DR SHYAMA PRASAD MUKHERJEE UNIVERSITY

Proposed Syllabus for

B.Sc. MICROBIOLOGY HONOURS

Under

CHOICE BASED CREDIT SYSTEM

Structure of B. Sc. Honours Microbiology under CBCS

Core Course

C-1: Introduction to Microbiology and Microbial Diversity C-2: Bacteriology
C-3: Biochemistry C-4: Biochemistry
C-5: Microbial Physiology and Metabolism C-6: Cell Biology
C-7: Molecular Biology C-8: Microbial Genetics
C-9: Environmental Microbiology
C-10: Food and Dairy Microbiology
C-11: Industrial Microbiology
C-12: Immunology
C-13: Medical Microbiology
C-14: Recombinant DNA Technology

Discipline Specific Elective (Any Four)

DSE-1: Bioinformatics
DSE-2: Microbial Biotechnology
DSE-3: Advances in Microbiology
DSE-4: Plant Pathology
DSE-5: Biomathematics and Biostatistics
DSE-6: Inheritance Biology
DSE-7: Microbes in Sustainable Agriculture and Development
DSE-8: Biosafety and Intellectual Property Rights
DSE-9: Instrumentation and Biotechniques
DSE-10: Project Work

Generic Electives (Any Four)

GE-1: Introduction and Scope of Microbiology
GE-2: Bacteriology and Virology
GE-3: Microbial Metabolism
GE-4: Industrial and Food Microbiology
GE-5: Microbes in Environment
GE-6: Medical Microbiology and Immunology
GE-7: Genetic Engineering and Biotechnology
GE-8: Microbial Genetics and Molecular Biology

Ability Enhancement Compulsory Courses

AE-1: Environmental Sciences
AE-2: English/MIL Communication

SkillEnhancementElectiveCourses(AnyTwo)

SE-1:MicrobialQualityControlinFoodandPharmaceuticalIndustries
SE-2: Microbial Diagnosis in HealthClinics

SE-3: Biofertilizers and Biopesticides

SE-4: Food Fermentation Techniques

SE-5: Management of Human Microbial Diseases

SE-6: Microbiological Analysis of Air and Water

B.Sc. MICROBIOLOGY HONOURS(CBCS)

Semester	CORE COURSE(!4)	Ability Enhancemnt Compulsory Course **(AEC)** (2)	Skill Enhancement Course **(SEC)** (2)	Discipline pecific Elective (4)	General Elective (4)
I	Introduction To Microbiology And Microbial Diversity				GE-1
	Bacteriology				
II	Biochemistry				GE-2
	Virology				
III	MicrobialPhysiologyAndMetabolism		SEC-1		GE-3
	Cell Biology				
	Molecular Biology				
IV	Microbial Genetics		SEC-2		GE-4
	Environmental Microbiology				
	Food And Dairy Microbiology				
V	Industrial Microbiology			DSE-1	
	Immunology			DSE-2	
VI	Medical Microbiology			DSE-3	
	Recombinant DNA Technology			DSE-4	

SEMESTER	**Course Offered**	Course Name	Credit
I	**Ability Enhancement Compulsory Course - I**	English/MIL Communication/: Environmental Sciences	2
	Core Course I	: Introduction to Microbiology and Microbial Diversity	4
	Core Course II	: Bacteriology	2
	Core Course-I Practical	Introduction to Microbiology and Microbial Diversity Practical	4
	Core Course-II Practical	Bacteriology Practical	2
	Generic Elective-1	GE-1	4
	Generic Elective-1 Practical	GE-1 Practical	2
II	**Ability Enhancement Compulsory Course - I**	English/MIL Communication/: Environmental Sciences	2
	Core Course III	Biochemistry	4
	Core Course III Practical	Biochemistry Practical	2
	Core Course IV	Biochemistry	4
	Core Course IV	Biochemistry Practical	2
	Generic Elective-2	GE-2	4
	Generic Elective-2 Practical	GE-2 Practical	2

SEMESTER	**Course Offered**	Course Name	Credit
III	Core Course -V	Microbial Physiology and Metabolism	4
	Core Course –V Practical	Microbial Physiology and Metabolism Practical	2
	Core Course –VI	Cell Biology	4
	Core Course –VI Practical	Cell Biology Practical	2
	Core Course –VII	Molecular Biology	4
	Core Course –VII Practical	Molecular Biology Practical	2
	SkillEnhancementElectiveCourse	BIOFERTILIZERS AND BIOPESTICIDES	2
	Generic Elective-3	GE-3	4
	Generic Elective-3 Practical	GE-3 Practical	2
IV	Core Course -VIII	Microbial Genetics	4
	Core Course –VIII Practical	Microbial Genetics Practical	2
	Core Course –IX	Environmental Microbiology	4
	Core Course –XI Practical	Environmental Microbiology Practical	2
	Core Course –X	Food and Dairy Microbiology	4
	Core Course –XI Practical	Food and Dairy Microbiology Practical	2
	SkillEnhancementElectiveCourse	SEC-2 FOOD FERMENTATION TECHNIQUES	2
	Generic Elective-4	GE-4	4
	Generic Elective-4 Practical	GE-4 Practical	2

Semester V	Core Course -XI	Industrial Microbiology	4
	Core Course –XI Practical	Industrial MicrobiologyPractical	2
	Core Course –XII	Immunology	4
	Core Course –XII Practical	Immunology Practical	2
	Discipline Specific Elective-1	DSE-1	4
	Discipline Specific Elective-1Practical	DSE-1 Practical	2
	Discipline Specific Elective-2	DSE-2	4
	Discipline Specific Elective-2 Practical	DSE-2 Practical	2
Semester V	**Core Course -XIII**	**Medical Microbiology**	4
	Core Course –XIII Practical	**Medical Microbiology Practical**	2
	Core Course -XIV	**Recombinant DNA technology**	4
	Core Course –XIV Practical	**Recombinant DNA technology Practical**	2
	Discipline Specific Elective-3	DSE-3	4
	Discipline Specific Elective-3Practical	DSE-3 Practical	2
	Discipline Specific Elective-4	DSE-4	4
	Discipline Specific Elective-4 Practical	DSE-4 Practical	2

Discipline Specific Elective

DSE-1: Bioinformatics

DSE-2: Plant Pathology

DSE-3: Inheritance Biology

DSE-9: Instrumentation and Biotechniques

General Electives

GE-1: Introduction and scope of Microbiology

GE-2: Bacteriology and Virology

GE-3: Industrial and Food Microbiology

GE-4: Microbes in Environment

Skill Enhancement Elective Courses

SE-1: Biofertilizers and Biopesticides

SE-2: Food Fermentation Techniques

B.Sc. MICROBIOLOGYSEMESTER –I
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC-1:INTRODUCTIONTOMICROBIOLOGYANDMICROBIALDIVERSITY

TOTALHOURS:60 **CREDITS:4**

Unit1HistoryofDevelopmentofMicrobiology **No. of Hours: 15**

Developmentofmicrobiologyasadiscipline,Spontaneousgeneration*vs*.biogenesis.Contributionsof AntonvonLeeuwenhoek,LouisPasteur,RobertKoch,JosephLister,AlexanderFleming.Germtheory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology:ContributionsofMartinusW.Beijerinck,SergeiN.Winogradsky,SelmanA.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, EdwardJenner.

Unit 2 Diversity ofMicrobialWorld **No. of Hours:40**

A. Systems ofclassification

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

B. Generalcharacteristicsofdifferentgroups:**Acellular**microorganisms(Viruses,Viroids,Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economicimportance.

- **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algaeincludingoccurrence,thallusorganization,algaecellultrastructure,pigments,flagella,eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment andfood.

- **Fungi**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexualreproduction,sexualreproduction,heterokaryosis,heterothallismandparasexualmechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration andmycotoxins.

• **Protozoa**General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

Unit3AnoverviewofScopeofMicrobiology **No. of Hours: 5**

C-1:INTRODUCTIONTOMICROBIOLOGYANDMICROBIALDIVERSITY (PRACTICALS)
SEMESTER –I
TOTALHOURS:60 **CREDITS:2**

1. Microbiology Good Laboratory Practices andBiosafety.
2. Tostudytheprincipleandapplicationsofimportantinstruments(biologicalsafetycabinets, autoclave,incubator,BODincubator,hotairoven,lightmicroscope,pHmeter)usedinthe microbiologylaboratory.
3. Preparation of culture media for bacterialcultivation.
4. Sterilization of medium using Autoclave and assessment forsterility
5. Sterilization of glassware using Hot Air Oven and assessment forsterility
6. Demonstrationofthepresenceofmicrofloraintheenvironmentbyexposingnutrientagar plates toair.
7. Study of *Rhizopus*, *Penicillium*, *Aspergillus*using temporarymounts
8. Study of *Spirogyra* and *Chlamydomonas, Volvox*using temporaryMounts
9. Studyofthefollowingprotozoansusing permanentmounts/photographs:*Amoeba*, *Entamoeba*, *Paramecium* and*Plasmodium*

SUGGESTED READING

1. TortoraGJ,FunkeBRandCaseCL.(2008).Microbiology:AnIntroduction.9thedition.Pearson Education
2. MadiganMT,MartinkoJM,DunlapPVandClarkDP.(2014).BrockBiologyofMicroorganisms . 14th edition. Pearson InternationalEdition
3. CappucinoJandShermanN.(2010).Microbiology:ALaboratoryManual.9thedition.Pearson EducationLimited
4. WileyJM,SherwoodLMandWoolvertonCJ.(2013)Prescott'sMicrobiology.9th Edition.McGraw HillInternational.
5. AtlasRM.(1997).PrinciplesofMicrobiology.2ndedition.WM.T.BrownPublishers.
6. PelczarMJ,ChanECSandKriegNR.(1993).Microbiology.5thedition.McGraw Hill BookCompany.
7. StanierRY,IngrahamJL,WheelisML,andPainterPR.(2005).GeneralMicrobiology. 5th edition. McMillan.

B.Sc. MICROBIOLOGYSEMESTER –I

INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
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CC -2: BACTERIOLOGY(THEORY)

TOTALHOURS:60 **CREDITS:4**

Unit 1Cellorganization **No.of Hours:14**

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. Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.Cytoplasm:Ribosomes,mesosomes,inclusionbodies,nucleoid,chromosom eandplasmids Endospore: Structure, formation, stages ofsporulation.

Unit 2Bacteriologicaltechniques **No. of Hours: 5**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stockingofpurecultures;cultivationofanaerobicbacteria,andaccessingnon-culturable bacteria.

