RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Syllabus for B.Sc. Honours in Microbiology

[NEP]

(Courses effective from Academic Year: 2024-2025)

SEMESTER I-VIII

GOPE PALACE, PASCHIM MEDINIPUR, WEST BENGAL -721102

Semester -wise Distribution of Credits for 4 Year UG Program as per NEP-2020- Proposed on 10.02.2024

Sem.	Discipline Specific Courses- Core/Major	Minor	Inter-disciplinary/ Multidisciplinary Courses	Ability Enhancement Courses (Languages)-AEC	Skill Enhancement Courses-SEC	Common Value Added Courses	Summer Internship/Community Engagement	Total Credits
I	4 CREDIT - 1 PAPER	4 CREDIT - 1 PAPER(1A)	3 CREDIT- ONE COURSE	2 CREDIT- ENGLISH	3 CREDIT- ONE COURSE	2 CREDIT- TWO COURSE =4 CREDIT		20
II	4 CREDIT - 1 PAPER	4 CREDIT - 1 PAPER(2A)	3 CREDIT- ONE COURSE	2 CREDIT-MIL	3 CREDIT- ONE COURSE	2 CREDIT- TWO COURSE =4 CREDIT	2 CREDIT- Community Engagement (4 CREDIT for those who want to exit at the end of 2nd Sem)	22
III	4 CREDIT – 2 PAPER =8 CREDIT	4 CREDIT - 1 PAPER(1B)	3 CREDIT- ONE COURSE	2 CREDIT- ENGLISH	3 CREDIT- ONE COURSE	------		20
IV	4 CREDIT - 3 PAPER=12 CREDIT	4 CREDIT - 1 PAPER(2B)	------	2 CREDIT- MIL	------	-----	2 CREDIT- Community Engagement	20
V	4 CREDIT – 4 PAPER=16 CREDIT	4 CREDIT - 1 PAPER(1C)	-----	-----	------	-----		20
VI	4 CREDIT – 4 PAPER=16 CREDIT	4 CREDIT - 1 PAPER(2C)	-----	-----	—	-----	2 CREDIT- Summer Internship	22
VII	4 CREDIT - 4 PAPER=16 CREDIT	4 CREDIT - 1 PAPER(1D)	-----	-----	-----	-----		20
VIII	4 CREDIT - 2 PAPER	4 CREDIT - 1 PAPER(2D)	-----	-----	-----	**RESEARCH PROJECT/DISSERTATION 12 CREDIT		24
TOTAL	4x21 =84 Min.Credit =80	4X 8=32 Min.Credit =32	3 X 3=9	2 X4=8	3 X 3=9 2 X 1=2	2 X 4=8 12 X 1=12		168 Min. Credit=160

**Additional 3 core Paper of 4 credit each to be studied by those who will not be opting for Hons. with Research Degree.

Laha 12-02-24

DR. JAYASREE LAHA
Principal
Rāja Narendra Lal Khan Women's College

RAJA NARENDRA LAL KHAN WOMEN'S COLLEGE MIDNAPORE

SEM	PAPER CODE	PAPER	NUMBER (T+P)	CREDIT (T+P)
I	MCBMJ-101	Introduction to Microbiology, Microbial Diversity with Concept of Microbiome	40+20	3+1
	MCBSEC-101	Biofertilizers and Biopesticides	20+20	2+1
II	MCBMJ-201	Bacteriology	40+20	3+1
	MCBSEC-201	Biostatistics	20+20	2+1
III	MCBMJ-301	Biochemistry	40+20	3+1
	MCBMJ-302	Microbial Physiology and Metabolism	40+20	3+1
	MCBSEC-301	Microbial Quality Control in Food and Pharmaceutical Industries	20+20	2+1
IV	MCBMJ-401	Cell Biology	40+20	3+1
	MCBMJ-402	Virology	40+20	3+1
	MCBMJ-403	Instrumentation and Biotechniques	40+20	3+1
V	MCBMJ-501	Molecular Biology	40+20	3+1
	MCBMJ-502	Microbial Genetics	40+20	3+1
	MCBMJ-503	Environmental and Space Microbiology	40+20	3+1
	MCBMJ-504	Fungal, Protozoal and Algal Pathogenesis	40+20	3+1
VI	MCBMJ-601	Immunology and Microbes in Cancer	40+20	3+1
	MCBMJ-602	Medical Microbiology with Epidemiology and Public Health	40+20	3+1
	MCBMJ-603	Recombinant DNA Technology, Microbial Biotechnology and Nanotechnology	40+20	3+1
	MCBMJ-604	Industrial Microbiology and Opportunities	40+20	3+1
VII	MCBMJ-701	Inheritance Biology	40+20	3+1
	MCBMJ-702	Microbiology of Food, Dairy and Veterinary Sciences	40+20	3+1
	MCBMJ-703	Microbial Diagnosis in Health Care	40+20	3+1
	MCBMJ-704	Agricultural Microbiology with Plant Pathology	40+20	3+1
VIII	MCBMJ-801	Ecology and Biodiversity	40+20	3+1
	MCBMJ-802	Applied Microbiology and Biomedical Sciences	40+20	3+1
	*MCBDSE-801	Essential Tools in Microbiological Research and Artificial Intelligence	60	4
	*MCBDSE-802	Bioinformatics with Concept of Omics	40+20	3+1
	*MCBDSE-803	Project Work	60	4

*MCBDSE papers only for Non-research students

MCBMI-1A/2A: Introduction to Microbiology, Microbial Diversity with Concept of Microbiome

MCBMI-1B/2B: Bacteriology

MCBMI-1C/2C: Biochemistry

MCBMI-1D/2D: Microbiology of Food, Dairy and Veterinary Sciences

SEMESTER –I

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-I01: INTRODUCTION TO MICROBIOLOGY, MICROBIAL DIVERSITY WITH CONCEPT OF MICROBIOME (THEORY)

MCBMJ-101T (Total marks-40)

TOTAL HOURS-40 **CREDIT-3**

Unit 1: History of Development of Microbiology **No. of Hours: 10**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit 2: An overview of Scope of Microbiology **No. of Hours: 02**

Application and scope in advanced research and development.

Unit 3: Diversity of Microbial World **No. of Hours: 28**

A. Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.

B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Algae: History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of algae in agriculture, industry, environment and food.

Fungi: Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, asexual reproduction, sexual reproduction, heterokaryosis, Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

Protozoa: General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia.

Microbiome: Basic concept and importance in research.

