B.Sc. in Microbiology Syllabus for 2ND Year
(Semester III & Semester IV)
(FYUGP Regulation 2022)
University of North Bengal

B.Sc. Syllabus in Microbiology according to the new curriculum and credit framework 2022, University of North Bengal

UG Syllabus scheme in microbiology for 2ND year

Course Component	No. of Course	Credit distribution of each paper		Total credit
		Theory	Practical	
Major Course (MAJ)	6	3	1	6x4=24
Minor Course (MIN)	2	3	1	2x4=8
Multidisciplinary Course (MDC)	1	3	0	1x3=3
Ability Enhancement Course (AEC)	2	2	0	2x2=4
Skill Enhancement Course (SEC)	1	2	1	1x3=3
				42

B.Sc. in Microbiology Syllabus, NBU

Question Pattern for MAJ, MIN & SEC (Theoretical) for 40 marks

Sl. No	Question to be answered	Out of	Marks of each question	Total Marks
1	5	8	1	5X1=5
2	3	5	5	3X5=15
3	2	4	10	2X10=20

Question carries 5 marks each may be bifurcated as 3+2 or as 5
Question carries 10 marks each may be bifurcated as 6|+4 or 7+3

Paper: MAJOR Paper Code: UMICMAJ23003 Paper Level: 200

BIOCHEMISTRY

(Paper Type: Theory)
Semester –III
Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Bioenergetics **No. of Hours: 4**

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, ATP

Unit 2 Carbohydrates **No. of Hours: 9**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 3 Lipids **No. of Hours: 9**

Definition and major classes of storage and structural lipids.Storage lipids.Fatty acids structure and functions.Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification, Iodine number, Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Introduction of lipid micelles, monolayers, bilayers

Unit 4 Proteins **No. of Hours: 10**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: D-alanine Oligopeptides: Structure and functions of naturally occurring insulin, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Unit 5. Enzymes **No. of Hours: 9**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km,Vmax, and allosteric mechanism: Aspartate Trans Carbamoylase Definitions of terms – enzyme unit, specific activity and turnover number, Buffer and buffer capacity Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

Unit 6. Vitamins **No. of Hours: 1**

Classification and characteristics

Unit 7 Nucleic Acid **No. of Hours: 3**

Miescher to Watson and Crick- historic perspective Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Chargaff's rule, Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). Chemical Properties of DNA & RNA: Hydrolysis (acid, alkali),

Paper: MAJOR Paper Code: UMICMAJ23003 Paper Level: 200

BIOCHEMISTRY

(Paper Type: Practical)
Semester –III
Lecture Hours : 30 h Marks: 20 Credits:1

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems toexplain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
3. Qualitative/Quantitative tests for carbohydrates,Total sugar (Anthrone method) reducing sugars (Di nitro salicylic acid method), non reducing sugars
4. Qualitative/Quantitative tests for lipids and proteins
5. Study of protein secondary and tertiary structures with the help of models
6. Study of enzyme kinetics – calculation of *V*max , Km, Kcat values
7. Study effect of temperature and pH on enzyme activity
8. Colorimetric estimation of DNA using Diphenylamine (DPA)

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freemanand Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiologyby. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

Paper: MAJOR Paper Code: UMICMAJ23004 Paper Level: 200

MICROBIAL PHYSIOLOGY AND METABOLISM

(Paper Type: Theory)
Semester –III
Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth **No. of Hours: 10**

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph,hemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 2 Nutrient uptake and Transport **No. of Hours: 5**

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration **No. of Hours: 10**

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation
No. of Hours: 5

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism **No. of Hours: 10**

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism – groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Unit 6 Nitrogen Metabolism - an overview **No. of Hours: 5**

Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

Paper: MAJOR Paper Code: UMICMAJ23004 Paper Level: 200

MICROBIAL PHYSIOLOGY AND METABOLISM

(Paper Type: Practical)
Semester –III
Lecture Hours : 30 h Marks: 20 Credits:1

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Determination of absorption spectra of chlorophyll.

SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014).Brock Biology of Microorganisms.14th edition. PrenticeHall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology.4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism.2nd edition. Springer Verlag
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ.(2013). Prescott's Microbiology.9th edition

B.Sc. in Microbiology Syllabus, NBU

Paper: MAJOR Paper Code: UMICMAJ23005 Paper Level: 200
FOOD AND DAIRY MICROBIOLOGY
(Paper Type: Theory)
Semester –III
Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Foods as a substrate for microorganisms **No. of Hours: 8**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various foods **No. of Hours: 9**

Principles, Spoilage of vegetables, fruits, Fish, meat, eggs, milk and butter, bread, canned Foods

Unit 3 Principles and methods of food preservation **No. of Hours: 9**

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 4 Fermented Food **No. of Hours:8**

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, cheese, other fermented foods: sauerkraut, tampeh, Probiotics: Health benefits,types of microorganisms used, probiotic foods available in market.

Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) No. of Hours: 8

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;Food infections: *Bacillus cereus*, , Salmonellosis, Shigellosis, ,*Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6 Food sanitation and control **No. of Hours: 3**

HACCP, Indices of food sanitary quality and sanitizers

Paper: MAJOR Paper Code: UMICMAJ23005 Paper Level: 200
FOOD AND DAIRY MICROBIOLOGY
(Paper Type:Practical)
Semester –III
Lecture Hours : 30 h Marks: 20 Credits:1

1. Isolation and enumeration of food borne bacteria from food products using standard plate count method (Fermented and Non fermented)
2. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
3. Isolation of spoilage microorganisms from bread.
4. Isolation of spoilage microorganisms from fish and meat products
5. Determination of the role of yeast in bread making.
6. Preparation of Yogurt.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology.1st edition. CBS Publishers and Distributors,

Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology.3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods.Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Paper: SEC Paper Code: UMICSEC23003 Paper Level: 100

Microbial Quality Control in Food Industries

(Paper Type: Theory)
Semester –III
Lecture Hours : 30 h Marks: 40 Credits: 2

Unit 1 Microbiological Laboratory and Safe Practices **No. of Hours: 8**

Good laboratory practices - Good laboratory practices, Good microbiological practices
Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples **No. of Hours: 10**

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products. Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water **No. of Hours: 8**

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar
Ascertaining microbial quality of milk by MBRT, Resazurin test, Rapid detection methods of microbiological qualityof milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards **No. of Hours: 4**

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations
Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

Paper: SEC Paper Code: UMICSEC23003 Paper Level: 100

Microbial Quality Control in Food Industries

(Paper Type: Practical)
Semester –III
Lecture Hours : 30 h Marks: 20 Credits: 1

1. MBRT test of milk sample for assessing the quality.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Resazurin test to check the quality of milk
4. Determination of the decimal reduction time of food borne bacteria.
5. Isolation and enumeration of Salmonella from food products.
6. Isolation and enumeration of yeast and mold from food products.

Paper: MINOR Paper Code: UMICMIN20002 Paper Level: 200

BIOCHEMISTRY AND MICROBIAL METABOLISM

(Paper Type: Theory)
Semester –III/IV
Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Bioenergetics **No. of Hours: 3**

First and second laws of Thermodynamics.

Unit 2 Carbohydrates **No. of Hours: 8**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine,Disaccharides; concept of reducing and non-reducing sugars, sucrose, Polysaccharides, storage polysaccharides, starch and glycogen.

Unit 3 Lipids **No. of Hours: 8**

Definition and major classes of storage and structural lipids.Storage lipids.Fatty acids structure and functions.Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine

Unit 4 Proteins **No. of Hours: 8**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Classification, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Unit 5 Microbial Growth and Effect of Environment on Microbial Growth **No. of Hours: 8**

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative

anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 6 Aerobic Respiration **No. of Hours: 10**

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. Glycolysis, Pyruvate oxidation, TCA and Electron transport chain: components of respiratory chain, mitochondrial and bacterial ETC, electron transport phosphorylation.