Unit3Microscopy **No. of Hours:6**

BrightFieldMicroscope,DarkFieldMicroscope,PhaseContrastMicroscope,Fluoresenc e Microscope,Confocalmicroscopy,ScanningandTransmissionElectronMicroscope

Unit 4 Growthand nutrition **No. of Hours:8**Nutritional requirements in bacteria and nutritional categories;Culturemedia:componentsofmedia,naturalandsyntheticmedia,chemicallyd efinedmedia, complexmedia, selective,differential,indicator,enrichedandenrichmentmedia.

Physicalmethodsofmicrobialcontrol:heat,lowtemperature,highpressure, filtration,desiccation, osmotic pressure,radiation*Chemical methods of microbial control*: disinfectants, types and mode of action

Unit 5 ReproductioninBacteria **No.ofHours:3**

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

Unit 6BacterialSystematics No. of Hours:8

Aim and principles of classification, systematic and taxonomy, concept of species, taxa, strain; conventional,molecular and recent approaches to poly phasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

Unit7ImportantarchaealandeubacterialgroupsNo. of Hours: 16

Archaebacteria:Generalcharacteristics,phylogeneticoverview

Eubacteria: Morphology,metabolism,ecologicalsignificanceandeconomicimportance offollowing groups:

Gram Negative: General characteristics with suitable examples.

GramPositive:Generalcharacteristicswithsuitableexamples

***Cyanobacteria*:** AnIntroduction

C-2:BACTERIOLOGY (PRACTICAL) SEMESTER –I

TOTALHOURS:60 **CREDITS:2**

1. Preparationofdifferentmedia:syntheticmediaBG-11,Complexmedia-Nutrient agar, McConkey agar, EMBagar.
2. Simplestaining
3. Negativestaining
4. Gram'sstaining
5. Acid fast staining-permanent slideonly.
6. Capsulestaining
7. Endosporestaining.
8. Isolation of pure cultures of bacteria by streakingmethod.
9. Preservation of bacterial cultures by varioustechniques.
10. Estimation of CFU count by spread plate method/pour platemethod.
11. Motility by hanging dropmethod.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.

2. BlackJG.(2008).Microbiology:PrinciplesandExplorations.7th edition.PrenticeHall

3. MadiganMT,and MartinkoJM(2014).BrockBiologyofMicro-organisms.14th edition.ParkerJ. Prentice Hall International,Inc.

4. PelczarJrMJ,ChanECS,andKriegNR.(2004).Microbiology.5theditionTataMcGraw Hill.

5. SrivastavaSandSrivastavaPS.(2003).UnderstandingBacteria.KluwerAcademicPublishers, Dordrecht

6. StanierRY,IngrahamJL,WheelisMLandPainterPR.(2005).GeneralMicrobiology.5thedition McMillan.

B.Sc. MICROBIOLOGYSEMESTER –II
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC-3: BIOCHEMISTRY(THEORY)

TOTALHOURS:60 **CREDITS:4**

Unit1Bioenergetics **No. of Hours:8**

FirstandsecondlawsofThermodynamics.DefinitionsofGibb'sFreeEnergy,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

Unit2Carbohydrates **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 formsofglucose,Sugarderivatives,glucosamine,galactosamine,muramicacid,N-acetylneuraminic 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 andchitin

Unit3Lipids **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. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structureofsphingosine,ceramide.Specialmentionofsphingomyelins,cerebrosidesandgangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Unit4Proteins **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, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and

hydroxyproline,Nonproteinaminoacids:Gramicidin,beta-alanine,D-alanineandD-glutamicacid. Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and syntheticaspartame,Secondarystructureofproteins:Tertiaryandquaternary.
Structure of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins.

Unit5.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, transitionstatecomplexandactivationenergy.Lockandkeyhypothesis,andInducedFithy pothesis.Km,andallostericmechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metalsalts

Unit6.Vitamins **No. of Hours:4**

Classification and characteristics with suitable examples, sources and importance

CC-3: BIOCHEMISTRY (PRACTICALS) SEMESTER –II

TOTALHOURS:60 **CREDITS:2**

1. Propertiesofwater,ConceptofpHandbuffers,preparationofbuffersandNumerical problemsto explain theconcepts
2. NumericalproblemsoncalculationsofStandardFreeEnergyChangeandEquilibriu mconstant
3. Standard Free Energy Change of coupledreactions
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducingsugars
5. Qualitative/Quantitative tests for lipids andproteins
6. Study of protein secondary and tertiary structures with the help ofmodels

SUGGESTED READING

1. Campbell,MK(2012)Biochemistry,7th ed.,Publishedby CengageLearning
2. Campbell,PNandSmithAD(2011)BiochemistryIllustrated,4th ed.,PublishedbyChurc hill Livingstone
3. TymoczkoJL,BergJMandStryerL(2012)Biochemistry:Ashortcourse,2nd ed.,W.H.Free man
4. BergJM,TymoczkoJLandStryerL(2011)Biochemistry,W.H.FreemanandCompany
5. NelsonDLandCoxMM(2008)LehningerPrinciplesofBiochemistry,5th Edition.,W.H. Freeman andCompany,
6. WilleyMJ,Sherwood,LM&WoolvertonCJ(2013)Prescott,HarleyandKlein'sMicrob iology by. 9th Ed.,McGrawHill
7. Voet,D.andVoetJ.G(2004)Biochemistry3rd edition,JohnWiley andSons,

B.Sc. MICROBIOLOGYSEMESTER –II
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
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CC-4: VIROLOGY(THEORY)
TOTALHOURS:60 **CREDITS:4**

Unit1NatureandPropertiesofVirusesNo. of Hours:12
Introduction:Discoveryofviruses,natureanddefinitionofviruses,generalproperties,concept of viroids, virusoids, satellite viruses and Prions. Theories of viralorigin. StructureofViruses:Capsidsymmetry,envelopedandnon-envelopedviruses Isolation, purification and cultivation ofviruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.

Unit2Bacteriophages **No. of Hours:10**
Diversity,classification,onestepmultiplicationcurve,lyticandlysogenicphages(lambda phage) concept of early and late proteins, regulation of transcription in lambdaphage

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 non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna), Assembly, maturation and release of virions

Unit 4 VirusesandCancer **No. of Hours:6**
Introduction to oncogenic viruses
Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit5Prevention&controlofviraldiseases **No. of Hours:8**
Antiviral compounds and their mode of action Interferon and their mode of action
General principles of viral vaccination

Unit 6 ApplicationsofVirology **No. ofHours: 4**
Use of viral vectors in cloning and expression, Gene therapy and Phage display

CPMIC-4: VIROLOGY (PRACTICAL) SEMESTER –II

TOTALHOURS:60 **CREDITS:2**

1. Studyofthestructureofimportantanimalviruses(rhabdo,influenza,paramyxohepatitis Band retroviruses) using electronmicrographs
2. Studyofthestructureofimportantplantviruses(caulimo,Gemini,tobaccoringspot,cucumber mosaic and alpha-alpha mosaic viruses) using electronmicrographs
3. Studyofthestructureofimportantbacterialviruses(ϕX174,T4,λ)usingelectronmicrograph.
4. Isolationandenumerationofbacteriophages(PFU)fromwater/sewagesampleusingdoubleagar layer technique
5. Studying isolation and propagation of animal viruses by chick embryotechnique
6. Study of cytopathic effects of viruses usingphotographs
7. Perform local lesion technique for assaying plantviruses.

SUGGESTED READING

1. Dimmock,NJ,Easton,AL,Leppard,KN(2007).IntroductiontoModernVirology.6th edition, Blackwell PublishingLtd.
2. CarterJandSaundersV(2007).Virology:PrinciplesandApplications.JohnWileyandSons.
3. FlintSJ,Enquist,LW,Krug,RM,Racaniello,VR,Skalka,AM(2004).PrinciplesofVirology, Molecularbiology,PathogenesisandControl.2nd edition.ASMpressWashingtonDC.
4. LevyJA,ConratHF,OwensRA.(2000).Virology.3rd edition.PrenticeHallpublication, New Jersey.
5. WagnerEK,Hew let MJ.(2004).BasicVirology.2nd edition.BlackwellPublishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, NewYork.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill,India.
8. BosL.(1999)Plantviruses-Atextbookofplantvirologyby.BackhuysPublishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe MedicalPublication.

B.Sc (HONOURS) MICROBIOLOGY SEMESTER–III
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC 5:MICROBIALPHYSIOLOGYANDMETABOLISM(THEORY)
TOTALHOURS:60 **CREDITS:4**

Unit1MicrobialGrowthandEffectofEnvironmentonMicrobialGrowth
No. of Hours:12
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture,
generationtimeandspecificgrowthrate,synchronousgrowth,diauxicgrowthcurve.
Microbialgrowthinresponsetoenvironment-
Temperature(psychrophiles,mesophiles,thermophiles,
extremophiles,thermodurics,psychrotrophs),pH(acidophiles,alkaliphiles),solute and water activity (halophiles,xerophiles,osmophilic),Oxygen (aerobic, anaerobic, ,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 uptakeandTransport **No. of Hours:10**
Passive and facilitated diffusionPrimaryandsecondaryactivetransport,conceptofuniport,symportand antiport, Grouptranslocation, iron uptake
Unit3ChemoheterotrophicMetabolism-AerobicRespiration **No. of Hours:16**
Conceptofaerobicrespiration,anaerobicrespirationandfermentation
Sugardegradationpathwayi.e.EMP,ED,Pentosephosphatepathway, TCAcycle.
Electrontransportchain:componentsofrespiratorychain,comparisonofmitochondrialandbacterial ETC, electron transport phosphorylation, uncouplers andinhibitors.

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation No. of Hours: 6
Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)Fermentation-
AlcoholfermentationandPasteureffect;Lactatefermentation(homofermentativeand heterofermentativepathways),conceptoflinearandbranchedfermentationpathways.