MCBMJ-I01: INTRODUCTION TO MICROBIOLOGY, MICROBIAL DIVERSITY WITH CONCEPT OF MICROBIOME (PRACTICAL)

MCBMJ-I01P (Total marks-20)

TOTAL HOURS-30 **CREDITS: 1**

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Sterilization of medium using Autoclave and assessment for sterility.
4. Sterilization of glassware using Hot Air Oven and assessment for sterility.
5. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
6. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
7. Study of *Rhizopus, Penicillium, Aspergillus* using temporary mounts.
8. Study of *Spirogyra, Chlamydomonas*, and *Volvox* using temporary mounts.
9. Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium* and *Plasmodium.*

SUGGESTED READINGS

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9thEd. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14thEd. Pearson International Ed.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9thEd. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9thEd. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2ndEd.WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5thEd. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5thEd. McMillan.

MCBSEC-101: BIOFERTILIZERS AND BIOPESTICIDES (THEORY)

MCBSEC-101T (Total marks: 20)

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Biofertilizers **No of Hours: 10**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants. Frankia - Isolation, characteristics, Alder,

Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, Azolla - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2: Non - Symbiotic Nitrogen Fixers **No of Hours: 4**

Free living Azospirillum, Azotobacter - free isolation, characteristics, mass inoculums, production and field application.

Unit 3: Phosphate Solubilizers **No of Hours: 4**

Phosphate solubilizing microbes- Isolation, characterization, mass inoculum production, fieldapplication.

Unit 4: Mycorrhizal Biofertilizers **No of Hours: 5**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculums production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5: Bioinsecticides **No of Hours: 7**

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

MCBSEC-101: BIOFERTILIZERS AND BIOPESTICIDES (PRACTICAL)

MCBSEC-101P (Total marks: 20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Isolation and characterization of Rhizobium, Azotobacter, PSB, and Mycorrhizae.
2. Internship on microbial application in different fields. (Individual report preparation, submission and assessment, duration -15-30 days).

SUGGESTED READINGS

1. Kannaiyan S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Subba Rao NS (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
4. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.
5. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

SEMESTER –II

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-201: BACTERIOLOGY (THEORY)

MCBMJ-201T (Total marks-40)

TOTAL HOURS: 40 **CREDITS:3**

Unit 1: Cell organization **No. of Hours: 12**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. **Cell wall:** Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. **Cell Membrane:** Structure, function and chemical composition of bacterial and archaeal cell membranes. **Cytoplasm:** Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2: Bacteriological techniques **No. of Hours: 4**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non- culturable bacteria.

Unit 3: Microscopy **No. of Hours: 4**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.

Unit 4: Growth and nutrition **No. of Hours: 3**

Nutritional requirements in bacteria and nutritional categories; **Culture media:** components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. **Physical methods of microbial control:** heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. **Chemical methods of microbial control:** disinfectants, types and mode of action.

Unit 5: Reproduction in Bacteria **No. of Hours: 3**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Unit 6: Bacterial Systematics **No. of Hours: 4**

Aim and principles of classification, systematics and taxonomy, rRNA oligonucleotide sequencing, signature sequences, and protein sequences.

Unit 7: Important archaeal and eubacterial groups **No. of Hours: 10**

Archaebacteria: General characteristics, phylogenetic overview, Three genera of archaea. **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following

groups-**Gram Negative** (General characteristics with suitable examples), **Gram Positive** (General characteristics with suitable examples), **Cyanobacteria-**An Introduction.

MCBMJ-201: BACTERIOLOGY (PRACTICAL)

MCBMJ-201P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, MacConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd Ed.WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th Ed. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th Ed. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th Ed. Tata McGraw Hill.
5. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th Ed.McMillan.
6. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th Ed. Pearson Education.
7. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th Ed. Pearson Education Limited

MCBSEC-201: BIOSTATISTICS (THEORY)

MCBSEC-201T (Total marks: 20)

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Introduction to Biostatistics **No. of Hours: 4**

Definition and scope of biostatistics, Importance of biostatistics in biological and health sciences, Types of data: qualitative and quantitative.

Unit 2: Descriptive Statistics **No. of Hours: 4**

Measures of central tendency: mean, median, mode, standard error, standard deviation; Graphical representation of data: bar diagram, pie diagram, histograms, scatter plots, ogives.

Unit 3: Probability Concepts **No. of Hours: 4**

Basic probability rules, Probability distributions, Measures of dispersion; skewness, kurtosis.

Unit 4: Sampling and Sampling Distributions **No. of Hours: 6**

Sampling parameters; Types of sampling methods: random, stratified, cluster; Difference between sample and Population; Sampling Errors; Censoring

Unit 5: Correlation and Regression **No. of Hours: 6**

Pearson and Spearman correlation coefficients; Simple linear regression: model, assumptions, and interpretation; Multiple regression analysis.

Unit 6: Hypothesis Testing **No. of Hours: 6**

Null and alternative hypotheses, Type I and Type II errors, p-values and significance levels, t-tests, chi-square tests, and ANOVA.

MCBSEC-2: BIOSTATISTICS (PRACTICAL)

MCBSEC-2P (Total marks: 20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting, Correlation, Regression
6. Finding area under the curve using normal probability
7. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
8. Confidence Interval

SUGGESTED READING

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet: Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. Edmondson A and Druce D: Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial: Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

SEMESTER –III

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-301: BIOCHEMISTRY (THEORY)

MCBMJ-301T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Bioenergetics **No. of Hours: 8**

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, 1,3- Bisphosphoglycerate, Thioesters, ATP.

Unit 2: Carbohydrates **No. of Hours: 12**

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: 12**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification. Structural lipids. Phoisphoglycerides: 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 Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

Unit 4: Proteins **No. of Hours: 12**

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 Ninhydrinreaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non-protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame. 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: 12**

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, and allosteric mechanism. Definitions of terms – enzyme unit, specific activity and turnover number, Multi enzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

Unit 6: Nucleic acid **No. Hours: 4**

Concept of purine and pyrimidine, nucleoside and nucleotide. Structure and Classification of DNA (A, B, C, D and Z) & RNA (mRNA, rRNA, tRNA), Miescher to Watson and Crick- historic perspective, DNA structure, and Salient features of double helix,

MCBMJ-301: BIOCHEMISTRY (PRACTICAL)

MCBMJ-301P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts.
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
3. Standard Free Energy Change of coupled reactions
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models
7. Study of enzyme kinetics – calculation of V_{max} , K_m, K_{cat} values
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of DNA and RNA.

