

1st year Direct Part Question Number System

H.M - 10

Only 16 marks come only from History

UNIVERSITY OF NORTH BENGAL

B.Sc. Courses in Microbiology (Honours)

Total Marks - 800 :: Duration 3 years

Bijoy Raj Sinha

Full Lecture
Marks Period

PART - I

Total Marks - 200 :: Duration - 1 year

Theoretical Paper - I	: Biophysics; Biochemistry; Biostatistics; History of development and scope of microbiology	70	130
Paper - II	: Microbial origin and diversity; Functional anatomy of microbial cells	70	130
Practical Paper - III		60	260

PART - II

Total Marks - 200 :: Duration - 1 year

Theoretical Paper - IV	: Microbial growth and growth control; Microbial nutrition and metabolism	70	130
Paper - V	: Microbial genetics; Virology	70	130
Practical Paper - VI		60	260

PART - III

Total Marks - 400 :: Duration - 1 year

Theoretical Paper - VII	: Medical microbiology and Immunology	80	120
Paper - VIII	: Food and Industrial microbiology	80	120
Paper - IX	: Environmental microbiology; Microbial biotechnology	80	120
Practical Paper - X		80	225
Paper - XI		80	225

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Theoretical

Paper - I

Biophysics

1. Physico-chemical properties of water, acids, bases and buffers
2. Laws of thermodynamics; bonding and non-bonding potentials; stabilizing interactions in protein and DNA structures;
3. Microscopy: theory and application in biology
4. Radio-isotopes and their use in microbiology
5. Spectrophotometry: types; Beer's law

Biochemistry

6. Carbohydrates: classification; chemical structures of representative examples of mon-, di, and poly-saccharides; stereoisomers; enantiomers; epimers
7. Lipids: classification; chemical structures of triglycerides and fatty acids
8. Amino acids and proteins: classification of amino acids; primary and higher order structures of protein
9. Nucleic acids: DNA structures- A, B and Z forms

Biometry

10. Sampling design: steps and types
11. Measurement of scaling techniques: classification of measurement scales; sources of error in measurement; tests of sound measurement (validity; reliability; practicality); scaling techniques
12. Collection, processing and analysis of data: methods of data collection; processing operations; measures of central tendency (mean, mode and median); measures of dispersion (range, mean deviation, standard deviation and standard error); measures of relationship (correlation and regression)

History of development and scope of microbiology

Complimentary Copy

13. Discovery of the microbial world; Ferdinand Cohn's, Louis Pasteur's and Robert Koch's contributions and other widening horizons; spontaneous generation versus biogenesis; germ theory of disease; pure culture concept; immunity; growth of organized microbiology in science; germ theory of fermentation; microorganisms in human welfare, industry, medicine, agriculture and environmental sanitation; development of major disciplines of microbiology

Paper - II

Microbial origin and diversity

1. Earliest life forms: evidence of microbial life on early earth; origin of life; primitive organisms and metabolic strategies
2. Microbial phylogeny as revealed by ribosomal RNA sequencing; the universal tree of life
3. Bacterial taxonomy, nomenclature and Bergey's Manual: classification and species concept; nomenclature and formal taxonomic standing; polyphasic approach
4. Phototrophic bacteria: anoxygenic phototrophs; cyanobacteria; prochlorophytes
5. Chemolithotrophs: ammonia-, nitrite-, sulfur-, iron- and hydrogen-oxidising bacteria
6. Endospore-forming bacteria
7. Gliding bacteria

8. Archaea: extreme halophiles; methanogens; hyperthermophiles
9. Algae, fungi and protozoa: characteristics of major groups; growth and reproduction; ecology

Functional anatomy of microbial cells

10. Overview of cell structure: prokaryotes and eukaryotes
11. Cell wall of prokaryotes: peptidoglycan and related molecules; outer membrane of Gram-negative bacteria; mechanism of Gram reaction
12. Cytoplasmic membrane; mesosome and chromatophore
13. Appendages: flagella and motility; pili and fimbriae
14. Prokaryotic cell surface structure and cell inclusions
15. Prokaryotic and eukaryotic ribosomes
16. Arrangement of DNA in prokaryotes
17. Nucleus; mitochondrion; chloroplast
18. Endospores and other persistent forms