Unit5ChemolithotrophicandPhototrophicMetabolismNo. of Hours:10
Introductiontoaerobicandanaerobicchemolithotrophywithanexampleeach.Hydrogeno xidation (definition and reaction) and methanogenesis (definition andreaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms,anoxygenic*vs.*oxygenicphotosynthesiswithreferencetophotosynthesi singreenbacteria,purple bacteria andcyanobacteria

Unit6NitrogenMetabolism-and overviewNo. of Hours:6
Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

CC-5: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)

SEMESTER–III
TOTAL HOURS: 60 **CREDITS:2**

1. Studyandplotthegrowthcurveof*E.coli*byturbidometricandstandardplatecountmetho ds.
2. Calculationsofgenerationtimeandspecificgrowthrateofbacteriafromthegraphplotted withthe givendata
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. Demonstration of alcoholicfermentation

SUGGESTED READINGS

1. MadiganMT,andMartinkoJM(2014).BrockBiologyofMicroorganisms.14thedition. Prentice Hall InternationalInc.
2. MoatAGandFosterJW.(2002).MicrobialPhysiology.4th edition.JohnWiley&Sons
3. ReddySRandReddySM.(2005).MicrobialPhysiology.ScientificPublishersIndia
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. SpringerVerlag
6. StanierRY,IngrahmJI,WheelisMLandPainterPR.(1987).GeneralMicrobiology.5th edition, McMillanPress.

B.Sc (HONOURS) MICROBIOLOGY SEMESTER - III
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
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CC-6: CELL BIOLOGY (THEORY)
SEMESTER –III
TOTALHOURS:60 **CREDITS:4**

Unit1Structureandorganizationof Cell **No. of Hours:12**

CellOrganization–Eukaryotic(Plantandanimalcells)andprokaryotic Plasma membrane: Structure and transport of small lmolecules
Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions-adhesionjunctions,tightjunctions,gapjunctions,andplasmodesmata(onlystructural aspects)
Mitochondria, chloroplasts and peroxisomesCytoskeleton:Structureandorganizationofactinfilaments,associationofact infilamentswithplasma membrane, cell surface protrusions, intermediate filaments,microtubules

Unit2Nucleus **No. of Hours:4**

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

Unit 3 Protein Sortingand Transport **No. of Hours: 12**

Ribosomes,EndoplasmicReticulum–
Structure,targetingandinsertionofproteinsintheER,protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids, GolgiApparatus–
Organization,proteinglycosylation,proteinsortingandexportfromGolgi Apparatus, Lysosomes.

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

Signalling molecules and their receptors Function of cell surface receptors
Pathwaysofintra-cellularreceptors–
CyclicAMPpathway,cyclicGMPandMAPkinasepathway

Unit5CellCycle,CellDeathandCellRenewal **No. of Hours:12**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types, Programmed cell death Stem cellsEmbryonic stem cell, induced pleuripotent stem cells

CC-6: CELL BIOLOGY (PRACTICAL) SEMESTER –III
TOTALHOURS:60 CREDITS:2

1. Study a representative plant and animal cell bymicroscopy.
2. Study of the structure of cell organelles through electronmicrographs
3. Cytochemical staining of DNA –Feulgen
4. Demonstrationofthepresenceofmitochondriainstriatedmusclecells/cheekepithelialcellusing vital stain Janus GreenB
5. Study of polyploidy in Onion root tip by colchicines treatment.
6. Identification and study of cancer cells by photomicrographs.
7. StudyofdifferentstagesofMitosis.
8. StudyofdifferentstagesofMeiosis.

SUGGESTED READING

1. HardinJ,BertoniGandKleinsmithLJ.(2010).Becker'sWorldoftheCell.8th edition.Pearson.
2. KarpG.(2010)CellandMolecularBiology:ConceptsandExperiments.6th edition.John Wiley& Sons.Inc.
3. DeRobertis,EDPandDeRobertis EMF (2006).CellandMolecularBiology.8th edition.Lipincott Williams and Wilkins,Philadelphia.
4. Cooper,G.M.andHausman,R.E.(2009).TheCell:AMolecularApproach.5th Edition.ASMPress&Sunderland,Washington,D.C.;SinauerAssociates,MA.

B.Sc (HONOURS) MICROBIOLOGY SEMESTER – III
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC -7: MOLECULAR BIOLOGY (THEORY) SEMESTER –III
TOTAL HOURS: 60 CREDITS:4

Unit1StructuresofDNAandRNA/GeneticMaterial No.ofHours:12

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Silentfeaturesofdoublehelix,TypesofDNA,Typesofgenetic material,denaturationandrenaturation,cotcurves.DNAtopology-linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNAStructure,OrganelleDNA—mitochondriaandchloroplastDNA.

Unit2ReplicationofDNA(ProkaryotesandEukaryotes) No. of Hours: 10

Bidirectionalandunidirectionalreplication,semi-conservative,semi-discontinuousreplication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases,DNAligase,primase,telomerase–forreplicationoflinearends VariousmodelsofDNAreplicationincludingrollingcircle,D-loop(mitochondrial),Θ(theta)mode of replication and other accessory protein, Mismatch and excisionrepair

Unit3TranscriptioninProkaryotesand Eukaryotes No. of Hours: 8

Transcription:Definition,differencefromreplication,promoter-conceptandstrengthofpromoter RNA Polymerase and the transcriptionunit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors

Unit 4Post-Transcriptional Processing No. of Hours: 9

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternativesplicing,Polyadenylationandcapping,ProcessingofrRNA,RNAinterference: siRNA, miRNA and itssignificance.

Unit5Translation(ProkaryotesandEukaryotes)No. of Hours: 10

Translationalmachinery,ChargingoftRNA,aminoacyltRNAsynthetases, Mechanismsofinitiation, elongationandterminationofpolypeptidesinbothprokaryotesandeukaryotes,Fidelityoftranslation, Inhibitors of protein synthesis in prokaryotes andeukaryotes

Unit6RegulationofgeneExpressioninProkaryotesandEukaryotes

No. of Hours:12

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp*operons, Sporulation in *Bacillus,*Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylationmechanisms.

CC-7:MOLECULARBIOLOGY(PRACTICAL) SEMESTER–III

TOTALHOURS:60 CREDITS:2

1. StudyofdifferenttypesofDNAandRNAusingmicrographsandmodel/schematic representations
2. Studyofsemi-conservativereplicationofDNAthroughmicrographs/schematic representations
3. Isolation of genomic DNA from *E.coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter(diphenylaminereagent) or UV spectrophotometer (A_{260} measurement)
5. EstimationofRNAusingcolorimeter(orcinolreagent)orUVspectrophotometer (A_{260}measurement)
6. Resolution and visualization of DNA by Agarose GelElectrophoresis.

SUGGESTED READINGS

1. WatsonJD,BakerTA,BellSP,GannA,LevineMandLosickR(2008)MolecularBiologyofthe Gene, 6th edition, Cold Spring Harbour Lab. Press, PearsonPublication
2. BeckerWM,KleinsmithLJ,HardinJandBertoniGP(2009)TheWorldoftheCell,7thedition, Pearson Benjamin Cummings Publishing, SanFrancisco
3. DeRobertisEDPandDeRobertisEMF(2006)CellandMolecularBiology,8thedition.Lippincott Williams and Wilkins,Philadelphia
4. KarpG(2010)CellandMolecularBiology:ConceptsandExperiments,6thedition,JohnWiley& Sons.Inc.
5. SambrookJandRussellDW.(2001).MolecularCloning:ALaboratoryManual.4thEdition,Cold Spring Harbour Laboratorypress.
6. KrebsJ,GoldsteinE,KilpatrickS(2013).Lewin'sEssentialGenes,3rdEd.,JonesandBartlett Learning
7. GardnerEJ,SimmonsMJ,SnustadDP(2008).PrinciplesofGenetics.8thEd.Wiley-India

B.Sc (HONOURS) MICROBIOLOGY SEMESTER –IV

INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC-8: MICROBIAL GENETICS (THEORY)

SEMESTER –IV
TOTAL HOURS:60 **CREDITS:4**

Unit 1 Genome Organization and Mutations **No. of Hours:18**

Genome organization: *E. coli, Saccharomyces, Tetrahymena*
Mutationsandmutagenesis:DefinitionandtypesofMutations;Physicalandchemicalmutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations
Reversionandsuppression:Truerevertants;Intra-andinter-genicsuppression;Amestest;Mutator genes

Unit2 Plasmids **No. of Hours:10**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2µplasmid,Plasmidreplicationandpartitioning,Hostrange,plasmid-incompatibility,plasmid amplification, Regulation of copy number, curing ofplasmids

Unit3MechanismsofGenetic Exchange **No. of Hours:12**

Transformation - Discovery, mechanism of natural competence
Conjugation-
Discovery,mechanism,HfrandF'strains,Interruptedmatingtechniqueandtimeof entrymapping. Transduction-Generalizedtransduction,specializedtransduction,LFT&HFTlysates,Mappingby recombination and co-transduction ofmarkers

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

Features of T4 genetics , Genetic basis of lytic *versus* lysogenic switch of phage lambda

Unit 5TransposableelementsNo. of Hours:12

Prokaryotictransposableelements–InsertionSequences,compositeandnon-compositetransposons, Replicative and Non replicative transposition, Mutransposon.
Eukaryotictransposableelements-
Yeast(Tyretrotransposon),Drosophila(Pelements),Maize (Ac/Ds). Uses of transposons and transposition

CC-8:MICROBIALGENETICS(PRACTICAL) SEMESTER–IV
TOTALHOURS:60 CREDITS:2

1. Preparation of Master and ReplicaPlates
2. Studytheeffectofchemical (HNO_2)andphysical(UV)mutagensonbacterialcells
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 throughAgaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

SUGGESTED READING

1. KlugWS,CummingsMR,Spencer,C,Palladino,M(2011).ConceptsofGenetics,10th Ed., BenjaminCummings
2. KrebsJ,GoldsteinE,KilpatrickS(2013).Lewin'sEssentialGenes,3rd Ed.,JonesandBartlett Learning
3. PierceBA(2011)Genetics:AConceptualApproach,4thEd.,MacmillanHigherEducation Learning
4. WatsonJD,BakerTA,BellSPetal.(2008)MolecularBiologyoftheGene,6th Ed.,Benjamin Cummings
5. GardnerEJ,SimmonsMJ,SnustadDP(2008).PrinciplesofGenetics.8th Ed.Wiley-India
6. RussellPJ.(2009).Genetics-AMolecularApproach.3rd Ed,BenjaminCummings
7. SambrookJandRussellDW.(2001).MolecularCloning:ALaboratoryManual.4th Edition,Cold Spring Harbour Laboratorypress.
8. MaloySR,CronanJEandFriefelderD(2004)MicrobialGenetics2nd EDITION.,JonesandBarlett Publishers

B.Sc (HONOURS) MICROBIOLOGY SEMESTER–IV
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC-9: ENVIRONMENTAL MICROBIOLOGY (THEORY) SEMESTER–IV
TOTAL HOURS:60 **CREDITS:4**