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7thed., Published by Cengage Learning
2. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, WH Freeman and Company
3. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5thEd., WH Freeman and Company
4. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiologyby. 9thEd.,McGrawHill.
5. Voet D and Voet JG (2004) Biochemistry, John Wiley and Sons,

MCBMJ-302: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)

MCBMJ-302T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Microbial Growth and Effect of Environment on Microbial Growth No. of Hours: 12

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 2: Nutrient uptake and Transport No. of Hours: 10

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, gluconeogenesis, and glycogenolysis, 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: 6

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/ nitrite, 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

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: 6

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

MCBMJ-302: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)

MCBMJ-302P (Total marks-20)

TOTAL HOURS: 30 **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. Estimation of nirate reduction
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*

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SUGGESTED READINGS

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

MCBSEC-301: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES (THEORY)

MCBSEC-301T (Total marks: 20)

TOTAL HOURS: 30 **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 BSL1, 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, MacConkey Agar, Sabouraud Agar. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of 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.

MCBSEC-301: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES (PRACTICAL)

MCBSEC-301P (Total marks: 20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Internship in Food and Pharmaceutical industries for 15 to 30 days.

SUGGESTED READINGS

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd Ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th Ed. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

SEMESTER –IV

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-401: CELL BIOLOGY (THEORY)

MCBMJ-401T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Structure and organization of Cell **No. of Hours: 12**

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic. Plasma membrane: Structure and transport of small molecules, Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell, Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects). Mitochondria, chloroplasts and peroxisomes, Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules protoplasm.

Unit 2: Nucleus **No. of Hours: 4**

Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus.

Unit 3: Protein Sorting and Transport **No. of Hours: 12**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids. Golgi apparatus – Organization, protein glycosylation, protein sorting and export from Golgi apparatus, Lysosomes.

Unit 4: Cell Signalling **No. of Hours: 8**

Signalling molecules and their receptors. Function of cell surface receptors. Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.

Unit 5: Cell Cycle, Cell Death and Cell Renewal **No. of Hours: 12**

Eukaryotic and prokaryotic cell cycle and its regulation, Mitosis and Meiosis, Programmed cell death, Stem cells Embryonic stem cell, induced pleuripotent stem cells

MJ-401: CELL BIOLOGY (PRACTICAL)

MJ-401P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Study of polyploidy in Onion root tip by colchicine treatment.

5. Identification and study of cancer cells by photomicrographs.
6. Study of different stages of Mitosis.
7. Study of different stages of Meiosis.

SUGGESTED READING

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8thEd. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6thEd. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8thEd. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper GM and Hausman RE (2009). The Cell: A Molecular Approach. 5thEd. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

MCBMJ-402: VIROLOGY (THEORY)

MCBMJ-402T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Nature and Properties of Viruses **No. of Hours: 12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin. **Structure:** Capsid symmetry, enveloped and non-enveloped viruses. **Taxonomy:** Classification and nomenclature of different groups of viruses. **Cultivation:** Isolation, purification and cultivation 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: 20**

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, 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: 6**

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: 8**

Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination.

Unit 6: Applications of Virology **No. of Hours: 4**

Use of viral vectors in cloning and expression, Gene therapy and Phage display

MCBMJ-402: VIROLOGY (PRACTICAL)

MCBMJ-402P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6thEd.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. 2ndEd. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd Ed. Prentice Hall publication, NewJersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd Ed. 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.

MCBMJ-403: INSTRUMENTATION AND BIOTECHNIQUES (THEORY)

MCBMJ-403T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Microscopy **No. of Hours: 10**

Bright field and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2: Chromatography **No. of Hours: 14**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3: Electrophoresis **No. of Hours: 14**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

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

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Unit 5: Centrifugation **No. of Hours: 12**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

MCBMJ-403: INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)

MCBMJ-403P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Separation of amino acids mixtures by paper / thin layer chromatography.
2. Demonstration of column chromatography.
3. Separation of protein mixtures by chromatography.
4. Determination of λmax for sample of biomolecules and calculation of extinction coefficient.
5. Workshop /Hands-on training
6. A visit to any educational institute for training in advanced Instrumental Techniques: Report preparation and presentation.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed. Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed. W.H. Freeman and Company.
3. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed. McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Ed. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8thEd.Lipincott Williams and Wilkins, Philadelphia.
6. Cooper GM and Hausman RE. (2009). The Cell: A Molecular Approach. 5th Ed. ASM Press & Sunderland, Washington DC, Sinauer Associates, MA.
7. Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

SEMESTER –V

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-501: MOLECULAR BIOLOGY (THEORY)

MCBMJ-501T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Structures of DNA and RNA / Genetic Material **No. of Hours: 12**

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, C value paradox, Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair, Fidelity of replication.

Unit 3: Transcription in Prokaryotes and Eukaryotes **No. of Hours: 8**

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

Unit 4: Post- Transcriptional Possessing **No. of Hours: 8**

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance.

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: 12**

Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

MCBMJ-501: MOLECULAR BIOLOGY (PRACTICAL)

MCBMJ-501P (Total marks-20)

TOTAL HOURS: 30 **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* and visualization of DNA by Agarose Gel Electrophoresis
4. 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 Ed. Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7thEd., Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8thEd. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6thEd. John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4thEd. Cold Spring Harbour Laboratory press.
6. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8thEd. Wiley-India

MCBMJ-502: MICROBIAL GENETICS (THEORY)

MCBMJ-502T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Introduction to Genetics **No. of Hours: 6**

Historical developments. Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomyces cerevisiae, Candida albicans*

Unit 2: Mutations **No. of Hours: 16**

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of Mutations. **Reversion and suppression:** True revertants; Intra- and inter-genic suppression; Ames test; replica plating, and fluctuation test. Mutator genes.

Unit 3: Plasmids **No. of Hours: 10**

Types of plasmids: F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

Unit 4: Mechanisms of Genetic Exchange **No. of Hours: 16**

Transformation: Discovery, mechanism of natural competence. **Conjugation:** Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping. **Transduction:** Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers.

Unit 5: Transposable elements **No. of Hours: 12**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon. Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds). Uses of transposons and transposition.

MCBMJ-502: MICROBIAL GENETICS (PRACTICAL)

MCBMJ-502P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E. coli*
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

SUGGESTED READING

1. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed. Jones and Bartlett Learning
2. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed. Macmillan Higher Education Learning
3. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8thEd. Wiley-India
4. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed. Benjamin Cummings
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4thEd.Cold Spring Harbour Laboratory press.
6. Maloy SR, Cronan JE and FriefelderD (2004) Microbial Genetics 2ndEd. Jones and Barlett Publishers

MCBMJ-503: ENVIRONMENTAL AND SPACE MICROBIOLOGY (THEORY)

MCBMJ-503T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Microorganisms and their Habitats **No. of Hours: 14**

Structure and function of ecosystems. Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes. Animal environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low

temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter.

