

Gujarat University, Ahmedabad
Syllabus for TYBSc.
Biochemistry [In force from
June 2008]

PAPER VI METABOLISM

Unit 1 - Carbohydrate
Metabolism

1) Introduction

- A) Basic Concept:
 - a) Catabolism
 - b) Anabolism
 - c) Intermediary Metabolism
 - d) Metabolic pathways
 - e) Regulation of metabolism
 - f) Techniques used to study metabolism
- B) Overall view of cellular metabolism
Carbohydrates, Protein, Fat.

2) Carbohydrate metabolism

- A) Overview
 - a) Concepts
 - b) Design
- B) Enzymatic steps, regulation and Energetic:
 - a) Glucose metabolism
 - 1) Glycolysis
 - 2) Gluconeogenesis
 - 3) Intermediate step (PDH):
(Oxidative decarboxylation, Pyruvate oxidation)
 - 4) Complete oxidation of Glucose
 - b) Miscellaneous pathways
 - 1) Pentose phosphate pathway
 - 2) Cori's cycle
 - c) Glycogen Metabolism
Glycogenesis, Glycogenolysis

Paper VI - METABOLISM

3) Disorders in Carbohydrate metabolism

- (only metabolic aspects)
- A) Glycogen storage disease
 - B) Galactosaemia
 - C) Fructosaemia

Unit 2 Common Metabolic Pathways

4) Enzymatic steps,

regulation, & energetics:

- A) TCA (Citric acid, Kreb's cycle)
 - a) Reaction, Regulation
 - b) Amphibolic nature
 - c) Anaplerotic reactions
- B) Glyoxalate Cycle
- C) Respiratory Chain
(Oxidative phosphorylation)
 - a) Conservation of metabolic energy
by electron transport
(Chemiosmotic model)
 - b) Oxidative phosphorylation
 - c) Energy-rich compounds

5) Metabolic Shuttles:

- 1) Glycerol-phosphate
- 2) Malate-aspartate

6) Role of Hormones: in Metabolism

Insulin, Glucagon,
Epinephrine

7) Integration of Metabolism:

- A) Metabolism as an integrated process (metabolic homeostasis)
- B) Relation among carbohydrate, fat, and Protein metabolism

Unit 3 Lipid Metabolism

8) Overview

- A) Basic Concepts
- B) Design
- C) Breakdown of Lipids
- D) Transport of fatty acids across cell membrane

9) Enzymatic steps, regulation, & energetic:

- A) Fatty acid oxidation
 - a) Saturated fatty acids (α, β, ω)
 - b) Unsaturated and Odd-chain fatty acids
- B) Fatty acid biosynthesis
 - a) The *de novo* synthesis
 - b) Elongation of fatty acids
 - c) Biosynthesis of Unsaturated fatty acids
 - d) Stoichiometry of fatty acid synthesis
- C) Comparison of fatty acid Synthesis and oxidation
- D) Triacylglycerol
 - a) Biosynthesis (Lipogenesis)
 - b) Degradation (Lipolysis)
- E) Ketone bodies
 - a) Formation
 - b) Degradation
- F) Phospholipids,
 - a) Formation
 - b) Degradation
- G) Biosynthesis of Sphingolipids
- H) Role of Liver and adipose tissues in lipid metabolism

10) Disorders of Lipid Metabolism

- (only metabolic aspects);
- A) Gaucher's disease
 - B) Niemann-Pick disease
 - C) Tay-Sachs disease

Unit 4 Protein Metabolism

11) Overview

- A) Basic Concepts
- B) Design

**12) Transport of amino acids
 γ -glutamyl cycle**

13) Enzymatic steps in protein metabolism:

- A) Deamination
- B) Transamination
- C) Decarboxylation

14) End products of protein metabolism: (Excretory products)

- A) Urea cycle:
 - a) Enzymatic steps
 - b) Regulation
 - c) Energetics
 - d) Significance
- B) Uric acid formation
- C) Creatine & Creatinine Metabolism: Biosynthesis

15) Fate of carbon skeleton of amino acids:

- A) Flow chart (general overview not individual amino acids):
Amino acids degradation to:
 - a) Pyruvate
 - b) TCA cycle intermediates
- B) Amino acids
 - a) Glucogenic
 - b) Ketogenic

16) Disorders of protein metabolism

(only metabolic aspects)

- A) Phenylketouria
- B) Albinism
- C) Maple syrup urine disease
- D) Homocysteineuria