Unit 1 Microorganisms andtheirHabitatsNo. 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.
ExtremeHabitats:Extremophiles:Microbesthrivingathigh&lowtemperatures,pH, highlydrostatic & osmotic pressures, salinity, & low nutrientlevels.Microbial succession in decomposition of plant organic matter

Unit 2MicrobialInteractions No. of Hours:12

Microbeinteractions:Mutualism,synergism,commensalism,competition,amensalism,parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animalinteraction:Microbesinruminants,nematophagusfungiandsymbioticluminescent bacteria

Unit 3BiogeochemicalCyclingNo. of Hours:12

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogencycle:Nitrogenfixation,ammonification,nitrification,denitrificationandnitratereduction Phosphorus cycle: Phosphate immobilization andsolubilisation
Sulphur cycle: Microbes involved in sulphur cycle other elemental cycles: Iron and manganese

Unit 4WasteManagement No. of Hours:12

SolidWastemanagement:Sourcesandtypesofsolidwaste,Methodsofsolidwastedisposal (composting and sanitaryandfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary(oxidationponds,tricklingfilter,activatedsludgeprocessand septic tank)andtertiary sewagetreatment

Unit 5MicrobialBioremediation No. of Hours:5

Principlesanddegradationofcommonpesticides,organic(hydrocarbons,oilspills)andinr

oganic (metals) matter,biosurfactants

Unit 6WaterPotability **No. of Hours:5**

Treatmentandsafetyofdrinking(potable)water,methodstodetectpotabilityofwatersamples:(a) standardqualitativeprocedure:presumptivetest/MPNtest,confirmedandcompletedtests forfaecal coliforms (b) Membrane filter technique and (c) Presence/absencetests

CC-9: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL) SEMESTER –IV

TOTALHOURS:60 **CREDITS:2**

1. Analysisofsoil-pH,moisturecontent,waterholdingcapacity,percolation,capillaryaction.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere andrhizoplane.
4. Assessment of microbiological quality ofwater.
5. Determination of BOD of waste watersample.
6. Studythepresenceofmicrobialactivitybydetecting(qualitatively)enzymes(dehydrogenase, amylase, urease) insoil.
7. Isolation of *Rhizobium* from rootnodules.

SUGGESTED READINGS

1. AtlasRMandBarthaR.(2000).MicrobialEcology:Fundamentals&Applications.4th edition. Benjamin/Cummings Science Publishing,USA
2. MadiganMT,MartinkoJMandParkerJ.(2014).BrockBiologyofMicroorganisms.14th edition. Pearson/ BenjaminCummings
3. MaierRM,PepperILandGerbaCP.(2009).EnvironmentalMicrobiology.2nd edition,Academic Press
4. Okafor,N(2011).EnvironmentalMicrobiologyofAquatic&Wastesystems.1st edition, Springer, NewYork
5. SinghA,Kuhad,RC&WardOP(2009).AdvancesinAppliedBioremediation.Volume17, Springer-Verlag, BerlinHedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

CampbellRE.(1983).MicrobialEcology.BlackwellScientificPublication,Oxford,England.

7. CoyneMS.(2001).SoilMicrobiology:AnExploratoryApproach.DelmarThomsonLearning.
8. LynchJM&HobbieJE.(1988).MicroorganismsinAction:Concepts&ApplicationinMicrobial Ecology. Blackwell Scientific Publication,U.K.
9. MartinA.(1977).AnIntroductiontoSoilMicrobiology.2nd edition.JohnWiley&SonsInc.New York &London.
10. StolpH.(1988).MicrobialEcology:OrganismsHabitatsActivities.CambridgeUniver

sityPress, Cambridge,England.
11. SubbaRaoNS.(1999).SoilMicrobiology.4th edition.Oxford&IBHPublishingCo.NewDelhi.
12. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013).Prescott'sMicrobiology.9th edition. McGraw Hill HigherEducation.

B.Sc (HONOURS) MICROBIOLOGYSEMESTER–IV
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attemptfour questions out of seven options given. 5 × 4 = 20
Group III will have long answer questions. Students have to attempt two questions out of five options given. 15 × 2 = 30

CC-10: FOOD AND DAIRY MICROBIOLOGY (THEORY) SEMESTER–IV
TOTAL HOURS: 60 CREDITS:4

Unit1Foodsasasubstrateformicroorganisms No. of Hours: 8
Intrinsicandextrinsicfactorsthataffectgrowthandsurvivalofmicrobes infoods,naturalfloraand source of contamination of foods ingeneral.

Unit2MicrobialspoilageofvariousfoodsNo. of Hours:10
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

Unit3PrinciplesandmethodsoffoodpreservationNo. of Hours: 12
Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemicalmethodsoffoodpreservation:salt,sugar,organicacids, SO_2,nitriteandnitrates,ethylene oxide, antibiotics andbacteriocins

Unit 4FermentedfoodsNo. of Hours:10
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese,otherfermentedfoods:dosa,sauerkraut,soysauceandtampeh,Probiotics:Healthbenefits, types of microorganisms used, probiotic foods available inmarket.

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; Foodinfections:*Bacilluscereus*,*Vibrioparahaemolyticus*,*Escherichiacoli*,*Salmonellosis*,*Shigellosis*,*Yersiniaenterocolitica*,*Listeriamonocytogenes*and*Campylobacterjejuni*

Unit 6 Food sanitationandcontrol No. of Hours:5
HACCP, Indices of food sanitary quality and sanitizers
Unit7Culturalandrapiddetectionmethodsoffoodbornepathogensinfoodsandintroduction topredictivemicrobiology. No. of Hours:5

C-10:FOODANDDAIRYMICROBIOLOGY(PRACTICAL) SEMESTER–IV
TOTALHOURS:60 CREDITS:2

1. MBRT of milk samples and their standard platecount.
2. Alkaline phosphatase test to check the efficiency of pasteurization ofmilk.
3. Isolation of any food borne bacteria from foodproducts.
4. Isolation of spoilage microorganisms from spoiledvegetables/fruits.
5. Isolation of spoilage microorganisms frombread.
6. Preparation ofYogurt/Dahi.

SUGGESTED READINGS

1. AdamsMRandMossMO.(1995).FoodMicrobiology.4th edition,NewAgeInternationa l(P) Limited Publishers, New Delhi,India.
2. BanwartJM.(1987).BasicFoodMicrobiology.1st edition.CBSPublishersandDistributors, Delhi,India.
3. DavidsonPMandBrannenAL.(1993).AntimicrobialsinFoods.MarcelDekker,NewYork.
4. DillionVMandBoardRG.(1996).NaturalAntimicrobialSystemsandFoodPreservation.CAB International, Wallingford,Oxon.
5. FrazierWCandWesthoffDC.(1992).FoodMicrobiology.3rd edition.TataMcGraw-Hill Publishing Company Ltd, New Delhi,India.
6. GouldGW.(1995).NewMethodsofFoodPreservation.BlackieAcademicandProfessional, London.
7. JayJM,LoessnerMJandGoldenDA.(2005).ModernFoodMicrobiology.7th edition,CBS Publishers and Distributors, Delhi,India.
8. LundBM,BairdParkerAC,andGouldGW.(2000).TheMicrobiologicalSafetyandQualityof Foods. Vol. 1-2, ASPEN Publication, Gaithersberg,MD.
9. TortoraGJ,FunkeBR,andCaseCL.(2008).Microbiology:AnIntroduction.9th edition. Pearson Education.

B.Sc(HONOURS)MICROBIOLOGYSEMESTER–V
INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10
Group II will have short answer type concept based question. Student will attempt three questions out of six options given. 15 × 3 = 45
Group III will have long answer questions. Students have to attempt five questions out of nine options given. 5 × 5 = 25

CC-11: INDUSTRIAL MICROBIOLOGY (THEORY) SEMESTER–V
TOTALHOURS:60 **CREDITS:4**

Unit1Introductiontoindustrialmicrobiology **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 parameters **No. of Hours:12**
Typesoffermentationprocesses-Solid-stateandliquid-state(stationaryandsubmerged) fermentations;batch,fed-batch(eg.baker'syeast)andcontinuousfermentations
Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters,constantlystirredtankandair-liftfermenters,Measurementandcontroloffermentation parameters - pH, temperature, dissolved oxygen, foaming andaeration

Unit 4Down-streamprocessing **No. of Hours: 6**
Celldisruption,filtration,centrifugation,solventextraction,precipitation,lyophilizationa ndspray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentationconditions,downstreamprocessinganduses) No. of Hours:18
Citric acid, ethanol, penicillin, glutamic acid, VitaminB12
Enzymes (amylase, protease, lipase) Wine, beer

Unit 6Enzymeimmobilization **No. of Hours:4**
Methodsofimmobilization,advantagesandapplicationsofimmobilization,largescaleap plicationsof immobilized enzymes (glucose isomerase and penicillinacylase)

CC-11: INDUSTRIAL MICROBIOLOGY (PRACTICAL) SEMESTER –V
TOTALHOURS:60 **CREDITS:2**

1. Study different parts offermenter
2. Microbialfermentationsfortheproductionandestimation(qualitativeandquantitative)of:

a) Enzymes: Amylase andProtease
b) Amino acid: Glutamicacid
c) Organic acid: Citricacid
d) Alcohol:Ethanol

3. Avisittoanyeducationalinstitute/industrytoseeanindustrialfermenter,andother downstream processingoperations.

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan IndiaLimited
2. OkaforN.(2007).ModernIndustrialMicrobiologyandBiotechnology.1st edition.Bios Scientific Publishers Limited.USA
3. WaitesM.J.,MorganN.L.,RockeyJ.S.andHigtonG.(2001).IndustrialMicrobiology:An Introduction. 1st edition.
4. Wiley – BlackwellGlazeN.andNikaidoH.(1995).MicrobialBiotechnology:Fundamentalsof Applied Microbiology. 1st edition.
5. W.H. Freeman andCompanyCasida LE. (1991).Industrial Microbiology. 1st edition. Wiley EasternLimited.
6. CruegerWandCruegerA.(2000).Biotechnology:AtextbookofIndustrialMicrobiology.2nd edition. Panima Publishing Co. NewDelhi.
7. StanburyPF,WhitakerAandHallSJ.(2006).PrinciplesofFermentationTechnology.2nd edition, Elsevier ScienceLtd.

