Detecting the presence of DNA
3. Density gradient centrifugation
4. Gel electrophoresis
5. Labelling of nucleic acids
6. Denaturation of Nucleic acid
7. Nucleic acid hybridization
8. Determining the sequence of DNA

UNIT-III INDUSTRIAL MICROBIOLOGY.

(30)

INDUSTRIAL MICROBIOLOGY

(20)

1. Screening, Primary and secondary
2. Fermentation media
3. Preparation of inoculum
4. Types of Fermentations- aerobic, anaerobic, surface, submerged, batch, continuous, solid state
5. Fermenter design

FOOD MICROBIOLOGY

(10)

1. Scope of food microbiology and role of microbiologist in food industry.
2. General principles of spoilage and contamination of food
3. General principles of preservation of food

A. PRACTICAL III

1. Immunodiffusion
2. Slide agglutination
3. Widal Qualitative, Quantitative
4. Blood grouping
5. Preparation of antigens O and H
6. ELISA- demonstration
7. Solving of problems on Mendelian genetics
8. Mitosis and Meiosis
9. Extraction of DNA from onion
10. Crowded plate technique + Wilkins
11. Antimicrobial spectrum - Bacterial, fungal
12. Optimization of industrial process: effect of incubation temperature, effect of aeration (shaker and static)
13. TDP and TDT
14. Food preservative: sugar and salt

15. Selective isolation of food spoilage organisms
16. Assignments:
 - a. Patent Law
 - b. Biological warfare
 - c. Social, ethical aspects of biotechnology (Reports)
 - d. Energy sources for the future
 - e. Pollution free fuel
17. Biodeterioration of cellulosic material.

REFERENCES

1. Advances in Biotechnology, S. N. Jogdand
2. Textbook of Biotechnology, R. C. Dubey
3. Medical Microbiology, Ananthanarayan, 5th Ed
4. Immunology, Pathak and Palan
5. Industrial Microbiology, Cassida
6. Industrial Microbiology, A. H. Patel
7. Food Microbiology, James Jay
8. Food Microbiology, Frazier
9. Biotechnology, Jogdand
10. Biotechnology, Principles and Applications, Higgins
11. Biotechnology, Keshav Trehan
12. Genetics, Russel
13. Molecular Biology, David, Freifelder, 2nd Ed.
14. General Microbiology, vol. 1, Powar and Daginawala
15. General Microbiology, Stainer, 4th Ed.
16. Biology of Microorganisms, Brock
17. Microbiology, Prescott, Harley and Klein, 5th Ed.
18. Biochemistry, Voet and Voet
19. Practical Biochemistry, Keith Wilson and John Walker, 4th Ed