17) Glucose-alanine cycle

Unit 5 Nucleic Acid & Porphyrin Metabolism

18) Nucleic acid metabolism

- A) Overview
 - a) Basic concepts
 - b) Design
- B) Enzymatic steps involved in:
 - a) Purine breakdown
 - b) Pyrimidine breakdown
- C) Disorders of nucleic acids metabolism
 - Gout

19) Porphyrin metabolism

- A) Basic concepts
- B) Porphyrin metabolism:
 - Biosynthesis & Degradation

20) Basic Introduction to Photosynthetic pathway

References

- 1) Principles of Biochemistry - Lehninger
- 2) Lehninger's Principles of Biochemistry - Nelson & Cox
- 3) Biochemistry - Bhagwan
- 4) Biochemistry - Stryer 4/e
- 5) Textbook of Biochemistry - West & Todd
- 6) Outlines of Biochemistry - Conn & Stumpf

- 7) Principles of Biochemistry - White, Handler & Smith
- 8) Biological Chemistry - Mahler & Cordes
- 9) Biochemistry - Orten & Neuhans
- 10) Textbook of Biochemistry - Mazur
- 11) Harper's Review of Biochemistry
- 12) Biochemistry - Voet & Voet

Paper VII - NUTRITION

Unit 1 Introduction, Fuels

1) Introduction

- A) Nutritional science
 - a) Historical background
 - b) Relation to other sciences
- B) Current trends in Nutrition
 - a) Nutrition: A global perspective
 - b) Nutrition in India:
 - 1) Advances
 - 2) Concerns
 - 3) Challenges

2) Nutritional & Physiological aspects of Dietary Carbohydrates

- A) Carbohydrates
 - a) Nutritionally important carbohydrates
 - b) Functions of carbohydrates
 - c) Requirement of carbohydrates
 - d) Carbohydrates loading
 - e) Lactose intolerance

- B) Dietary fibre: Role in human nutrition
- C) Dental carries
- D) Ethyl alcohol
- E) Diabetes
 - a) Types
 - b) Causes
 - c) Complications
 - d) Clinical features & biochemical examinations

3) Nutritional & Physiological aspects of Dietary Proteins

- A) Overview
 - a) Animal and vegetable proteins in diet
 - b) Utilization of absorbed proteins
 - c) Essential amino acids
 - d) Functions of proteins
 - e) Protein RDA
- B) Nitrogen balance
 - a) Factors affecting N-balance
 - b) Exo- and Endo-nitrogen
- C) Quality of Protein
 - a) Complete & incomplete proteins
 - b) Limiting amino acids
 - c) Supplementary value of protein
 - d) Indices
 - 1) Biological value(BV)
 - 2) Net protein utilization(NPU)
 - 3) NDpV
 - 4) PER
 - 5) Protein digestibility
 - 6) NDP \geq %

4) Nutritional & Physiological aspects of Dietary Lipids

- A) Overview
 - a) Animal and vegetable lipids in diet
 - b) Fatty acids
 - 1) Essential fatty acids
 - 2) PUFA
 - 3) P/S Ratio
 - c) Fats
 - 1) Saturated, Unsaturated & Trans fats
 - 2) Transport
 - 3) Storage: Role of Adipose tissue
 - 4) Mobilization
 - 5) Ketosis
 - 6) Functions of fat
 - 7) Requirements of fat
 - d) Dietary fat related to Coronary Heart diseases

Unit 2 Energy, Malnutrition

5) Energy metabolism

- A) Foods & energy
 - a) Introduction
 - 1) Energy nutrients
 - 2) Energy value of foods
 - 3) Energy (Fuel) value of foods:
 - a) Gross energy value
 - b) Physiological fuel value
 - 4) Units of Energy
 - B) Determination of energy value of foods
 - a) Direct calorimetry
 - b) Indirect calorimetry (food composition tables)

- C) Determination of energy expenditure:
 - a) Direct & Indirect methods
 - b) Respiratory quotient: Its significance
- D) Total energy requirements
 - a) Factors affecting energy requirements
 - b) Basal metabolic rate (BMR)
 - 1) Definition
 - 2) Measurement
 - 3) Factors influencing it
 - c) Specific dynamic action (SDA) of foods
 - d) Physical activity
 - e) Regulation
 - 1) Energy intake
 - 2) Body weight
 - f) RDA for energy

6) Protein-energy malnutrition

(PEM, PCM):