B.Sc(HONOURS)MICROBIOLOGYSEMESTER –V

INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10

Group II will have short answer type concept based question. Student will attempt three questions out of six options given. 15 × 3 = 45

Group III will have long answer questions. Students have to attempt five questions out of nine options given. 5 × 5 = 25

CC-12: IMMUNOLOGY(THEORY)SEMESTER –V

TOTALHOURS:60 **CREDITS:4**

Unit1Introduction **No.ofHours:4**

ConceptofInnateandAdaptiveimmunity;Contributionsoffollowingscientiststothedevelopment of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Unit 2 Immune CellsandOrgans **No. of Hours: 7**

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

Unit3Antigens **No.ofHours:4**

Characteristicsofanantigen(Foreignness,MolecularsizeandHeterogeneity);Haptens;Epitopes(T & B cell epitopes); T-dependent and T-independent antigens;Adjuvants

Unit4Antibodies **No.ofHours:6**

Structure,Types,FunctionsandPropertiesofantibodies;Antigenicdeterminantsonantibodies
(Isotypic,allotypic,idiotypic);VDJrearrangements;MonoclonalandChimericantibodies

Unit 5 MajorHistocompatibilityComplex **No.ofHours:5**

OrganizationofMHClocus(Mice&Human);StructureandFunctionsofMHCI&IImolecules; Antigen processing and presentation (Cytosolic and Endocyticpathways)

Unit 6ComplementSystem **No.ofHours:4**

ComponentsoftheComplementsystem;Activationpathways(Classical,Alternativeand Lectin pathways); Biological consequences of complementActivation

Unit 7 Generation ofImmuneResponse **No.ofHours:10**

PrimaryandSecondaryImmuneResponse;GenerationofHumoralImmuneResponse(Plasmaand Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit8ImmunologicalDisordersandTumor Immunity **No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (NudeandSCIDmice),SCID,DiGeorgesyndrome,Chediak-Higashisyndrome,Leukocyteadhesion deficiency,CGD;Typesoftumors,tumorAntigens,causesandtherapyforcancers.

Unit 9ImmunologicalTechniques No.ofHours:10

Principles of Precipitation, Agglutination, Immunodiffusion, Immuno electrophoresis, ELISA, ELISPOT,Westernblotting,Immunofluoresence,Flowcytometry,Immunoelectronmicroscopy.

CC-12: IMMUNOLOGY (PRACTICAL) SEMESTER –V

TOTALHOURS:60 CREDITS:2

1. Identification of human bloodgroups.
2. Perform Total Leukocyte Count of the given bloodsample.
3. Perform Differential Leukocyte Count of the given bloodsample.
4. Separate serum from the blood sample(demonstration).
5. Perform immunodiffusion by Ouchterlonymethod.
6. Perform DOTELISA.
7. Performimmunoelectrophoresis.

SUGGESTED READINGS

1. AbbasAK,LichtmanAH,PillaiS.(2007).CellularandMolecularImmunology.6th edition Saunders Publication,Philadelphia.
2. DelvesP,MartinS,BurtonD,RoittIM.(2006).Roitt'sEssentialImmunology.11th editionWiley- Blackwell Scientific Publication,Oxford.
3. GoldsbyRA,KindtTJ,OsborneBA.(2007).Kuby'sImmunology.6thedition W.H.Freemanand Company, NewYork.
4. MurphyK,TraversP,WalportM.(2008).Janeway'sImmunobiology.7thedition Garland Science Publishers, NewYork.
5. PeakmanM,andVerganiD.(2009).BasicandClinicalImmunology.2nd edition Churchill Livingstone Publishers,Edinberg.
6. RichardCandGeiffreyS.(2009).Immunology.6thedition.WileyBlackwellPublication.

B.Sc(HONOURS)MICROBIOLOGY

INSTRUCTIONS TO QUESTION SETTER

The questions will be divided into three groups. Group I will have objective type questions comprising of MCQ/ Fill in the blanks or True/False. 1 × 10 = 10

Group II will have short answer type concept based question. Student will attempt three questions out of six options given. 15 × 3 = 45

Group III will have long answer questions. Students have to attempt five questions out of nine options given. 5 × 5 = 25

CC-13: MEDICAL MICROBIOLOGY (THEORY) SEMESTER–VI

TOTALHOURS:60 **CREDITS:4**

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

Normalmicrofloraofthehumanbody:Importanceofnormalmicroflora,normalmicroflor aofskin, throat, gastrointestinal tract, urogenitaltract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity,Carriersandtheirtypes,Opportunisticinfections,Nosocomialinfections.Tr ansmission of infection, Pathophysiologic effects ofLPS

Unit2Samplecollection,transportanddiagnosis No. of Hours: 5

Collection,transportandculturingofclinicalsamples,principlesofdifferentdiagnostictest s(ELISA,
Immunofluorescence,Agglutinationbasedtests,Complementfixation,PCR,DNAprobe s).

Unit 3Bacterialdiseases No. of Hours:15

Listofdiseasesofvariousorgansystemsandtheircausativeagents.Thefollowingdiseasesi ndetail with Symptoms, mode of transmission, prophylaxis andcontrol
RespiratoryDiseases:*Streptococcus pyogenes*,*Haemophilus influenza* ,*Mycobacteriumtuberculosis* Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponemapallidum, Clostridiumdifficie*

Unit 4Viraldiseases No. of Hours:14

Listofdiseasesofvariousorgansystemsandtheircausativeagents.Thefollowingdiseasesi ndetail with Symptoms, mode of transmission, prophylaxis andcontrol
Polio,Herpes,Hepatitis,Rabies,Dengue,AIDS,Influenzawithbriefdescriptionofswinefl u,Ebola, Chikungunya, JapaneseEncephalitis

Unit 5Protozoaand Diseases No. of Hours:5

Listofdiseasesofvariousorgansystemsandtheircausativeagents.Thefollowingdiseasesi ndetail with Symptoms, mode of transmission, prophylaxis andcontrol
Malaria, Kala-azar

Unit 6Fungaldiseases No. of Hours:5

Briefdescriptionofeachofthefollowingtypesofmycosesandonerepresentativediseaseto be studied with respect to transmission, symptoms andprevention
Cutaneousmycoses:Tineapedis(Athlete'sfoot) Systemic mycoses: Histoplasmosis

Opportunistic mycoses:Candidiasis

Unit7Antimicrobialagents:Generalcharacteristicsandmodeofaction No. of Hours:8

Antibacterialagents:Fivemodesofactionwithoneexampleeach:Inhibitorofnucleicacids ynthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor ofmetabolism

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin

Antiviralagents:MechanismofactionofAmantadine,Acyclovir,Azidothymidine

Antibiotic resistance, MDR, XDR, MRSA,NDM-1

CC-13:MEDICALMICROBIOLOGY(PRACTICAL) SEMESTER–VI
TOTALHOURS:60 CREDITS:2

1. Identifybacteria(anythreeof*E.coli,Salmonella,Pseudomonas,Staphylococcus,Bacillus*)using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalasetests
2. Studyofcompositionanduseofimportantdifferentialmediaforidentificationofbacteria :EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar,TCBS
3. Study of bacterial flora of skin by swabmethod
4. Perform antibacterial sensitivity by Kirby-Bauermethod
5. Determination of minimal inhibitory concentration (MIC) of anantibiotic.
6. Studysymptomsofthediseaseswiththehelpofphotographs:Polio,anthrax,herpes,chickenpox, HPV warts, AIDS (candidiasis), dermatomycoses (ringworms)
7. Study of various stages of malarial parasite in RBCs using permanentmounts.

SUGGESTED READING

1. AnanthanarayanR.andPanikerC.K.J.(2009)TextbookofMicrobiology.8th edition,University PressPublication

2. BrooksG.F.,CarrollK.C.,ButelJ.S.,MorseS.A.andMietzner,T.A.(2013)Jawetz,Melnickand Adelberg's Medical Microbiology. 26th edition. McGraw HillPublication

3. GoeringR.,DockrellH.,ZuckermanM.andWakelinD.(2007)Mims'MedicalMicrobiology.4th edition.Elsevier

4. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013)Prescott,HarleyandKlein'sMicrobiology. 9th edition. McGraw Hill HigherEducation

5. MadiganMT,MartinkoJM,DunlapPVandClarkDP.(2014).BrockBiologyofMicroorganisms. 14th edition. Pearson InternationalEdition

B.Sc(HONOURS)MICROBIOLOGY SEMESTER–VI

INSTRUCTIONS TO QUESTION SETTER

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CC-14:RECOMBINANTDNATECHNOLOGY(THEORY) SEMESTER–VI

TOTALHOURS:60 **CREDITS:4**

Unit1IntroductiontoGeneticEngineering **No. of Hours:2**

Milestones in genetic engineering and biotechnology

Unit2MolecularCloning-Toolsand Strategies No. of Hours: 20

CloningTools;Restrictionmodificationsystems:TypesI,IIandIII.Modeofaction,nomenclature, applications of Type II restriction enzymes in geneticengineeringDNAmodifyingenzymesandtheirapplications:DNApolymerases.Terminaldeoxynucleotidyltransferase, kinases and phosphatases, and DNAligases

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs. Use of linkers and adaptors. Expressionvectors:*E.coli*lacandT7promoter-basedvectors,yeastYIp,YEpandYCpvectors, Baculovirus based vectors, mammalian SV40-based expressionvectors

Unit 3 Methods inMolecularCloning **No. of Hours:16**

Transformation of DNA: Chemical method, Electroporation,Genedelivery:Microinjection,electroporation,biolisticmethod(genegun),liposomeandviral- mediated delivery, *Agrobacterium* –mediateddeliveryDNA,RNAandProteinanalysis:Agarosegelelectrophoresis,Southern-andNorthern-blotting techniques,dotblot,DNAmicroarrayanalysis,SDS-PAGEandWesternblotting.