Unit 2: Microbial Interactions **No. of Hours: 12**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-plant interactions: symbiotic and non-symbiotic interactions. Microbe-animal interactions: microbes in ruminants.

Unit 3: Biogeochemical Cycling **No. of Hours: 12**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese.

Unit 4: Waste Management and Microbial Bioremediation **No. of Hours: 15**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, Biosurfactants.

Unit 5: Water Potability **No. of Hours: 5**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

Unit 6: Space Microbiology **No. of Hours: 2**

Concept of space, Microbes in space, Their importance and applications.

MCBMJ-503: ENVIRONMENTAL AND SPACE MICROBIOLOGY (PRACTICAL)

MCBMJ-503P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water (MPN, IMVIC).
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of Rhizobium from root nodules.

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4thEd. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th Ed. Pearson/ Benjamin Cummings
3. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
4. Subba Rao NS. (1999). Soil Microbiology. 4th Ed.. Oxford & IBH Publishing Co. New Delhi.

MCBMJ-504: FUNGAL, PROTOZOAL AND ALGAL PATHOGENESIS (THEORY)

MCBMJ-504T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Host pathogen interaction **No. of Hours: 10**

Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2: Algal diseases **No. of Hours: 13**

Causative agent, toxin produced, symptoms, transmission and control of algal diseases: Paralytic Shellfish Poisoning (PSP), Amnesic Shellfish Poisoning (ASP), Diarrhetic Shellfish Poisoning (DSP), Ciguatera Fish Poisoning (CFP), Cyanobacterial Harmful Algal Blooms (CyanoHABs), Seaweed Dermatitis.

Unit 3: Protozoal diseases **No. of Hours: 8**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar, amoebiosis.

Unit 4: Fungal diseases **No. of Hours: 12**

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention of Cutaneous mycoses: *Tinea pedis* (Athlete's foot), Systemic mycoses: Histoplasmosis, Opportunistic mycoses: Candidiasis

Unit 5: Antimicrobial agents **No. of Hours: 15**

General characteristics and mode of action; Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin; Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine; Anti Protozoal medicine: Chloroquine phosphate, Liposomal amphotericin B, Metronidazole

MCBMJ-504: FUNGAL, PROTOZOAL AND ALGAL PATHOGENESIS (PRACTICAL)

MCBMJ-504P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. A dissertation paper (review) will have to be submitted on any bacterial, algal, fungal and protozoan disease. [1 month]
2. A viva voce assessment will be conducted on the dissertation paper.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology, 4 th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology, 9 th edition, McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition, Pearson International Edition

SEMESTER –VI

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-601: IMMUNOLOGY AND MICROBES IN CANCER (THEORY)

MCBMJ-601T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Introduction **No. of Hours: 2**

Concept of Innate and Adaptive immunity.

Unit 2: Immune Cells and Organs **No. of Hours: 10**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Unit 3: Antigens and Antibodies **No. of Hours: 10**

Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants.

Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

Unit 4: Major Histocompatibility Complex **No. of Hours: 5**

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit 5: Complement System **No. of Hours: 5**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation.

Unit 6: Immune Response and Immunological Disorders **No. of Hours: 15**

Primary and Secondary Immune Response; Generation of Humoral Immune Response; Generation of Cell Mediated Immune Response; Killing Mechanisms by CTL and NK cells, Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD.

Unit 7: Immunological Techniques **No. of Hours: 8**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

Unit 8: Microbes in Cancer **No. of Hours: 5**

Basic concept of cancer development, Role of microbes in cancer development, Oncogenes and virus.

MCBMJ-601: IMMUNOLOGY AND MICROBES IN CANCER (PRACTICAL)

MCBMJ-601P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Determination of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Determination of Hb, ESR.
5. Separate serum from the blood sample (demonstration).
6. Perform immunodiffusion by Ouchterlony method.
7. Perform ELISA.
8. Perform immunoelectrophoresis.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6thEd.Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11thEd. Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6thEd. W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7thEd. Garland Science Publishers,New York.
5. PeakmanM, and Vergani D. (2009). Basic and Clinical Immunology. 2ndEd. Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6thEd. Wiley Blackwell Publication.

MCBMJ-602: MEDICAL MICROBIOLOGY WITH EPIDEMIOLOGY AND PUBLIC HEALTH (THEORY)

MCBMJ-602T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Normal microflora of the human body and host pathogen interaction **No. of Hours: 8**

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2: Sample collection, transport and diagnosis **No. of Hours: 5**

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

Unit 3: Bacterial diseases **No. of Hours: 15**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control. **Respiratory Diseases:** *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*. **Gastrointestinal Diseases:** *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* **Others:** *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*, *Treponema pallidum, Clostridium difficie*

Unit 4: Viral diseases **No. of Hours: 14**

Polio, Hepatitis, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephelatis.

Unit 5: Fungal diseases **No. of Hours: 5**

Type of fungal disease with example, Causative agent, symptoms, transmission and control of fungal diseases: Cryptococcosis, Aspergillosis, Ringworm (*Tinea corporis*).

Unit 6: Antimicrobial agents: General characteristics and mode of action **No. of Hours: 8**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin, Nystatin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

Unit 5: Epidemiology and public health **No. of Hours: 5**

Basic concept of epidemiology and public health, concept of pandemic, epidemic and endemic, epidemiological perspective of microbial disorders.

MCBMJ-602: MEDICAL MICROBIOLOGY WITH EPIDEMIOLOGY AND PUBLIC HEALTH (PRACTICAL)

MCBMJ-602P (Total marks-40)

TOTAL HOURS: 30 **CREDITS: 1**

1. Identify bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) on the basis of cultural, morphological and biochemical characteristics: TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Determination of antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

SUGGESTED READING

1. Ananthanarayan R and Paniker CKJ. (2009) Textbook of Microbiology. 8thEd. University Press Publication
2. Brooks GF, Carroll KC, Butel JS, Morse SA and Mietzner TA. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26thEd. McGraw Hill Publication.
3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007) Mims' Medical Microbiology. 4thEd. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.9thEd. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14thEd. Pearson International Ed.

MCBMJ-603: RECOMBINANT DNA TECHNOLOGY, MICROBIAL BIOTECHNOLOGY AND NANOTECHNOLOGY (THEORY)

MCBMJ-603T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Introduction to Genetic Engineering and Microbial Biotechnology **No. of Hours: 2**

Milestones in genetic engineering and biotechnology, Microbial biotechnology: Scope and its applications in human therapeutics, agriculture. Genetically engineered microbes for industrial application: Bacteria and yeast.