- Aetiology, Clinical features, Biochemistry
- A) Marasmus
 - B) Kwashiorkor

Unit 3 Water, Electrolytes, Food groups

7) Water & Electrolytes

- A) Sources
- B) Distribution in body
- C) Excretion
- D) Regulation
- E) Deficiency
- F) Water balance

8) Minerals & Trace Elements:

Ca, P, Fe, I, F, Se

- A) Concepts
 - a) Essentiality
 - b) Classification
 - c) General and Physiological functions

- B) Dietary sources
- C) Physiology
 - a) Absorption
 - b) Transport
 - c) Storage
 - d) Excretion
- D) Malnutrition
 - a) Deficiency
 - b) Toxicity

9) Food groups:

Composition & Nutritional significance

- A) Foods of plant origin:
 - a) Cereals
 - 1) Low- & High - extraction flours
 - 2) Processings
 - b) Legumes
 - c) Fruits & Vegetables
- B) Foods of animal origin:
 - a) Milk
 - b) Meat
 - c) Fish
 - d) Egg
- C) RDA & Balanced Diet

Unit 4 Deficiency diseases

10) Primary Deficiency Diseases Aetiological, Clinical & Biochemical aspects:

- A) Rickets
- B) Beriberi
- C) Pellagra
- D) Scurvy
- E) Xerophthalmia
- F) Nutritional anaemia
- G) Starvation
- H) Obesity

Unit 5 Miscellaneous

Food & Safety Aspects

11) Natural food toxins:

- A) Various natural food toxins
- B) Methods of detoxifications

12) Miscellaneous

- A) Food toxins
- B) Food Standards
- C) Food adulteration
- D) Food spoilage
- E) Food preservation
- F) Food allergies
- G) Assessment of nutritional status

13) Nutritional during physiological stress:

- A) Infancy & childhood
- B) Adolescence
- C) Pregnancy
- D) Lactation
- E) Old Age

References

- 1) Principles of Biochemistry - Lehninger:
- 2) Human Nutrition & Dietetics- Davidson, Passmore- 8/e
- 3) Textbook of Food & Nutrition- Swamination - Vols I & II
- 4) Food Science, Nutrition & Health- Fox, Cameron
- 5) Human Nutrition & Dietetics- Garrow, James, Ralph
- 6) Applied Nutrition- Rajalaxmi
- 7) Nutrition & Dietetics- Joshi S
- 8) Introductory Nutrition - Guthrie HA

- 9) Perspectives in Nutrition - Wardlaw, Insel
- 10) Human Nutrition - Vanji, Rao & Reddy
- 11) Food Science - B. Srilaxmi
- 12) Nutritional Science - B. Srilaxmi
- 13) Dietetics - B. Srilaxmi
- 14) Modern Nutrition & Health & diseases Shills, Shikes & Rose

Paper VIII- Enzymology

Unit 1 General aspects

1) Introduction:

- A) History of enzymology
- B) Definition of enzyme
Abzyme, Synzyme & Ribozyme
- C) Enzyme v/s chemical catalyst
Comparison with chemical catalysts

2) Enzyme specificity

- A) Substrate specificity
(Absolute)
- B) Group specificity
- C) Stereo -specificity

3) Protein nature of Enzyme

4) Zymogen

- A) Mechanism of action of enzyme
- B) Mechanism of activation
- C) Example: Chymotrypsin

5) Multienzyme complex:

- A) Properties
- B) Physiological importance
- C) Advantage

- D) Example:
- Pyruvate dehydrogenase
 - α - ketoglutarate dehydrogenase
 - Tryptophan synthase
 - Fatty acid synthetase

6) Isoenzymes

- Identification
- Separation
- Metabolic distribution pattern
- Importance
 - Medical (Clinical, Pathological)
 - Biochemcial
- Examples:
 - Lactate dehydrogenase
 - Alkaline phosphatase
 - Creatinine kinase

7) Metalloenzymes

- Role of metals in enzyme function
- Metalloenzymes & Metal-activated enzymes
- Ternary enzyme-metal-Substrate Complexes
- Enzymes activation by ions
 - Alkali metal
 - Alkaline earth metal
 - Transition metal
- Examples:
 - Pyruvate kinase
 - Carboxypeptidase A
 - Glutamine synthase
 - Superoxide dismutase (SOD)