Practical

Paper - III

1. Biochemistry

- (a) Preparation of buffers and standard solutions
- (b) Preparation of standard curve and quantitative estimation of protein by Biuret method
- (c) Preparation of standard curve and quantitative estimation of reducing sugars by arsenomolybdate method
- (d) Qualitative tests for carbohydrates, organic acids, amino acids, fats, DNA and RNA

2. Biostatistics

- Determination of mean, mode, median, range, mean deviation, standard deviation, standard error, correlation and regression analysis of samples

3. Microscopic examination of microbial cells

- (a) Components, use and care of brightfield compound microscope
- (b) Calibration of ocular micrometer for different objectives (low-power, high-power and oil immersion) of a microscope
- (c) Enumeration of microorganisms (bacteria/yeasts) by Breed's method
- (d) Enumeration of bacterial cells using Neubauer counting chamber
- (e) Temporary wet mount (TWM) technique for microscopic observation of living microorganisms
- (f) Hanging drop technique for demonstrating motility of bacteria
- (g) Microscopic examination of free-living protozoa of a pond
- (h) Slide culture technique for studying morphology of moulds
- (i) Scotch tape preparation for studying morphology of fungi

4. Staining methods and morphology of bacterial cells

- (a) Preparation of heat-fixed smear and simple staining
- (b) Negative staining
- (c) Gram staining
- (d) Loeffler's flagella staining
- (e) Ziehl Neelsen's acid-fast staining
- (f) Endospore staining
- (g) Cotton blue staining of fungi

PART - II

Theoretical

Paper - IV

Microbial growth and growth control

1. Measurements of growth: cell mass and cell number
2. Growth cycle of populations: phases of growth in a batch culture; mean generation time
3. Environmental factors affecting growth: nutrient concentration; temperature; pH; oxygen concentration; water availability; specific factors (quality and quantity of light; salt concentration)
4. Growth in a continuous culture; synchronization of cell division; diauxy
5. Sterilization using heat, radiation, chemicals, and filter
6. Antibiotics: classification; structure, mode of action and antimicrobial spectrum of penicillin, streptomycin, chloramphenicol and actinomycin D
7. Antibiotic resistance: mechanism; overcoming resistance
8. Viral control using chemicals and interferon

Microbial nutrition and metabolism

9. Microbial nutrition: macro- and micro-elements; growth factor requirement
10. Nutrient media and growth conditions: culture media; pH; carbon dioxide; water content and osmotic pressure; temperature; aeration; anaerobic culture
11. Selective culture methods: enrichment culture; pure (axenic) culture; mixed culture; preservation of cultures
12. Enzyme: classification and nomenclature; general properties; extraction, assay and purification; mechanism of action (enzyme-substrate reaction; kinetics; Michaelis-Menten equation); enzyme specificity; factors influencing enzymic activity; enzyme inhibition; feedback inhibition
13. Photosynthesis (anoxygenic and oxygenic) and chemosynthesis; photosynthetic pigments
14. Biosynthetic pathways: amino acids (glutamate family only); purines and pyrimidines; fatty acids
15. Fermentation: alcoholic; lactate; formate; acetate; propionate; butyrate; mixed acid and butanediol; Stickland reaction; Entner-Doudoroff pathway
16. Anaerobic respiration: nitrate; sulfate, thiosulfate, S^0 and carbon dioxide as electron acceptor
17. Aerobic respiration: oxidation of pyruvate, and tricarboxylic acid cycle; respiratory chain and electron transport phosphorylation

Complimentary Copy

Paper - V

Microbial genetics

1. DNA structure: DNA as a double helix; supercoiled DNA; types of DNA; effect of temperature on DNA structure
2. Genetic elements: experimental evidences for DNA as genetic material; chromosome; gene concept; nonchromosomal genetic elements (viruses; plasmids; episomes; mitochondria; transposable elements)
3. DNA replication: templates and primers; initiation of DNA synthesis; leading and lagging strands; fidelity of DNA replication; replicating linear genetic elements
4. Transcription: promoters; terminators; RNA polymerases; specific inhibitors of RNA polymerase action; messenger RNA; operons; RNA processing and ribozymes
5. Translation: structure, activation and charging of transfer RNA; chain initiation, elongation and termination
6. Genetic code: nature; deciphering; code-word dictionary
7. Mutations: molecular basis; mutagens (physical, chemical and biological); isolation of mutants