Paper: MINOR Paper Code: UMICMIN20002 Paper Level: 200

BIOCHEMISTRY AND MICROBIAL METABOLISM

(Paper Type: Theory)

Semester –III/IV

Lecture Hours : 30h Marks: 20 Credits: 1

1. Qualitative/Quantitative tests for carbohydrates, reducing sugars (Di nitro salicylic acid method).
2. Qualitative/Quantitative tests for lipids and proteins
3. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
4. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill

Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

7. Madigan MT, and Martinko JM (2014).Brock Biology of Microorganisms.14th edition. Prentice Hall International Inc.
8. Moat AG and Foster JW. (2002). Microbial Physiology.4th edition. John Wiley & Sons
9. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
10. Gottschalk G. (1986). Bacterial Metabolism.2nd edition. Springer Verlag
11. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
12. Willey JM, Sherwood LM, and Woolverton CJ.(2013). Prescott's Microbiology.9th edition

B.Sc. in Microbiology Syllabus, NBU

Paper: MAJOR Paper Code: UMICMAJ24006 Paper Level: 200

MOLECULAR BIOLOGY

(Paper Type: Theory)

Semester –IV

Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 5**

Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes) **No. of Hours: 10**

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNApolymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle,D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein.

Unit 3 Transcription in Prokaryotes and Eukaryotes **No. of Hours: 6**

Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unitTranscription in Eukaryotes: RNA polymerases, general Transcription factors

Unit 4 Post-Transcriptional Processing **No. of Hours: 4**

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA

Unit 5 Translation (Prokaryotes and Eukaryotes) **No. of Hours: 10**

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation,elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation,Inhibitors of protein synthesis in prokaryotes and eukaryote

Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes **No. of Hours: 10**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* operon, Sporulation in

*Bacillus,*Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms

Paper: MAJOR Paper Code: UMICMAJ24006 Paper Level: 200

MOLECULAR BIOLOGY

(Paper Type: Practical)

Semester –IV

Lecture Hours : 30 h Marks: 20 Credits: 1

1. Study of different types of DNA and RNA using micrographs and model / schematic representations

2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using UV spectrophotometer (A_{260} measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A_{260} measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons.Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

Paper: MAJOR Paper Code: UMICMAJ24007 Paper Level: 200

VIROLOGY

(Paper Type: Theory)
Semester –IV
Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Nature and Properties of Viruses **No. of Hours: 10**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit 2 Bacteriophages **No. of Hours**: **10**

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication No. of Hours: 15

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly,

maturation and release of virions

Unit 4 Viruses and Cancer **No. of Hours: 5**

Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5 Prevention & control of viral diseases **No. of Hours: 5**

Antiviral compounds and their mode of action, Interferon and their mode of action

General principles of viral vaccination

Paper: MAJOR Paper Code: UMICMAJ24007 Paper Level: 200

VIROLOGY

(Paper Type: Practical)
Semester –IV
Lecture Hours : 30 h Marks: 20 Credits: 1

1. Study of the structure of important animal viruses (influenza, hepatitis B andretroviruses) using electron micrographs
2. Study of the structure of important plant viruses (Gemini, tobacco ring spot andalpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agarlayer technique
5. Phage titration
6. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition,Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology,Molecular biology, Pathogenesis and Control.2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology.3rd edition. Prentice Hall publication, NewJersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology.2nd edition.Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology.Wolfe Medical Publication.

Paper: MAJOR Paper Code: UMICMAJ24008 Paper Level: 200

INDUSTRIAL MICROBIOLOGY

(Paper Type: Theory)
Semester –IV
Lecture Hours : 45 h Marks: 40 Credits: 3

Unit 1 Introduction to industrial microbiology **No. of Hours: 2**

Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media **No. of Hours: 10**

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteepliquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentationparameters **No. of Hours: 12**

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged)fermentations; batch, fed-batch (eg. baker's yeast) and continuous

fermentationsComponents of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and productionfermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentationparameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit 4 Down-stream processing **No. of Hours: 6**

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) **No. of Hours: 12**

Citric acid, ethanol, penicillin, Glutamic acid,Vitamin B12,Enzymes (amylase, protease, lipase)Wine, beer

Unit 6 Enzyme immobilization **No. of Hours: 3**

Methods of immobilization, advantages and applications of immobilization, large scale applications ofimmobilized enzymes : amylase

Paper: MAJOR Paper Code: UMICMAJ24008 Paper Level: 200

INDUSTRIAL MICROBIOLOGY

(Paper Type: Practical)

Semester –IV

Lecture Hours : 30 h Marks: 20 Credits: 1

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
(a) Enzymes: Amylase
(b) Organic acid: Citric acid
3. Immobilization of amylase in calcium alginate beads and perform amylase activity assay with these beads.
4. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology.1st edition. Bios ScientificPublishers Limited. USA
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