8) Membrane-bound enzymes

- Role of membrane
- Advantages of anchoring enzyme on a membrane
- Examples:
 - Glycerol shuttle
 - Adenylate cyclase

Unit 2 Classification, Factors, Models

9) Enzyme Classification & Nomenclature:

- Need for classification
- Enzyme Commission system

Four -number classification system: (EC number)
- Enzyme Commission Recommendations on Nomenclature
- Examples from each class:

Including:

 - Trivial name
 - Systematic name
 - EC number

10) Factors affecting enzyme catalyzed reactions (enzyme activity):

- Factors:
 - Enzyme concentration
 - Substrate concentration
 - The pH
 - Temperature
 - Time
 - Radiation
 - Oxidizing agents
 - Modulators: Activators & Inhibitors
- Optimum activity
- Normal curve
- Variations
- Functional groups

11) Models to explain enzyme action:

Mechanisms of enzyme catalyzed reactions

- One-substrate reactions:
 - Fischer model
 - Koshland model

- B) Two substrate reaction:
(with Example)
- Ordered
 - Random
 - Ping-Pong

12) Cofactors and coenzymes:

- i) B-group vitamins as coenzyme.

Unit 3:

Kinetics, Inhibition, Allosteric enzymes

13) Enzyme Kinetics

- Importance of Enzyme kinetics
- K_m : The Michaelis-Menten constant
 - Definition
 - Significance
 - Derivation of mathematical equation
- Derivation of Michaelis-Menten equation
- Determination of K_m : Plots: Advantages & Disadvantages:
 - Lineweaver-Burk plot
 - Hofstee plot
 - Wolf plot
 - Hanc's plot

14) Enzyme inhibition:

- Types: Examples
 - Reversible inhibition
 - Irreversible inhibition
 - Competitive inhibition
 - Non-competitive inhibition
 - Un-competitive inhibition
 - Product inhibition
 - Feedback inhibition

- B) Kinetics of inhibition
As observe by various plots
Effect of inhibition on:
 K_m & V_{max}

15) Regulatory enzymes

- Allosteric enzymes
With specific reference to Aspartate Transcarbamylase (ATCase)
 - Properties
 - Mechanism of action
 - Sigmoidal curve (Comparison with non-allosteric enzyme)
 - Kinetic aspects (Comparison with non-allosteric enzyme)
 - Advantages
 - Evidence for allosteric site on enzymes
 - Regulatory role of allosteric Enzyme in metabolism (Example; Reference: Lehniger)
 - Threonine dehydrase
 - Phosphofructokinase
 - Fructose-1,6-biphosphatase
 - Isocitrate dehydrogenase
 - Acety -CoA carboxylase
 - Aspartate transcarbamylase
 - Carnitine acyl transferase
 - Phosphorylase
 - Pyruvate dehydrogenase
 - Glycogen synthetase
- Covalently-modulated enzymes
- Models to explain kinetics of non-Michaelis-Menton enzymes
 - Monod-Wyman-Changoux (MWC) model

- b) Koshland (KNF) model

Unit 4: Isolation, Purification, Quantification.

16) Isolation & Purification of Enzymes

- A) Why to purify enzyme
- B) General outline of Purification Scheme
- C) Units
 - a) Enzyme units
 - b) Specific activity of enzyme
- D) Methods for determination of protein
- E) Purification table
- F) Initial purification procedures (from various biological sources):
 - a) Source
 - b) Principle
 - c) Isolation & Extraction Method
 - d) Efficiency
- G) Specialized purification procedures:
 - a) Examples
 - b) Advantages
- H) Fractionation methods
- I) Homogeneity of enzyme protein
 - a) What is homogeneity of enzyme
 - b) Determination of homogeneity

17) Quantitative methods

(for the following enzyme reactions): (Methodology, Examples, Advantages, Disadvantages.

- A) Spectrophotometric & Spectrofluorimetric methods
- B) Thurnberg & Electrochemical methods

- C) Manometric methods
- D) Polarimetric methods
- E) Chromatographic methods
- F) Chemical quantitative estimations

18) Handling of enzyme

- A) General aspects
- B) Some practical points

Unit 5 Applied Enzymology

19) Enzymes in Clinical, & Medicinal Biochemistry

- A) Clinical aspects of Enzymology
 - a) Laboratory investigations
 - Enzymes as analytical reagents in quantitative estimation of metabolites
 - b) Diagnosis of disease: Enzymes as indices in diagnosis of diseases
 - B) Medicinal & Therapeutic applications of Enzymes