Unit 2: Molecular Cloning- Tools and Strategies **No. of Hours: 14**

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases. Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids. Use of linkers and adaptors. Expression vectors: E.coli lac and T7 promoter-based vectors, mammalian SV40-based expression vectors.

Unit 3: Methods in Molecular Cloning **No. of Hours: 12**

Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, Agrobacterium - mediated delivery. DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit4: DNA Amplification and DNA sequencing **No. of Hours: 6**

PCR: Basics of PCR, RT-PCR, Real-Time PCR. Sanger's method of DNA Sequencing: traditional and automated sequencing. Primer walking and shotgun sequencing.

Unit 5: Construction and Screening of Genomic and cDNA libraries **No. of Hours: 6**

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

Unit 6: Therapeutic and Industrial Biotechnology **No. of Hours: 6**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics. Microbial biosensors.

Unit 7: Applications of Recombinant DNA Technology **No. of Hours: 8**

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, golden rice, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

Unit 8: Nanotechnology **No. of Hours: 6**

Concept of nanoparticles, advances and applications of nanotechnology, DNA based nano-structure, organic and inorganic nano-particles.

MCBMJ-603: RECOMBINANT DNA TECHNOLOGY, MICROBIAL BIOTECHNOLOGY AND NANOTECHNOLOGY (PRACTICAL)

MCBMJ-603P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
2. Cloning of DNA insert and Blue white screening of recombinants.
3. Amplification of DNA by PCR
4. Sequence the DNA from the supplied Data.
5. To attend the seminar /conference

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th Ed.. Blackwell Publishing, Oxford,U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. ElsevierAcademic Press, USA
3. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd Ed..ColdSpring Harbor Laboratory Press
4. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. BlackwellPublishing, Oxford, U.K.
5. Demain AL and Davies JE. (1999). Manual of Industrial Microbiology and Biotechnology, 2ndEd., ASM Press.
6. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd Ed.., Elsevier Science.

MCBMJ-604: INDUSTRIAL MICROBIOLOGY AND OPPORTUNITIES (THEORY)

MCBMJ-604T (Total marks-40)

TOTAL HOURS: 60 **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, corn steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 3: Types of fermentation processes, bio-reactors and measurement of fermentation parameter **No. of Hours: 16**

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - 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 **No. of Hours: 10**

Micro-organisms involved, media, fermentation conditions, downstream processing and uses of- Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase), Wine, beer.

Unit 6: Enzyme immobilization **No. of Hours: 8**

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase) whole cell immobilization for production.

Unit 7: Opportunities of Microbiologists in Different Sectors **No. of Hours: 8**

Role, skills and qualifications of Microbiologist in mentioned sectors: healthcare and clinical laboratories, pharmaceuticals and biotechnology, environmental microbiology, agriculture and food industry, academia and research, government and public health, industrial microbiology, bioinformatics and computational biology, veterinary microbiology, non-profit and international organizations.

MCBMJ-604: INDUSTRIAL MICROBIOLOGY AND OPPORTUNITIES (PRACTICAL)

MCBMJ-604P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Study different parts of fermenter.
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzymes: Amylase and Protease; (b) Alcohol: Ethanol.

3. A visit to any industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st Ed., Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st Ed. Bios Scientific Publishers Limited. USA
3. Casida LE. (1991). Industrial Microbiology. 1st Ed. Wiley Eastern Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd Ed., Elsevier Science Ltd.

SEMESTER –VII

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-701: INHERITANCE BIOLOGY (THEORY)

MCBMJ-701T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Mendelian Principles **No. of Hours: 12**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles. **Chromosome theory of inheritance:** Allele, multiple alleles, pseudo allele, complementation tests. **Extensions of Mendelian genetics:** Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.

Unit 2: Linkage and Crossing over **No. of Hours: 9**

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping

Unit 3: Extra-Chromosomal Inheritance **No. of Hours: 9**

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in Chlamydomonas, mitochondrial, mutations in Saccharomyces, Maternal effects – Shell coiling in *Limnaea peregra* Infectious heredity - Kappa particles in Paramecium.

Unit 4: Characteristics of Chromosomes **No. of Hours: 15**

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities -Klinefelter syndrome, Turner syndrome, Down syndrome

Unit 5: Recombination **No. of Hours: 3**

Homologous and non-homologous recombination, including transposition, site-specificrecombination.

Unit 6: Human genetics **No. of Hours: 3**

Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Unit 7: Quantitative genetics **No. of Hours: 3**

Polygenic inheritance, heritability and its measurements, QTL mapping.

MCBMJ-701: INHERITANCE BIOLOGY (PRACTICAL)

MCBMJ-701P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Mendelian deviations in dihybrid crosses
2. To demonstrate the presence of Barr Body from the oral mucosa.
3. Studying Rhoeo translocation with the help of photographs.
4. Karyotyping with the help of photographs.
5. Chi-Square Analysis.
6. Study of pedigree analysis.
7. Analysis of a representative quantitative trait.
8. Preparation of polytene chromosome from salivary gland of Drosophila larvae

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed.Benjamin Cummings
4. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and BartlettPublishers
5. Russell PJ. (2009). i Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

MCBMJ-702: MICROBIOLOGY OF FOOD, DAIRY AND VETERINARY SCIENCES

(THEORY)

MCBMJ-702T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

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

Components of food, Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, source of contamination of foods in general. Normal microbial flora of common foods (milk, meat, fish, cereals, vegetables and fruits).

Unit 2: Microbial spoilage of various foods **No. of Hours: 8**

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

Unit 3: Principles and methods of food preservation **No. of Hours: 10**

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 foods **No. of Hours: 8**

Preparation of inoculums, types of microorganisms and production process: Dahi, yogurt, Buttermilk, kumiss, kefir, and cheese, other fermented foods: Idli, dosa, sauerkraut, soy sauce and tampeh

Unit 5: Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **No. of Hours: 10**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; **Food infections:** *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6: Microorganisms as food **No. of Hours: 8**

Single cell protein, algae as food, mushroom, Concept of probiotics, prebiotics and synbiotics (Health benefits, probiotic foods available in market).

Unit 7: Veterinary Science **No. of Hours: 8**

Major microbial diseases in shrimp, fish, cattle and poultry. Gut Probiotics formulation, opportunities and importance.

MCBMJ-702: MICROBIOLOGY OF FOOD, DAIRY AND VETERINARY SCIENCES (PRACTICAL)

MCBMJ-702P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
4. Isolation of spoilage microorganisms from bread.
5. Preparation of Yogurt/Dahi.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4thEd. New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1stEd. CBS Publishers and Distributors,Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd Ed. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
5. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9thEd. Pearson Education.
6. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
7. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
8. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th Ed. Springer.