Unit4DNAAmplificationandDNAsequencingNo. of Hours:10

PCR: Basics of PCR, RT-PCR, Real-Time PCR, Sanger'smethodofDNASequencing:traditionalandautomatedsequencing Primer walking and shotgunsequencing

Unit5ConstructionandScreeningofGenomicandcDNAlibraries

No. of Hours: 6

GenomicandcDNAlibraries:Preparationanduses,Screeningoflibraries:Colonyhybridizationand colony PCR, Chromosome walking and chromosomejumping

Unit6ApplicationsofRecombinantDNATechnology **No. of Hours:6**

ProductsofrecombinantDNAtechnology:Productsofhumantherapeuticinterest-insulin,hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directedmutagenesis

CC-14:RECOMBINANTDNATECHNOLOGY(PRACTICAL) SEMESTER–VI

TOTALHOURS:60 CREDITS:2

1. Preparation of competent cells fortransformation
2. DemonstrationofBacterialTransformationandcalculationoftransformationefficiency.
3. DigestionofDNAusingrestrictionenzymesandanalysisbyagarosegelelectrophoresis
4. Ligation of DNAfragments
5. Cloning of DNA insert and Blue white screening ofrecombinants.
6. Interpretation of sequencing gelelectropherograms
7. Designing of primers for DNAamplification
8. Amplification of DNA byPCR
9. Demonstration of Southernblotting

SUGGESTED READING

1. BrownTA.(2010).GeneCloningandDNAAnalysis.6th edition.BlackwellPublishing, Oxford, U.K.
2. ClarkDPandPazdernikNJ.(2009).Biotechnology:ApplyingtheGeneticRevolution.Elsevier Academic Press,USA
3. PrimroseSBandTwymanRM.(2006).PrinciplesofGeneManipulationandGenomics, 7th edition. Blackwell Publishing, Oxford,U.K.
4. SambrookJandRussellD.(2001).MolecularCloning-ALaboratoryManual.3rd edition.Cold Spring Harbor LaboratoryPress
5. WileyJM,SherwoodLMandWoolvertonCJ.(2008).Prescott,HarleyandKlein'sMicrobiology. McGraw Hill HigherEducation
6. Brown TA. (2007). Genomes-3. Garland SciencPublishers
7. PrimroseSBandTwymanRM.(2008).Genomics:Applicationsinhumanbiology.Blackwell Publishing, Oxford,U.K.

B.Sc(HONOURS)MICROBIOLOGYSEMESTER –V/VI

INSTRUCTIONS TO QUESTION SETTER

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ioDSE-1: BIOINFORMATICS(THEORY)SEMESTER –V/VI

TOTALHOURS:60 **CREDITS:4**

Unit1IntroductiontoComputerFundamentals No. of Hours:8

RDBMS - Definition of relational database. Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

Unit2IntroductiontoBioinformaticsandBiologicalDatabases No. of Hours: 14

Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases,Databaseofmetabolicpathways,Modeofdatastorage-Fileformats-FASTA,Genbank andUniprot,Datasubmission&retrievalfromNCBI,EMBL,DDBJ,Uniprot,PDB

Unit3SequenceAlignments,PhylogenyandPhylogenetictrees
No. of Hours:16

LocalandGlobalSequencealignment,pairwiseandmultiplesequencealignment. Scoringanalignment,scoringmatrices,PAM&BLOSUMseriesofmatrices. Typesofphylogenetictrees,Differentapproachesofphylogenetictreeconstruction-UPGMA, Neighbour joining, Maximum Parsomony, Maximumlikelihood

Unit 4 Genome organizationandanalysis No. of Hours:10

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, Genome,transcriptome,proteome,2-Dgelelectrophoresis,MaldiToffspectroscopy Majorfeaturesofcompletedgenomes:*E.coli*,*S.cerevisiae*,*Arabidopsis*,Human

Unit 5 ProteinStructurePredictionsNo. of Hours:12

Hierarchyofproteinstructure-primary,secondaryandtertiarystructures,modeling Structural Classes, Motifs, Folds andDomainsProteinstructurepredictioninpresenceand absence ofstructuretemplate Energy minimizations and evaluation by RamachandranplotProtein structure and rational drug design

DSE-1: BIOINFORMATICS (PRACTICAL) SEMESTER –V/VI

TOTALHOURS:60 **CREDITS:2**

1. Introduction to different operating systems - UNIX, LINUX andWindows
2. Introductiontobioinformaticsdatabases(anythree):NCBI/PDB/DDBJ,Uniprot,PDB
3. Sequence retrieval usingBLAST
4. Sequence alignment & phylogenetic analysis using clustalW&phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification,repeatingenome,ORFprediction).Genefindingtools(Glimmer,GENSCAN),Primer designing,Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- p red, homology modeling using Swiss model. Molecular visualization using j mol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functionalgene

SUGGESTED READING

1. Saxena Sanjay (2003) A First Course in Computers, Vikas PublishingHouse
2. PradeepandSinhaPreeti(2007)FoundationsofComputing,4th ed.,BPBPublications
3. LeskM.A.(2008)IntroductiontoBioinformatics.OxfordPublication,3rd International Student Edition
4. RastogiS.C.,MendirattaN.andRastogiP.(2007)Bioinformatics:methodsandapplications, genomics,proteomicsanddrugdiscovery,2nd ed.PrenticeHallIndiaPublication
5. PrimroseandTwyman(2003)PrinciplesofGenomeAnalysis&Genomics.Blackwell

B.Sc(HONOURS)MICROBIOLOGY SEMESTER –V/VI

INSTRUCTIONS TO QUESTION SETTER

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DSE-4: PLANT PATHOLOGY(THEORY)

SEMESTER –V/VI
TOTALHOURS:60 **CREDITS:4**

Unit1IntroductionandHistoryofplantpathology **No. of Hours: 5**

Conceptofplantdisease-definitionsofdisease,diseasecycle&pathogenicity,symptomsassociated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet,Burrill,E.Smith,AdolphMayer,Ivanowski,Diener,Stakman,H.H.Flor,VanDerPlank, molecular Koch's postulates. Contributions of eminent Indian plantpathologists.

Unit2Stagesindevelopmentofadisease **No. of Hours:2**

Infection, invasion, colonization, dissemination of pathogens and per ennation.

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

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indiancontext.

Unit 4 HostPathogenInteractionNo. of Hours:19

A. *MicrobialPathogenicity*
Virulencefactorsofpathogens:enzymes,toxins(hostspecificandnonspecific)growthregulators, virulencefactorsinviruses(replicase,coatprotein,silencingsuppressors)indiseasedevelopment. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth andreproduction).

B. *Genetics of PlantDiseases*
Conceptofresistance(R)geneandavirulence(avr)gene;geneforgenehypothesis,typesofplant resistance: true resistance– horizontal & vertical, apparentresistance.

C. *Defense Mechanisms inPlants*
Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-corklayer,abscissionlayer,tyloses,gums),induciblebiochemicaldefenseshypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantbodies, phenolics, quinones, oxidativebursts.

Unit 5 Control ofPlantDiseases **No.ofHours:10**

Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory-quarantine,cropcertification,avoidanceofpathogen,useofpathogenfreepropagative material

Cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches

Chemicalprotectantsandsystemicfungicides,antibiotics,resistanceofpathogensto chemicals. Biological-suppressivesoils,antagonisticmicrobes-bacteriaandfungi,trapplants

Genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit 6 SpecificPlantdiseases **No.ofHours:19**

Studyofsomeimportantplantdiseasesgivingemphasisonitsetiologicalagent,symptoms, epidemiology andcontrol

A. Important diseases caused by fungi Whiterustofcrucifers-*Albugocandida*

Late blight of potato –*Phytophthorainfestans*Ergot of rye –*Clavicepspurpurea*

Black stem rust of wheat –*Pucciniagraministritici*

Loose smut of wheat –*Ustilagonuda*

Wilt of tomato –*Fusariumoxysporum*sp. *lycopersici*

Red rot of sugarcane –*Colletotrichumfalcatum*

Early blight of potato –*Alternariasolani*

B. Importantdiseasescausedbyphytopathogenicbacteria:crown galls, bacterial cankers ofcitrus

C. Important diseases caused by phytoplasmas: Aster yellow, citrusstubborn

D. Importantdiseasescausedbyviruses:Papayaringspot,bananabunchy top, ricetungro

E. Important diseases caused by viroids: Potato spindle tuber,

DSE-4:PLANTPATHOLOGY(PRACTICAL) SEMESTER–V/VI
TOTALHOURS:60 **CREDITS:2**

1. Demonstration of Koch's postulates in fungal, bacterial and viral plantpathogens.
2. Studyofimportantdiseasesofcropplantsbycuttingsectionsofinfectedplantmaterial-*Albugo, Puccinia, Ustilago, Fusarium,Colletotrichum.*

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, SanDiego,
2. LucasJA.(1998).PlantPathologyandPlantPathogens.3rdedition.BlackwellScience,Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-HillLimited.
4. RangaswamiG.(2005).DiseasesofCropPlantsinIndia.4thedition.PrenticeHallofIndia Pvt. Ltd., NewDelhi.
5. SinghRS.(1998).PlantDiseasesManagement.7thedition.Oxford&IBH,NewDelhi.

B.Sc(HONOURS)MICROBIOLOGY

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DSE-6: INHERITANCE BIOLOGY (THEORY) SEMESTER–V/VI

TOTALHOURS:60 **CREDITS:4**

Unit 1 IntroductiontoGenetics **No. of Hours:5**

Historical developments. Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomyces cerevisiae,Neurosporacrassa,Caenorhabditiselegans, Drosophilamelanogaster, Arabidopsis thaliana*

Unit 2MendelianPrinciplesNo. of Hours:13

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance,RediscoveryofMendel'sprinciples,Chromosometheoryofinheritance:Allele,multiple alleles,pseudoallele,complementationtests,ExtensionsofMendeliangenetics:Allelicinteractions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance andexpressivity

Unit 3 Linkage andCrossingoverNo. of Hours: 9

Linkageandrecombinationofgenes,Cytologicalbasisofcrossingover,Crossingoveratfour-strand stage, Molecular mechanism of crossing over,mapping

Unit 4Extra-ChromosomalInheritance **No. of Hours: 9**

Rulesofextranuclearinheritance,Organelleheredity-Chloroplastmutationsin*Chlamydomonas,* mitochondrial,mutationsin*Saccharomyces,*Maternaleffects–Shellcoilingin*Limnaeaperegra*Infectious heredity Kappa particles in*Paramecium*

Unit 5 CharacteristicsofChromosomesNo. of Hours: 15

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormalkaryotypesofhumanchromosomes,Chromosomebanding,Giantchromosomes:Polytene andlampbrushchromosomes,Variationsinchromosomestructure:Deletion,duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities-

Klinefelter syndrome, Turner syndrome, Down syndrome.

Unit6Recombination **No. of Hours:3**

Homologousandnon-homologousrecombination,includingtransposition,site-specific recombination.

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

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

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

Polygenic inheritance, heritability and its measurements, QTL mapping.