20) Enzymes in Industries

Industrial applications of enzymes in :

- A) Food industry
- B) Pharmaceutical industry
- C) Other industry

21) Immobilized enzymes:

- A) Enzyme immobilization (Elementary aspects)
 - a) Methods
 - b) Properties
 - c) Kinetics
- B) Industrial application of Immobilized Enzymes
- C) Immobilized enzymes as Biosensors

References

- 1) Enzymes- (1979) - Dixon M, Webb E C
- 2) Fundamental of Enzymology - (1989) - Price N L, Stevents.
- 3) Understanding Enzymes - (1981)- Palmer
- 4) The Nature if Enzymes-(1980) Poster R L
- 5) Outlines of Biochemistry - Conn & Stumpf
- 6) Principles of Biochemistry - Lehninger
- 7) Enzymes: Biochemistry Biotechnological & Clinical Applications- (1981) - Palmer T. S

Paper IX-Molecular Biology & Immunology

(Note: The focus of the course will on Procaroytes

Unit 1 Molecular Biology

1) DNA as genetic material

- a) Fred Griffith's Experiments
- b) Avery Mcleod et al's Experiments
- c) Phage mode of Roger Herriot
- d) Fershey & Chase's Experiment
- e) Chargaff's Experiments and postulates
- f) Watson and Crick's Model of DNA

2) Structure of Nucleic Acids

- a) Various forms of DNA (A,B,C,D,E, and Z forms)
- b) Secondary structures of RNA

3) Properties of DNA

- Denaturation, Renaturation
- a) Hypochromicity, Hypertchromicity
 - b) Melting temperature and factors affecting T_m
 - c) Supercoiling and its biological significance

4) Replication

- a) Types of Replication (conservative, semi-conservative, dispersive)
- b) Meselsohn and Stahl's Experiments
- c) Mechanism of Replication:
 - i. Initiation, elongation and termination
 - ii. Leading and lagging strand replication
 - iii. Role of various enzymes
- d) Methods of replication
 - i) Rolling circle replication
 - ii. D-loop replication

Unit 2 Molecular Biology

5) Transcription

- a) Promoters
- b) Properties and functions of RNA polymerase and its subunits
- c) Steps in Initiation
- d) Elongation and the transcription bubble
- e) Termination (rho dependent and rho independent)
- f) Post transcriptional processing (details of splicing)

mechanisms to be omitted)

6) The Genetic code

- a) What is genetic code
- b) Characteristics

7) Mutation

- a) Definitions:
 - i. Muton
 - ii. Mutant
 - iii. Mutagenic agent
- b) Mutagenic agents:
 - i. Physical
 1. Non-ionizing radiation: UV
 2. Ionizing radiations
 - ii. Chemical mutagenic agents:
 1. Base analogues
 2. Alkylating agents
 3. Acridine derivatives
 4. Deaminating agents
- c) Repair of injury to DNA
Various mechanisms.

Unit 3 Molecular Biology

8) Translation

- a) Ribosome as translation factory
- b). Role of tRNA as adaptor in protein biosynthesis
 - i. Activation
 - ii. Initiation
 - iii. Elongation
 - iv Translocation
 - v. Termination
- c. Post-translational modification:
Post-translational membrane insertion
- d. Regulation of protein biosynthesis in prokaryotes:
The Lac Operon

9) Genetic Engineering

- a) Tools
 - i. Restriction enzymes:
 1. Classification
 2. Uses
 - ii. Vectors
 1. Plasmid
 2. Bacteriophages
 - iii. Cloning organisms
 - iv. Splicing & insertion of DNA
- b) Applications
- c) Potential biohazards and Ethics

Unit 4 Molecular Biology

10) Bacterial recombination

- a) Types of recombination
- b) Transposable elements
- c) Transformation
- d) Conjugation
 - i. DNA in the form of plasmids
 - ii. F & Hfr factors
 - iii. Chromosomal mapping
 - iv. Other major of plasmids: r and Ccl factors
- e) Transduction: Mechanism of:
 - i. Generalized transduction
 - ii. Specialized transduction

11) Molecular Techniques

- a. Hybridization
- b. Southern Blotting
- c. Northern Blotting
- d. Western Blotting
- e. DNA Sequencing
- f. Quantitation of DNA
Isolation & Estimation of Nucleic Acid