MCBMJ-703: MICROBIAL DIAGNOSIS IN HEALTH CARE (THEORY)

MCBMJ-703T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Importance of Diagnosis of Diseases **No of Hours: 8**

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit 2: Collection of Clinical Samples **No of Hours: 12**

How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit 3: Direct Microscopic Examination and Culture **No of Hours: 15**

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria. Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar. Distinct colony properties of various bacterial pathogens.

Unit 4: Kits for Rapid Detection of Pathogens **No of Hours: 10**

Typhoid, Dengue and HIV, Swine flu

Unit 5: Testing for Antibiotic Sensitivity in Bacteria **No of Hours: 15**

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

MCBMJ-703: MICROBIAL DIAGNOSIS IN HEALTH CARE (PRACTICAL)

MCBMJ-703P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Preparation of blood smear and demonstration of malarial parasite
2. WIDAL test and titer estimation,
3. Estimation of blood sugar
4. Determination of Mycobacterium tuberculosis: Montoux test
5. Estimation of blood urea & cholesterol,
6. Estimation of SGOT & SGPT.

SUGGESTED READING

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8thEd. Universities Press Private Ltd.
2. Brooks GF, Carroll KC, Butel JS, Morse SA and Mietzner TA. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26thEd. McGraw Hill Publication.

3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd Ed. Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th Ed. Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th Ed. Elsevier.

MCBMJ-704: AGRICULTURAL MICROBIOLOGY WITH PLANT PATHOLOGY (THEORY)

MCBMJ-704T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Introduction to Agricultural Microbiology **No. of Hours: 2**

History and scope of agricultural microbiology, Importance of microorganisms in agriculture.

Unit 2: Soil Microbiology **No. of Hours: 8**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil. Methods for studying soil microorganisms.

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

Basic concept of mineralization and immobilization. Factors control the mineralization in soil. Organic matter decomposition: cellulose, hemicelluloses, lignocelluloses, lignin and humus, Classification of humus and formation of humus with its importance for crops.

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

Farmyard manure, Method of composting (aerobic, anaerobic), enrichment of compost with microbial inoculants. Super digested compost, biogas production. Vermiculture process, Vermicomposting materials, Advantages of vermicompost.

Unit 5: Introduction and History of plant pathology **No. of Hours: 8**

Concept of plant disease - definitions of disease, disease cycle (Infection, invasion, colonization, dissemination of pathogens and perennation) & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases.

Unit 6: Host Pathogen Interaction **No. of Hours: 8**

Virulence factors of pathogens: enzymes, toxins, Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

Unit 7: Defense Mechanisms in Plants **No. of Hours: 8**

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses (hypersensitive response (HR), phytoalexins.

Unit 8: Specific Plant diseases and control **No. of Hours: 10**

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control: White rust of crucifers (*Albugo candida*), Downy mildew of onion (*Peronospora destructor*), Late blight of potato (*Phytophthora infestans*), Powdery mildew of wheat (*Erysiphe graminis*), Early blight of potato (*Alternaria solani*), bacterial leaf blight of rice, crown galls, bacterial cankers of citrus, banana bunchy top, rice tungro. Principles & practices involved in the management of plant diseases by different methods.

MCBMJ-704: AGRICULTURAL MICROBIOLOGY WITH PLANT PATHOLOGY (PRACTICAL)

MCBMJ-704P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Puccinia, Fusarium, Alterneria, Phytophthora*
3. Isolation of fungal pathogen from diseased plant specimen.
4. Study of inclusion bodies in viral infected plants
5. Study of stomatal nature in virus-infected plants
6. Biochemical tests for plant pathogens.
7. Identification of pathological plant specimen (Demonstration of sheet preparation).

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th Ed. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd Ed. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4thEd. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7thEd. Oxford & IBH, New Delhi.

SEMESTER –VIII

B. Sc. (HONOURS) MICROBIOLOGY (NEP)

MCBMJ-801: ECOLOGY & BIODIVERSITY (THEORY)

MCBMJ-801T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: The Environment **No. of Hours: 13**

Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Population Ecology: Characteristics of a population; population growth curves; population regulation.

Unit 2: Community Ecology **No. of Hours: 15**

Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit 3: Ecosystem Ecology **No. of Hours: 12**

Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); Food Chain, Food web, Trophic level, Ecological pyramids, primary production and decomposition; topographical structure and function of some ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; biogeographical zones of India, Concept of CRZ.

Unit 4: Biodiversity **No. of Hours: 20**

Concept of biodiversity, alpha, beta and gamma diversity, hotspots of biodiversity, Threat to species diversity, Extinction vortex, Causes of extinction; Red Data Book, Biodiversity conservation approaches: Local, National and International, In situ and ex situ conservation, Sanctuary, National Park and Biosphere reserves; Threats to wildlife conservation and wildlife trade; Use of Radiotelemetry and Remote sensing in wildlife research.

MCBMJ-801: ECOLOGY & BIODIVERSITY (PRACTICAL)

MCBMJ-801P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

Student will have to make a field visit to any *ex-situ* conservation site and submit a field report. Evaluation will be based on the viva voce and examination of field report by an external examiner.

SUGGESTED READINGS

1. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Sounders Natraj publication (Indian edition).

2. Sharma, P.D.(2017) Ecology and environment, 13th edition, Rastogi Publication.
3. Kormandy E. J. (1996) Concepts of ecology, Prentice Hall of India Pvt. Ltd.
4. Chapman J.L. and Reiss M.J. (2000) Ecology: Principles and applications 2nd edition, Cambridge: University Press.

MCBMJ-802: APPLIED MICROBIOLOGY AND BIOMEDICAL SCIENCES

(THEORY)

MCBMJ-802T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Metagenomics **No. of Hours: 8**

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Unit 2: Sequencing of nucleic acids and proteins **No. of Hours: 12**

Nucleic acid sequencing technologies: Maxam Gilbert sequencing, Sanger's dideoxy sequencing, Pyrosequencing, Next-Generation Sequencing, Protein sequencing technologies: Edman degradation, Sanger's method, Trypsin and Cyanogen Bromide fragmentation, Dansyl and Dabsyl chloride derivatisation

Unit 3: Natural Therapeutics **No. of Hours: 5**

Molecular principles of drug targeting, Drug delivery system: concept of pharmacokinetics and pharmacodynamics, Application of phage therapy, and meditation

Unit 4: Application of Microbial Technology **No. of Hours: 12**

Production of biopolymer (dextran, alginate, pullunan, xanthan gum, PHB) and bioplastic. Steroid biotransformation for preparation of useful drugs, Production of therapeutic agents from microbial origin: antibiotics, recombinant product, enzymes, phenolics.