(Verma & Agarwal)
(अणुजीव विज्ञान)
(Molecular biology)

8. Genetic recombination: transformation, transduction and conjugation; detection of recombinants; overview of bacterial genetic map
9. DNA damage by UV, and its repair

Virology

10. Viruses: occurrence; nature; morphological classes; structure; nomenclature; preservation
11. Bacteriophages: isolation and demonstration; structure of adenoviruses, tobacco mosaic viruses and coliphage T₄
12. Multiplication of coliphage T₄ (lytic cycle)
13. Lysogeny: nature of lysogeny; vegetative cycle; lysogenic state; prophage cycle; induction of a lysogenic cell
14. Assay of viruses: chemical and physical determinations; assays of infectivity
15. Virus diseases in plants: symptoms of diseases; general transmission of viruses
16. Relation of viruses and plasmids to tumour formation: formation of plant tumours; formation of animal tumours by DNA viruses and RNA viruses (retroviruses)
17. Viroids and prions

Practical

Paper - VI

- I. Microbial growth and its control
 - (a) Study of bacterial growth using turbidimetric method
 - (b) Control by moist heat
 - (c) Control by dry heat
 - (d) Control by ultraviolet radiation
 - (e) Evaluation of antiseptics by filter paper disc method
 - (f) Evaluation of alcohol effectiveness as a skin antiseptic
 - (g) Evaluation of disinfectants (phenol coefficient)
2. Preparation of culture media for routine cultivation of bacteria
 - (a) Preparation of a basic liquid medium (nutrient broth)
 - (b) Preparation of a basic solid medium (nutrient agar), slants (slopes) and deep tubes (stabs), and pouring of plates
3. Cultivation techniques for isolation and enumeration of microorganisms
 - (a) Isolation and enumeration of microorganisms from soil by serial dilution-agar plate method (or viable plate count method)
 - (b) Isolation of microorganisms from air
 - (c) Effect of dusting and sweeping on the indoors microbial population of a laboratory
4. Methods for obtaining pure cultures of microorganisms
 - (a) Isolation by streak-plate method
 - (b) Isolation by pour-plate method
 - (c) Isolation by spread-plate method
 - (d) Subculturing technique

PART - III

Theoretical

Paper - VII: Medical microbiology and Immunology

1. Epidemiology and public health microbiology: epidemiological terminology; infectious disease transmission; public health measures for the control of epidemics (controls directed against reservoir and transmission of pathogens; vaccination; quarantine; surveillance); emergence and resurgent infectious diseases
2. Mechanism of pathogenicity: entry of pathogen into host (portal of entry; adherence; invasion); colonization and growth; mechanism of damaging host cells and establishment of disease; virulence; nonspecific host defenses
3. Immune response: cells and organs of the immune system; immunoglobulin classes; formation and structure of immunoglobulin G
4. Systemic microbiology (morphology, cultural characteristics, toxins and enzymes, wherever applicable) of staphylococci, streptococci, mycobacteria, enteric bacilli (*Escherichia coli*, *Salmonella*, *Shigella*, *Cholera Vibrios*), *Neisseria gonorrhoeae*, *Treponema pallidum*, *Clostridium perfringens*, *Clostridium tetani*, Plasmodia, *Entamoeba histolytica*, *Leishmania donovani*, cestode (tape worm), nematodes (round worm, hook worm and filarial worms)
5. Microbial diseases - pathogenesis, laboratory diagnosis and treatment: tuberculosis and influenza (respiratory); syphilis and acquired immunodeficiency syndrome (sexually transmitted); malaria and kala-azar (insect transmitted); staphylococcal food poisoning (foodborne); cholera (waterborne); candidosis (respiratory and contact)
6. Antigen-antibody reactions: neutralization; precipitation; agglutination
7. Polyclonal and monoclonal antibodies; immunodiagnosics
8. Immune diseases: delayed-type hypersensitivity; immediate-type hypersensitivity; autoimmune diseases; superantigens
9. Immunity to infectious diseases: vaccination; passive immunity