Immunology

Unit 5 Immunology

12) Lines of Defence

- a) First line of Defence
- b) Antimicrobial substances present in blood & tissue fluids:
 - i. Complement
 - ii. Properdin
 - iii. Lysozyme
 - iv. Basic polypeptides
 - v. Interferons
- c) Second line of Defence
 - i. Mechanism of phagocytosis
 - ii. Cellular v/s humoral immunity
- d) Third line of defence
 - i. Antigen-Antibody reaction
 - ii. Hapten: definition
 - iii. Iso-antigen
 - iv. Auto-antigen etc.
- e) Antibodies
 - a. Nature & Properties
 - b. Mechanism of antigen-antibody reaction (Serological reactions)
 - c. Bacterial antigens

13. Active & passive immunity

14. ELISA: Principle, Types, Applications

15. Hypersensitivity & Allergy: Types of hypersensitivity: Delayed & Immediate

Reference

- 1) Fundamental of Microbiology - Frobisher et al
- 2) Essential Immunology - Roitt
- 3) General Microbiology - Power & Dajinawala, Vols I & II
- 4) General Microbiology - Stanier, Edelberg, Ingraham
- 5) Principles of Biochemistry - Lehninger
- 6) Biochemistry - Stryer
- 7) Genes - Lewin
- 8) Cell & Molecular Biology - deRobertis & deRobertis
- 9) Biochemistry - Devlin
- 10) Immunology - Kuby - 3/e
- 11) Gene Cloning - T.A. Brown

Paper X - MICROBIOLOGY

Unit 1 Microorganisms: Overview & Morphology

1) Cell morphology & Fine Structure of bacteria

- A) Size, shape, arrangement of bacteria
- B) Study of Organelles: Structure, Chemical composition, Functions
 - a) Cell wall
L-forms
 - b) Mesosomes
 - c) Flagella
 - d) Fimbriae & Pili
 - e) Capsules
 - f) Intracellular inclusions

Unit 3 Control, Chemotherapy, Diseases

5) Control of Microorganisms

- A) Sterilization & disinfection by Chemical means
 - a) Characteristics of an ideal Antimicrobial agent
 - b) Evaluation of disinfectants: Phenol Coefficient
 - c) Mode of action & uses of some disinfectants:
 - 1) Halogen & halogen compounds
 - 2) Compounds of heavy metals
 - 3) Phenols & its derivatives
 - 4) Alcohol
 - 5) Detergents disinfectants
 - a) Cationic
 - b) Anionic
 - 6) Microbicidal (chemosterilant) gases:
 - a) Formaldehyde
 - b) Ethylene oxide
 - c) Beta propiolactone

7) Chemotherapy & Chemotherapeutic agents:

- A) Properties of ideal chemotherapeutic Agents
- B) Chemotherapeutic index
- C) Non-therapeutic uses of chemotherapeutic agents
- D) Chemotherapeutic agents: Modes of action (microbial, microstatic), Limitations, Uses:
 - a) Penicillins
 - b) Streptomycin
 - c) Tetracyclines
 - d) Polymixins
 - e) Chloramphenicol

- f) Sulpha drugs
- e) Drug resistance
 - a) Introduction
 - b) Prevention

8) Infectious Diseases

- A) Bacterial Diseases
 - Causative agent, Pathogenesis, Chemotherapy, Prophylaxis, Diagnosis (names of tests only)
 - a) Syphilis
 - b) Typhoid
 - c) Tuberculosis

Unit 4 Growth & Nutrition

9) Effect of Environment on Bacteria

Effect of various factors on Growth & Reproduction of Bacteria:

- A) Physical factors
 - a) Temperature: High & Low
 - b) Osmotic pressure
 - c) Radiation
 - d) Hydrostatic pressure
 - e) Mechanical impact & Vibration
 - f) Surface tension
- B) Chemical factors
 - a) Water & dessication
 - b) Gaseous environment: Oxygen
 - c) Buffers & pH

10) Nutrition of microorganisms

- A) Classification of bacteria according to:
 - a) Energy source
 - b) Electron source
 - c) Carbon source
 - d) Oxygen source
- B) Cultivation & Growth of bacteria:

g) Endospores

2) Microorganisms other than eubacteria:

Salient Features, Economic importance;

- A) Archebacteria (Introduction)
- B) Rickettsia
- C) Fungi
 - a) Yeast
 - b) Mould
- D) Algae

Unit 2 Techniques, Control

3) Microscope & Microscopy:

- A) Parts of a compound microscope: Important lens systems: Condenser, Objective, Ocular
- B) Relationship between:
 - a) Magnification, & Numerical Aperture
 - b) Angular aperture & Resolving Power
- C) Basic principles of image formation
- D) Principle, Construction, Working, Limitations, Applications (Uses):
 - a) Dark-field microscopy
 - b) Phase-contrast microscopy
 - c) Fluorescent microscopy
 - d) Electron microscopy.
 - 1) TEM & SEM
 - 2) Preparation of sample for TEM

4) Dyes & Stains

- A) Definitions & Functions / Significance
 - a) Stains
 - b) Chromogen
 - c) Acidic stains, Basic stain
 - d) Mordant, Intensifier
 - e) Leuco compound

f) Compound stain

- B) Classification of stains
- C) Dyes as pH indicators
- D) Theories of staining
- E) Staining techniques: Principles, procedures & Mechanisms
 - a) Differential staining.
 - 1) Gram staining
 - 2) Acid fast staining
 - b) Structural staining
 - 1) Spore
 - 2) Capsule
 - 3) Cell wall
 - 4) Metachromatic granules
 - 5) Flagella

5) Control of Microorganisms

- A) Definition of terms:
 - a) Sterilization
 - b) Disinfection
 - c) Microbicidal
 - d) Microbistasis
 - e) Sepsis
 - f) Asepsis
 - g) Antiseptic etc
- B) Factors affecting sterilization & disinfection: Physical Chemical
- C) Sterilization & disinfection by physical means;
 - a) Moist heat
 - b) Dry heat
 - c) Radiations
 - d) Filtration

- a) Culture media:
 - 1) Classification
 - (i) Defined, Empirical, Living
 - (ii) Differential, Selective, Enriched, assay, Maintenance
 - 2) Components
 - 3) Composition:
 - (i) For *Thiobacillus thiooxidans*
 - (ii) For *Escherichia coli*
- b) Pure culture methods:
 - Pore -plate, streak-plate
- c) Enumeration of microorganisms
- d) Bacterial growth curve
- e) Continuous cultivation techniques (Applications, merits Demerits)
 - 1) Chemostat
 - 2) Turbidostat
- f) Synchronus growth
 - 1) Induction
 - 2) Selection
- g) Diauxic curve
- h) Procedures in:
 - 1) Identification of bacteria
 - 2) Preservation of pure cultures

Unit 5 Applied & Industrial Microbiology

11) Applied Microbiology

- A) Microbiology of Milk
 - a) Microbial analysis of milk: SPC, Dye-reduction tests, etc
 - b) Pasteurization & Sterilization
 - c) Role of microorganisms in fermented dairy products:
 - 1) Butter
 - 2) Cheese
 - 3) Curd & Yoghurt

- B) Microbiology of water & Sewage
 - a) Water microbiology
 - 1) Drinking water
 - (i) Definition of potable water
 - (ii) Purification of water
 - a. Municipal water works
 - b. Domestic methods
 - c. Reverse osmosis
 - 2) Index organisms of faecal contamination & their significance
 - 3) Microbial analysis of water SPC, Filtration, MTFT, MPN, etc
 - b) Sewage microbiology
 - 1) BOD & COD:
 - 2) Definition & Significance
 - 3) Composition of sewage
 - 4) Sewage treatments (Disposal):
 - a) Single-dwelling
 - (i) Septic tank
 - (ii) Imhoff tank
 - b) Municipal treatment plant
 - (i) Primary treatment
 - (ii) Secondary treatment
 - Trickling filter, Activated-Sludge process, Oxidation ponds
 - c) Advanced treatment
 - d) Final treatment
 - e) Solid processing
 - Anaerobic sludge
 - Digestion
 - Composting
- C) Air & Soil Microbiology
 - a) Microbial analysis of Air
 - 1) Solid-impingement Techniques
 - 2) Liquid impingement Technique.
 - b) Air pollution

- c) Significance of soil microorganisms
 - 1) Nitrogen cycle: Nitrogen fixation
 - 2) Sulphur cycle
 - 3) Biodegradation

12) Industrial Microbiology

- A) General types of industrial processes
- B) Introduction to developing an Industrial process
- C) Types of Fermentation processes
- D) Role of microorganisms in:
 - a) Fermentation of Beverage: Beer, Wine
 - b) Production of Antibiotics: Penicillin
 - c) Production of Organic acids: Vinegar, Lactic acid,
 - d) Production of Vaccines
 - e) Production of Vitamin B-12
 - f) Production of Amino acids: Lysine, Glutamic acid
 - g) Bioconversion of Steroids: General aspects
 - h) Production of Bioinsecticides (Bacillus thuringiensis)
 - i) Production of Single-cell protein (SCP)
 - j) Microbioassay