Unit 5: Antimicrobial Resistance **No. of Hours: 5**

Drug resistance in microbes and its effect in the society, MDR status.

MCBMJ-802: APPLIED MICROBIOLOGY AND BIOMEDICAL SCIENCES

(PRACTICAL)

MCBMJ-802P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Extraction of metagenomic DNA from soil/water
2. Estimation of Preservative in any pharmaceutical product.
3. Microbial limit test (MLT), Water analysis for various Pharmaceutical Products and raw materials.
4. Drug resistance properties study on microbes.

5. Demonstration on QC and QA analysis by specialist

SUGGESTED READINGS

1. Biochemistry, Donald Voet and Judith G. Voet, 4th Edition, John Wiley and Sons, 2011.
2. DNA Sequencing Protocols, 2nd edition, by Graham, Humana Press Inc. 2001
3. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
4. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
5. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
6. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011) Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press.
7. Introduction to Nano: basics to nanoscience and nanotechnology by Amretashis Sengupta (Editor); Chandan Kumar Sarkar (Editor)

MCBDSE-801: ESSENTIAL TOOLS IN MICROBIOLOGICAL RESEARCH AND ARTIFICIAL INTELLIGENCE (THEORY)

MCDSE-801T (Total marks-60)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1: Principles of Biosafety **No. of Hours: 12**

Biosafety guidelines and regulations (National and International); GMOs LMOs- Concens and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC ete. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit 2: Introduction to Intellectual Property Rights **No. of Hours: 8**

Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications, legal protection of biotechnological inventions World Intellectual Property Rights Organization (WIPO)

Unit 3: Documentation and presentation of biological data **No. of Hours: 10**

The art of scientific writing: numbers, units, abbreviations and nomenclature used in scientific writing. Types of scientific writings: Original Research articles, Short communications, Perspectives, Review/mini-reviews.

Unit 4: Research Design **No. of Hours: 8**

Concept and Importance in Research, Features of a good research design, Exploratory Research Design- concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Unit 5: Use of tools/techniques for Research **No. of Hours: 6**

Methods to search required information effectively, Reference Management Software like Zotero/Mendeley.

Unit 6: Interpretation of Data and Paper Writing **No. of Hours: 8**

Layout of a Research Paper, Journals in Biological Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit 7: Areas of Microbiological Research and Important Tools **No. of Hours: 6**

Concept and history of Artificial Intelligence (AI), Performance of AI, Application of AI in medical field.

SUGGESTED READING

1. Wilson and Walker's Principles and Techniques of Biochemistry And Molecular Biology Edited by Andreas Hofmann , Samuel Clokie First published 2018
2. Biostatistics & Research Methodology: G Nageswara Rao PharmaMed Press, 2018
3. Research Methodology for Biological science, Gurumani, N, MJP Publishers, 2020
4. Introduction to Biostatistics, Pranab K. Banerjee, S. Chand Publication, 2007
5. IPR, Biosafety And Bioethics 2013 Edition by Goel, Pearson

MCBDSE-802: BIOINFORMATICS AND CONCEPT OF OMICS (THEORY)

MCDSE-802T (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Introduction to bioinformatics **No. of Hours: 8**

Introduction to bioinformatics, Types of biological databases: - Genome databases, Protein sequence and structure databases, gene expression databases, Database of metabolic pathways, Indexing databases and Citation databases, retrieval and handling of data from Biological databases.

Unit 2: Sequence alignment **No. of Hours: 10**

Sequence comparison, pairwise alignment, multiple alignment, database searching, algorithms of FASTA and BLAST, Mutation matrix and its application.

Unit 3: Phylogenetic trees **No. of Hours: 12**

Phylogeny and Phylogenetic trees, Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood.

Unit 4: Protein Structure Predictions **No. of Hours: 10**

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling. Ligand- protein interaction. System biology: approaches and application

Unit 5: Introduction of Computer Fundamental **No. of Hours: 12**

History of Computer, Generation of computer, Basic computer architecture, Software's-use of MS word, MS EXCEL MS power point, Application of SPSS, Use of software for Microbial data analysis.

Unit 6: Concept of omics **No. of Hours: 8**

Basic concept of omics, major divisions, importance and applications.

MCBDSE-802: BIOINFORMATICS AND CONCEPT OF OMICS (PRACTICAL)

MCDSE-802P (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Operation Microsoft word, Microsoft excel, Microsoft Power Point and internet.
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB.
3. Sequence retrieval using BLAST.
4. Sequence alignment & phylogenetic analysis using clustalW & Phylip.
5. Protein structure prediction,
6. Protein ligand interaction & amino acid analysis

SUGGESTED READING

1. M. Mano, Computer System Architecture, Pearson Education 1992
2. W. Stallings, Computer Organization and Architecture Designing for Performance, 8 Edition, Prentice Hall of India, 2009
3. JinXiong, Essential Bioinformatics, 2006, Cambridge University Press, The Edinburgh Building, Cambridge, UK

MCBDSE-803: PROJECT WORK

MCDSE-803 (Total marks-60)

TOTAL HOURS: 60 **CREDITS: 4**

The Topic for Dissertation will be assigned to the students by the concerned supervisor (Internal/External) at the beginning of the Semester: -

The Project Work may be carried out in the Home Institute or any chosen laboratory from a Research Institute/University/Autonomous Body.

Project Work pertaining to any Pure Microbiology/ Applied microbiology / Advanced Microbiology / Plant Pathology/ Animal pathology/ Immunology/ Biochemistry/ Molecular Biology/ Biophysics/ Bioinformatics/ Biostatistics/ Inter-disciplinary biological science may be carried out.

[Laboratory assessment + submission of project report + PowerPoint presentation]

MICROBIOLOGY MINOR (NEP)

SEMESTER-I/II

MCBMI-1AT/2AT: INTRODUCTION TO MICROBIOLOGY, MICROBIAL DIVERSITY WITH CONCEPT OF MICROBIOME (THEORY)

MCBMI-1AT/2AT

[Total marks-40]

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: History of Development of Microbiology **No. of Hours: 12**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister,Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, SergeiN. Winogradsky, Selman A. Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit 2: Diversity of Microorganisms **No. of Hours: 10**

Systems of classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa) giving definitions and citingexamples. Protozoa: Methods of nutrition, locomotion & reproduction - Amoeba, Parameciumand Plasmodium.