DSE-6:INHERITANCEBIOLOGY(PRACTICAL) SEMESTER–V/VI
TOTALHOURS:60 CREDITS:2

1. Mendelian deviations in dihybridcrosses
2. Studying Barr Body with the temporary mount of human cheekcells
3. Studying *Rhoeo*translocation with the help ofphotographs
4. Karyotyping with the help ofphotographs
5. Chi-SquareAnalysis
6. Studyofpolytenechromosomesusingtemporarymountsofsalivaryglandsof*Chiromonas/ Drosophila*larvae
7. Study of pedigreeanalysis
8. Analysis of a representative quantitativetrait

SUGGESTED READING

1. GardnerEJ,SimmonsMJ,SnustadDP(2008).PrinciplesofGenetics.8th Ed.Wiley-India
2. SnustadDP,SimmonsMJ(2011).PrinciplesofGenetics.6th Ed.JohnWileyandSonsInc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-HillEducation
4. KlugWS,CummingsMR,SpencerCA,PalladinoM(2012).ConceptsofGenetics.10th Ed. BenjaminCummings
5. GriffithAJF,WesslerSR,LewontinRC,CarrollSB.(2007).IntroductiontoGeneticAnalysis.9th Ed. W.H.Freeman and Co., NewYork
6. HartlDL,JonesEW(2009).Genetics:AnalysisofGenesandGenomes.7th Ed,Jonesand Bartlett Publishers
7. RussellPJ.(2009).Genetics-AMolecularApproach.3rd Ed,BenjaminCummings

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DSE-9:INSTRUMENTATIONANDBIOTECHNIQUES(THEORY)

SEMESTER –V/VI
TOTALHOURS:60 CREDITS:4

Unit1MicroscopyNo. of Hours:10

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit2ChromatographyNo. 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.

Unit3ElectrophoresisNo. 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.

Unit4SpectrophotometryNo. of Hours:10

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

Unit5CentrifugationNo. of Hours:12

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

DSE-9:INSTRUMENTATIONANDBIOTECHNIQUES(PRACTICAL)

SEMESTER–V/VI

TOTALHOURS:60 **CREDITS:2**

1. Study of fluorescent micrographs to visualize bacterialcells.
2. Ray diagrams of phase contrast microscopy and Electronmicroscopy.
3. Separation of mixtures by paper / thin layerchromatography.
4. Demonstration of column packing in any form of columnchromatography.
5. Separation of protein mixtures by any form ofchromatography
6. Determinationofλ_{max}foranunknownsampleandcalculationofextinctioncoefficient.
7. Separation of components of a given mixture using a laboratory scale centrifuge. Understanding density gradient centrifugation with the help of pictures

SUGGESTED READINGS

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

B.Sc (HONOURS) MICROBIOLOGY)

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GE-1:INTRODUCTIONANDSCOPEOFMICROBIOLOGY(THEORY)

SEMESTER–I

TOTALHOURS:60 **CREDITS:4**

Unit1HistoryofDevelopmentof Microbiology No. of Hours: 12

Developmentofmicrobiologyasadiscipline,Spontaneousgeneration*vs*.biogenesis.Contributionsof Antony vonLeeuwenhoek,LouisPasteur,RobertKoch,JosephLister,AlexanderFleming. 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:ContributionsofMartinusW.Beijerinck,SergeiN.Winogradsky,Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, EdwardJenner

Unit 2 Diversityof Microorganisms No. of Hours: 10

Systemsofclassification:Binomialnomenclature,Whittaker'sfivekingdomandCarlWoese'sthree kingdom classification systems and theirutility. Generalcharacteristicsofdifferentgroups:Acellularmicroorganisms(Viruses,Viroids,Prions)and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa) giving definitions and citinexamplesProtozoa : Methods of nutrition, locomotion & reproduction - Amoeba*, Paramecium* and *Plasmodium*

Unit3Microscopy No. of Hours:7

BrightFieldMicroscope,DarkFieldMicroscope,PhaseContrastMicroscope,FluoresenceMicroscope,Transmission Electron Microscope, Scanning ElectronMicroscope

Unit4Sterilization No. of Hours:5

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

Unit5MicrobesinHumanHealth&Environment No. of Hours:10

Medical microbiology and immunology: List of important human diseases and their causative agentsofvarioushumansystems.Definitionsofimmunity(active/passive),primaryandsecondary immune response, antigen, antibody and theirtypes

Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers,inbiodegradation,biodeteriorationandbioremediation(*e.g.*hydrocarbonsi

noilspills)

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

Definitionoffermentation,primaryandsecondarymetabolites,typesoffermentationsand fermenters and microbes producing important industrial products throughfermentation.

Unit 7 Food andDairyMicrobiology **No. of Hours: 8**

Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non-dairy based fermentedfoodproducts)andprobiotics.Microorganismsinfoodspoilageandfoodbornei nfections.

GE-1:INTRODUCTIONANDSCOPEOFMICROBIOLOGY(PRACTICALS)
SEMESTER–I

TOTALHOURS:60 **CREDITS:2**

1. Microbiology Laboratory Management andBiosafety.
2. Tostudytheprincipleandapplicationsofimportantinstruments(biologicalsafetycabinets, autoclave,incubator,BODincubator,hotairoven,lightmicroscope,pHmeter)usedinthe microbiologylaboratory
3. Preparation of culture media for bacterialcultivation
4. Sterilization of medium using Autoclave and assessment forsterility
5. Sterilization of glassware using Hot Air Oven and assessment forsterility
6. Sterilization of heat sensitive material by filtration and assessment forsterility
7. Demonstrationofpresenceofmicrofloraintheenvironmentbyexposingnutrientagarplate s toair.
8. Study of different shapes of bacteria using permanentslides
9. Study of *Rhizopus*and *Penicillium*using permanentmounts
10. Study of *Spirogyra* and *Chlamydomonas*using permanentMounts
11. Studyofthefollowingprotozoansusingpermanentmounts/photographs:*Amoeba, Entamoeba, Paramecium* and*Plasmodium*

SUGGESTED READING

1. TortoraGJ,FunkeBRandCaseCL.(2008).Microbiology:AnIntroduction.9th edition.P earson Education

2. MadiganMT,MartinkoJM,DunlapPVand ClakDP.(2014).BrockBiologyofMicroorganisms. 14th edition. Pearson InternationalEdition

3. CappucinoJandShermanN.(2010).Microbiology:ALaboratoryManual.9thedition.Pe arson EducationLimited

4. WileyJM,SherwoodLMandWoolvertonCJ.(2013)Prescott'sMicrobiology.9thEditio n.McGraw HillInternational.

5. AtlasRM.(1997).PrinciplesofMicrobiology.2nd edition.WM.T.BrownPublishers.

6. PelczarMJ,ChanECSandKriegNR.(1993). Microbiology5thedition.McGraw Hill BookCompany.

7. StanierRY,IngrahamJL,WheelisML,andPainterPR.(2005).General Microbiology. 5th edition. McMillan.

B.Sc.(HONOURS)MICROBIOLOGY

GE-2: BACTERIOLOGY AND VIROLOGY (THEORY) SEMESTER –II

TOTALHOURS:60 **CREDITS:4**

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

Cellsize,shapeandarrangements,capsule,flagellaandpili,Compositionanddetailedstructureof gram-positiveandgram-negativecellwallandarchaealcellwall,Structure,chemicalcomposition andfunctionsofbacterialandarchaealcellmembranes,Ribosomes,inclusions,nucleoid,plasmids, structure, formation and stages ofsporulation

Unit 2 Bacterial growthandcontrol **No. of Hours: 8**

Culturemedia:Componentsofmedia,Syntheticordefinedmedia,Complexmedia,enrichedmedia, selective media, differential media, enrichment culturemedia
Pureculture isolation:Streaking,serialdilutionandplatingmethods,cultivation,maintenanceand stocking of pure cultures, cultivation of anaerobicbacteria.Growth: Binary fission, phases of growth

Unit3BacterialSystematicsandTaxonomyNo. of Hours:12

Taxonomy, nomenclature, systematics, types of classifications. Morphology,ecologicalsignificanceandeconomicimportanceofthefollowinggroups: Archaea: methanogens, thermophiles andhalophiles. Eubacteria: Gram negative and Gram positive Gram negative:Non-proteobacteria– *Deinococcus,Chlamydiae,*Spirochetes Alphaproteobacteria- *Rickettsia,Rhizobium,Agrobacterium* Gammaproteobacteria– *Escherichia,Shigella,Pseudomonas*Gram positive: Low G+C: *Mycoplasma, Bacillus, Clostridium, Staphylococcus* High G+C:*Streptomyces, Frankia*

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

Properties of viruses; general nature and important features Subviral particles; viroids, prions and their importance Isolation and cultivation of viruses

Unit5Structure,andmultiplicationofvirusesNo. of Hours:12

Morphologicalcharacters:Capsidsymmetryanddifferentshapesofviruseswithexamples
Viral multiplication in the Cell: Lytic and lysogeniccycle
Description of important viruses: salient features of the viruses infecting different hosts – Bacteriophages(T4&Lambda);Plant(TMV&CauliflowerMosaicVirus),Human(HIV& Hepatitis viruses)

Unit6RoleofVirusesinDiseaseanditspreventionNo. of Hours:10

Viruses as pathogens: Role of viruses in causing diseases
Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

GE-2:BACTERIOLOGYANDVIROLOGY(PRACTICAL) SEMESTER –II

TOTALHOURS:60 **CREDITS:2**

1. Preparation of different media: Nutrient agar, Nutrientbroth
2. To perform simple staining and Gram's staining of the bacterialsmear
3. To perform sporestaining
4. Isolation of pure cultures of bacteria by streakingmethod
5. Enumerationofcolonyformingunits(CFU)countbyspreadplatemethod/pourplate
7. Studythemorphologicalstructuresofviruses(DNAandRNA)andtheirimportantch aracters using electronmicrographs
8. Study of the methods of isolation and propagation of plantviruses
9. Study of cytopathic effects of viruses usingphotographs

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers
2. MadiganMT,MartinkoJM,DunlapPVandClarkDP(2014).BrockBiologyofMicro-organisms. 14th edition. Pearson Education,Inc.
3. StanierRY,IngrahamJL,WheelisMLandPainterPR.(2005).GeneralMicrobiology. 5th edition.McMillan
4. CarterJandSaundersV (2007).Virology;principlesandApplications.JohnWileyandSons
5. FlintSJ,Enquist,LW,Krug,RM,Racaniello,VRSkalka,AM(2004)PrinciplesofVirolo gy, Molecular Biology, Pathogenesis and Contro*l*.2nd edition.ASMPress
6. ShorsTeri(2013)UnderstandingViruses2nd editionJonesandBartlettLearningBurling tonUSA
7. PelczarJrMJ,ChanECS,andKriegNR.(2004).Microbiology.5th editionTataMcGrawHil l.
8. TortoraGJ,FunkeBR,andCaseCL.(2008).Microbiology:AnIntroduction.9th editionP earson Education.
9. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013).Prescott'sMicrobiology.9th editi on. McGraw Hill HigherEducation.
10. Dimmock,NJ,Easton,AL,Leppard,KN(2007).IntroductiontoModernVirology.6the dition, Blackwell PublishingLtd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic PressOxford UK

B.Sc. (HONOURS) MICROBIOLOGY

GE-3:INDUSTRIALANDFOODMICROBIOLOGY(THEORY)

SEMESTER – IV

TOTALHOURS:60 **CREDITS:4**

Unit1IntroductiontoIndustrialmicrobiology **No. of Hours:10**

Brief history and developments in industrial microbiology.