References

- 1) Microbiology- Pelczar, Reid- 5/e
- 2) General Microbiology - Powar & Dagainawala - Vol I & II

- 3) Fundamentals of Microbiology - Frobisher, Hinsdill, Crabtree, Goodheart
- 4) Microbiology: Fundamentals & Applications- Atlas - 1980 - 2/e
- 5) General Microbiology- Stanier' Adelber, Ingraham
- 6) Cell Biology - Scheler, Bianchi
- 7) Cell & Molecular Biology - 8/e
- 8) General Microbiology - Prescott

BIOCHEMISTRY PRACTICAL

1) Enzymes:

- B- Glycerophosphatase:
 - A) Unit of enzyme
 - B) Determining the optimum:
 - a) Enzyme concentration
 - b) Substrate concentration
 - c) The pH
 - d) Time

2) Clinical (Blood/ Serum) Analysis

Estimation of :

- A) Blood Sugar by Folin Wu method
- B) Blood sugar by Arsenomolybdate method
- C) Blood Urea by Diacetylmonooxime Method

6) Molecular Biology & Immunology

(Demonstration experiments)

A) Serological tests

a) Agglutination tests

1) Slide agglutination technique

2) Widal test

b) Precipitation tests:

1) Kahn test, or

2) VDRL test

References

1) Laboratory Manual in Biochemistry-
Jayaraman J

2) Handbook of Practical Biochemistry-
Malhotra V K

3) A Manual of Laboratory Techniques
NIN, ICMR Pub

4) Practical Clinical Biochemistry
Varley H

5) An Introduction to Practical
Biochemistry - Plummer

6) Microbes in Action - seeley H W,
Van Denmark P J

7) Laboratory Exercise in Microbiology -
Wistreich G A, Lechman M D

8) Standard Methods for the
Examination of water and Wastewater

-13/e

- D) Serum Creatine & Creatinine by Alkaline Picrate method
- E) Serum Uric acid
- F) Serum Cholesterol by FeCl_3 Acetic Method
- G) Serum Phosphorus by Fiske- Subbaroa method
- H) Blood Iron & Haemoglobin by Wong's Method
- I) Serum Calcium by KMnO_4 method

3) Liver Function Tests

- A) Estimation of :
 - a) Serum Total Protein & Albumin: Globulin ratio by Biuret Method
 - b) Bilirubin: Direct & Indirect
- B) Assay of :
 - a) Serum GPT
 - b) Serum GOT
 - c) Serum Alkaline phosphatase

4) Food & Nutrition

- A) Food Analyses
 - a) Estimation of Iron by KCNS method
 - b) Estimation of Total Nitrogen by Kjeldahl's method
 - c) Estimation of Magnesium
 - d) Extraction and Estimation of Ascorbic acid
 - e) Extraction and Estimation of Oxalic acid
 - f) Estimation of Chloride
 - g) Extraction & Estimation of Cholesterol in brain
 - h) Estimation of RNA in tissues

i) Estimation of DNA in tissues

5) Microbiology

- A) Sterilization & disinfection of articles
- B) Preparation of:
 - a) Stains
 - b) Media
- C) Microscope
 - a) Bright-field microscope, its components
 - b) Care & Maintenance of microscope
- D) Staining Techniques:
 - a) Menechrome staining
 - b) Negative staining
 - c) Gram staining
 - d) Spore staining
 - e) Capsule staining
 - f) Metachromatic granule staining
 - g) Acid-fast staining (demonstration)
- E) Study of Permanent slides of Fungi, Yeast, Aspergillus, Penicillium, Mucor, Rhizopus
- F) Isolation of pure culture and study of its characteristics
- G) Antibiotic sensitivity tests:
- H) Biochemical reactions of bacteria
 - a) Fermentation of sugar to alcohol & glycerol
 - b) IMViC test
- I) Enzymatic reactions of bacteria
 - a) Amylase, Casease, Gelatinase, Lipase
 - b) Catalase, Dehydrogenase
- J) Qualitative analysis of Milk (MBRT)
- L) Demonstration of flagellar motility by Hanging-drop method