Unit 3: Microscopy **No. of Hours: 7**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Transmission Electron Microscope, Scanning Electron Microscope

Unit 4: Sterilization **No. of Hours: 5**

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filtration.

Unit 5: Microbes in Human Health & Environment **No. of Hours: 10**

Medical microbiology and immunology: List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types. ***Environmental microbiology:*** Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (e.g. hydrocarbons in oil spills)

Unit 6: Industrial Microbiology **No. of Hours: 8**

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

Unit 7: Food and Dairy Microbiology **No. of Hours: 8**

Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non-dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

MCBMI-1AP/2AP: INTRODUCTION TO MICROBIOLOGY, MICROBIAL DIVERSITY WITH CONCEPT OF MICROBIOME (PRACTICAL)

MCBMI-1AP/2AP

[Total marks-20]

TOTAL HOURS: 30 **CREDITS: 1**

1. Microbiology Laboratory Management and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility.
5. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.
6. Study of Aspergillus, Penicillium, Volvox, Spirulina, Spirogyra, Entamoeba using permanent Mounts.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9thEd.PearsonEducation
2. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9thEd.PearsonEducation Limited.
3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5thEd. McGrawHill Book Company.
4. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). GeneralMicrobiology. 5thEd. McMillan.

MICROBIOLOGY MINOR (NEP)

SEMESTER-III/IV

MCBMI-1BT/2BT: BACTERIOLOGY (THEORY)

MCBMI-1BT/2BT [Total marks-40]

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Cell organization **No. of Hours: 12**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. **Cell wall:** Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. **Cell Membrane:** Structure, function and chemical composition of bacterial. **Cytoplasm:** Ribosomes, inclusion bodies, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2: Bacteriological techniques **No. of Hours: 4**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non- culturable bacteria.

Unit 3: Application of Microscope **No. of Hours: 4**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.

Unit 4: Growth and nutrition **No. of Hours: 3**

Nutritional requirements in bacteria and nutritional categories; **Culture media:** components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. **Physical methods of microbial control:** heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. **Chemical methods of microbial control:** disinfectants, types and mode of action.

Unit 5: Reproduction in Bacteria **No. of Hours: 3**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Unit 7: Important archaeal and eubacterial groups **No. of Hours: 10**

Archaebacteria: General characteristics, phylogenetic overview, Three genera of archaea. **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups-**Gram Negative** (General characteristics with suitable examples), **Gram Positive** (General characteristics with suitable examples), **Cyanobacteria**-An Introduction.

MCBMI-1BP/2BP: BACTERIOLOGY (PRACTICAL)

MCBMI-1BP/4BP [Total marks-20]

TOTAL HOURS: 30 **CREDITS: 1**

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform simple staining and Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate

SUGGESTED READING

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms.14th Ed. Pearson Education, Inc.
2. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5thEd. McMillan
3. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5thEd. Tata McGraw Hill.
4. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9thEd. PearsonEducation.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9thEd.McGraw Hill Higher Education.

MICROBIOLOGY MINOR (NEP)

SEMESTER-V/VI

MCBMI-1CT/2CT: BIOCHEMISTRY (THEORY)

MCBMI-1CT/2CT (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

Unit 1: Bioenergetics **No. of Hours: 8**

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them.

Unit 2: Carbohydrates **No. of Hours: 12**

Structure and classification of carbohydrate (monosaccharide, disaccharide, polysaccharide). Physical of chemical property of carbohydrate. Biological importance of carbohydrate.

Unit 3: Lipids **No. of Hours: 12**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. General structure, functions and properties. Biomedical function of Lipid

Unit 4: Proteins **No. of Hours: 12**

Functions of proteins, Primary structures of proteins, Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame. 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.

Unit 5: Enzymes **No. of Hours: 12**

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. MM equation of uni enzyme substrate reaction. Definitions of terms – enzyme unit, specific activity and turnover number, Effect of pH and temperature on enzyme activity.

Unit 6: Nucleic acid **No. of Hours: 4**

Concept of purine and pyrimidine, nucleoside and nucleotide. Structure and Classification of DNA (A, B and Z) & RNA (mRNA, rRNA, tRNA), RNADNA Structure: Watson and Crick- historic perspective,

MCBMI-1CP/2CP: BIOCHEMISTRY (PRACTICAL)

MCBMI-1CP/2CP (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts.

2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars
3. Qualitative/Quantitative tests for lipids and proteins
4. Estimation of DNA and RNA.

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, WH Freeman and Company
3. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Ed., WH Freeman and Company
4. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiologyby. 9th Ed., McGrawHill.
5. Voet D and Voet JG (2004) Biochemistry, John Wiley and Sons,

MICROBIOLOGY MINOR (NEP)

SEMESTER-VII/VIII

MCBMI-1DT/2DT: MICROBIOLOGY OF FOOD, DAIRY AND VETERINARY SCIENCES (THEORY)

MCBMI-1DT/2DT (Total marks-40)

TOTAL HOURS: 60 **CREDITS: 3**

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

Components of food, Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, source of contamination of foods in general. Normal microbial flora of common foods (milk, meat, fish, cereals, vegetables and fruits).

Unit 2: Microbial spoilage of various foods **No. of Hours: 8**

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

Unit 3: Principles and methods of food preservation **No. of Hours: 10**

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 foods **No. of Hours: 8**

Preparation of inoculums, types of microorganisms and production process: Dahi, yogurt, Buttermilk, kumiss, kefir, and cheese, other fermented foods: Idli, dosa, sauerkraut, soy sauce and tampeh

Unit 5: Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **No. of Hours: 10**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; **Food infections:** *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes*and *Campylobacter jejuni*

Unit 6: Microorganisms as food **No. of Hours: 8**

Single cell protein, algae as food, mushroom, Concept of probiotics, prebiotics and synbiotics (Health benefits, probiotic foods available in market).

Unit 7: Veterinary Science **No. of Hours: 8**

Major microbial diseases in shrimp, fish, cattle and poultry. Importance of Gut microbiology, Probiotics formulation and opportunities.

MCBMI-1DP/2DP: MICROBIOLOGY OF FOOD, DAIRY AND VETERINARY SCIENCES (PRACTICAL)

MCBMI-1DP/2DP (Total marks-20)

TOTAL HOURS: 30 **CREDITS: 1**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
4. Isolation of spoilage microorganisms from bread.
5. Preparation of Yogurt/Dahi.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4thEd. New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1stEd. CBS Publishers and Distributors,Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd Ed. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
5. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9thEd. Pearson Education.
6. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
7. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
8. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th Ed. Springer.