Paper - VIII: Food and Industrial microbiology

Complimentary Copy

1. Factors affecting growth and survival of microorganisms in foods: intrinsic (substrate limitations: nutrient content; buffering capacity; redox potential; antimicrobials; water activity) and extrinsic (environmental limitations: relative humidity; temperature; gaseous atmosphere)
2. Microbiology of food (raw, cooked or canned) spoilage: cereals; pulses; nuts; oilseeds; vegetables; fruits; milk and milk products; fish; meat and meat products; eggs
3. Microbiology of food preservation: heat processing (Pasteurization; Appertization; aseptic packaging); irradiation (microwave, UV and ionizing radiation); high-pressure processing (Pascalization); low-temperature storage (chilling and freezing); chemical preservatives (common antioxidants; organic acids and esters; sulfur dioxide; 'natural' food preservatives); modification of atmosphere; control of water activity; compartmentalization
4. Industrial microorganisms and fermentation products: origin of industrial strains; strain improvement; properties of a useful industrial microorganism; primary metabolites (biosurfactants and extracellular polysaccharides) and secondary metabolites (antibiotics)
5. Fermentation scale-up: construction of an aerobic fermentor; process control and monitoring; steps towards commercial production of ascorbic acid, cyanocobalamin; glutamic acid, protease, benzylpenicillin, alcohol and alcoholic beverages, yeasts and vinegar
6. Microbiology of traditional food fermentations: tempe; yogurt; idli; dhokla; todi; wari; kinema
7. Activities of lactic acid bacteria in foods: antimicrobial activity; health-promoting effects; types of foci

- 8. Production of flavours by fermentation: type of flavour components; producing culture
- 9. Bacterial leaching

Paper - IX: Environmental microbiology; Microbial biotechnology

Environmental microbiology:

- 1. Microorganisms in nature: surfaces and biofilms; nutrient levels and growth rates; microbial competition and cooperation
- 2. Ecology of microorganisms: ecosystem; habitat; ecological niche; number and diversity of microorganisms in an ecosystem
- 3. Biogeochemical cycles: carbon; nitrogen; sulfur; phosphorus
- 4. Aquatic ecosystem: aquatic microorganisms; role and importance; oxygen relationships; biological oxygen demand; productivity
- 5. Deep-sea ecosystem: barotolerant and barophilic bacteria; physiology of barophiles
- 6. Sewage treatment and water purification: chemical and microbiological characteristics of waste water; treatment processes; determining sanitary quality
- 7. Biodegradation of petroleum and xenobiotics (pesticides; reductive dechlorination; synthetic polymers); bacterial plastics

Microbial biotechnology:

- 8. Isolation and hybridization of nucleic acids; Southern, Northern and Western blotting and hybridization
- 9. Methods of inserting foreign DNA; cloning vectors (plasmids; bacteriophage lambda; others)
- 10. Amplifying and fingerprinting DNA
- 11. Construction and screening c-DNA libraries
- 12. Cloning and expression of mammalian genes in bacteria
- 13. Study of microbial communities in nature using nucleic acid probes
- 14. Biomethanation from agricultural and food processing wastes

Practical

Paper - X

- 1. Enzyme tests : (a) catalase; (b) oxidase; (c) diastase; (d) gelatinase; (e) caseinase; (f) lipase; (g) β -galactosidase
- 2. Biochemical, nutritional and miscellaneous tests: (a) oxidation/fermentation (O/F); (b) fermentation acid and gas detection; (c) IMViC; (d) nitrate reduction; (e) sensitivity to antibiotics
- 3. Serodiagnosis: (a) Widal test and (b) V.D.R.L. test
- 4. Slide agglutination test for ASO titre estimation, rheumatoid factor study and hepatitis-B surface antigen detection
- 5. Routine microscopical study of stool: detection of ova, cyst of common helminths and protozoa

Paper - XI

- 1. Study on the microflora of curd
- 2. Study on bacteroides and bacteria from root nodules of leguminous plant
- 3. Enrichment and isolation of endospore-forming and nitrogen-fixing bacteria from soils
- 4. Determination of quality of milk by methylene blue reductase test
- 5. Enumeration of bacteria in milk by standard plate count (SPC)
- 6. Determination of change in pH and volume of fermenting batter during idli preparation
- 7. An educational trip to at least one food/fermentation industry