Typesoffermentationprocesses-solidstate,liquidstate,batch,fed-batchandcontinuous

Types of fermenters – laboratory, pilot-scale and productionfermenters

Components of a typical continuously stirred tank bioreactor

Unit2IsolationofIndustrialStrainsandFermentationMedium **No. of Hours:8**

Primary and secondary screening

Preservation and maintenance of industrial strains

Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

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

Downstreamprocessing-filtration,centrifugation,celldisruption,solventextraction.

Microbialproductionofindustrialproducts-citricacid,ethanolandpenicillin.

Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Unit4Foodasasubstrateformicrobialgrowth **No. of Hours:9**

Intrinsic and extrinsic parameters that affect microbial growth in food Microbial spoilage of food - milk, egg, bread and canned foods

Unit5Principlesandmethodsoffoodpreservationandfoodsanitation

No. of Hours:9

Physical methods - high temperature, low temperature, irradiation, aseptic packaging

Chemicalmethods-salt,sugar,benzoates,citricacid,ethyleneoxide,nitrateandnitrite

Food sanitation and control –HACCP

Unit6Dairyproducts,probioticsandFood-borneDiseases

No. of Hours:12

Fermenteddairyproducts-yogurt,acidophilusmilk,kefir,dahiandcheese Probiotics definition, examples andbenefits

Food intoxication by *Clostridium botulinum*and *Staphylococcus aureus*

Food infection by *Salmonella* and *E.coli*

GE-4:INDUSTRIALANDFOODMICROBIOLOGY(PRACTICAL)
SEMESTER –IV
TOTALHOURS:60 **CREDITS:2**

1. Microbial fermentation for the production and estimation ofamylase
2. Microbial fermentation for the production and estimation of citricacid
3. Microbial fermentation for the production and estimation ofethanol
4. Determination of the microbiological quality of milk sample byMBRT
5. Isolation of fungi from spoiltbread/fruits/vegetables
6. Preparation ofYogurt/Dahi

SUGGESTED READING

1. CruegerWandCruegerA.(2000).Biotechnology:AtextbookofIndustrialMicrobiology.2nd Edition. Panima Publishing Company, NewDelhi
2. PatelAH.(1996).IndustrialMicrobiology.1st Edition.MacMillanIndiaLimitedPublishing Company Ltd. New Delhi, India
3. TortoraGJ,FunkeBR,andCaseCL.(2008).Microbiology:Anintroduction.9th Edition. Pearson Education
4. WilleyJM,SherwoodLMANDWoolvertonCJ(2013),Prescott,HarleyandKlein's Microbiology.9th Edition. McGraw Hill Highereducation
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley EasternLimited.
6. StanburyPF,WhitakerAandHallSJ.(2006).PrinciplesofFermentationTechnology.2nd edition, Elsevier ScienceLtd.
7. AdamsMRandMossMO.(1995).FoodMicrobiology.4th edition,NewAgeInternational(P) Limited Publishers, New Delhi,India.
8. BanwartJM.(1987).BasicFoodMicrobiology.1st edition.CBSPublishersandDistributors, Delhi,India.
9. FrazierWCandWesthoffDC.(1992).FoodMicrobiology.3rd edition.TataMcGraw-Hill Publishing Company Ltd, New Delhi,India.
10. JayJM,LoessnerMJandGoldenDA.(2005).ModernFoodMicrobiology.7th edition,CBS Publishers and Distributors, Delhi,India.

B.Sc.(HONOURS)MICROBIOLOGY(CBCSSTRUCTURE) GE-4: MICROBES IN ENVIRONMENT (THEORY) SEMESTER –IV
TOTALHOURS:60 CREDITS:4

Unit 1 Microorganisms andtheirHabitatsNo. 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.
ExtremeHabitats:Extremophiles:Microbesthrivingathigh&lowtemperatures,pH,highhyrostatic & osmotic pressures, salinity, & low nutrientlevels.

Unit 2MicrobialInteractionsNo. of Hours:12
Microbeinteractions:Mutualism,synergism,commensalism,competition,amensalism,parasitism, predation
Microbe-Plant interaction: Symbiotic and non-symbiotic interactions
Microbe-
animalinteraction:Microbesinruminants,nematophagusfungiandsymbioticluminescent bacteria

Unit 3BiogeochemicalCyclingNo. of Hours:12
Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogencycle:Nitrogenfixation,ammonification,nitrification,denitrificationandnitratereduction Phosphorus cycle: Phosphate immobilization andsolubilisation
Sulphur cycle: Microbes involved in sulphur cycle other elemental cycles: Iron and manganese

Unit 4WasteManagementNo. of Hours:12
SolidWastemanagement:Sourcesandtypesofsolidwaste,Methodsofsolidwastedisposal (composting and sanitarylandfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary,
secondary(oxidationponds,tricklingfilter,activatedsludgeprocessandseptictank)andtertiary sewagetreatment

Unit 5MicrobialBioremediation No. of Hours:5
Principles and degradation of common pesticides, hydrocarbons (oil spills).

Unit 6WaterPotability No. of Hours:5
Treatmentandsafetyofdrinking(potable)water,methodstodetectpotabilityofwatersamples:(a)
standardqualitativeprocedure:presumptivetest/MPNtest,confirmedandcompletedtests forfaecal coliforms (b) Membrane filter technique and (c) Presence/absencetests

GE-5:MICROBESINENVIRONMENT(PRACTICAL) SEMESTER–IV
TOTALHOURS:60 CREDITS:2

1. Analysisofsoil-pH,moisturecontent,waterholdingcapacity,percolation,capillaryaction.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere andrhizoplane.
4. Assessment of microbiological quality ofwater.
5. Determination of BOD of waste watersample.
6. Studythepresenceofmicrobialactivitybydetecting(qualitatively)enzymes(dehydrogenase, amylase, and urease) insoil.
7. Isolation of *Rhizobium* from rootnodules.

SUGGESTED READINGS

1. AtlasRMandBarthaR.(2000).MicrobialEcology:Fundamentals&Applications.4th edition. Benjamin/Cummings Science Publishing,USA
2. MadiganMT,MartinkoJMandParkerJ.(2014).BrockBiologyofMicroorganisms.14th edition. Pearson/ BenjaminCummings
3. MaierRM,PepperILandGerbaCP.(2009).EnvironmentalMicrobiology.2nd edition,Academic Press
4. Okafor,N(2011).EnvironmentalMicrobiologyofAquatic&Wastesystems.1st edition, Springer, NewYork
5. SinghA,Kuhad,RC&WardOP(2009).AdvancesinAppliedBioremediation.Volume17, Springer-Verlag, BerlinHedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

CampbellRE.(1983).MicrobialEcology.BlackwellScientificPublication,Oxford,England.

7. CoyneMS.(2001).SoilMicrobiology:AnExploratoryApproach.DelmarThomsonLearning.
8. LynchJM&HobbieJE.(1988).MicroorganismsinAction:Concepts&ApplicationinMicrobial Ecology. Blackwell Scientific Publication,U.K.
9. MartinA.(1977).AnIntroductiontoSoilMicrobiology.2nd edition.JohnWiley&SonsInc.New York &London.
10. StolpH.(1988).MicrobialEcology:OrganismsHabitatsActivities.CambridgeUniversityPress, Cambridge,England.
11. SubbaRaoNS.(1999).SoilMicrobiology.4th edition.Oxford&IBHPublishingCo.NewDelhi.
12. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013).Prescott'sMicrobiology.9th edition. McGraw Hill HigherEducation.

B.Sc.(HONOURS)MICROBIOLOGYSEMESTER –IV

(CBCSSTRUCTURE)

SE-1: BIOFERTILIZERS AND BIOPESTICIDES

TOTALHOURS:30 **CREDITS:2**

Unit1Biofertilizers **No of Hours:10**

General account ofthemicrobesusedasbiofertilizersforvariouscropplantsandtheiradvantages over chemicalfertilizers.

SymbioticN2fixers:*Rhizobium*-Isolation,characteristics,types, inoculums productionandfield application, legume/pulsesplants

Frankia- Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria,*Azolla*-Isolation,characterization,massmultiplication,Roleinricecultivation,Crop response, fieldapplication.

Unit2Non-SymbioticNitrogenFixers **No of Hours: 4**

Freeliving*Azospirillum*,*Azotobacter*-freeisolation,characteristics, massinoculums,production and fieldapplication.

Unit 3PhosphateSolubilizers **No of Hours:4**

Phosphatesolubilizingmicrobes-Isolation,characterization,mass inoculums production,field application

Unit 4MycorrhizalBiofertilizers **No of Hours:5**

Importanceofmycorrizalinoculum,typesofmycorrhizaeandassociatedplants,Massinoculum production of VAM, field applications of Ectomycorrhizae andVAM.

Unit5Bioinsecticides **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.

Suggested Readings

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS,Texas.
2. MahendraK.Rai(2005).HandbookofMicrobialbiofertilizers,TheHaworthPress,Inc.New York.
3. Reddy,S.M.et.al.(2002).Bioinoculantsforsustainableagricultureandforestry,Scientific Publishers.
4. SubbaRaoN.S(1995)SoilmicroorganismsandplantgrowthOxfordandIBHpublishingco.Pvt. Ltd.NewDelhi.
5. SaleemFandShakooriAR(2012)DevelopmentofBioinsecticide,LapLambertAcademic Publishing GmbHKG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APHpublication.

B.Sc (HONOURS)MICROBIOLOGY

SE-4: FOOD FERMENTATION TECHNIQUES SEMESTER –IV
TOTALHOURS:30 **CREDITS:2**

Unit 1FermentedFoods **NoofHours:4**

Definition, types, advantages and health benefits

Unit2MilkBasedFermentedFoods **No of Hours:8**

Dahi,Yogurt,Buttermilk(Chach)andcheese:Preparationofinoculums,typesofmicroorganisms and productionprocess

Unit3GrainBasedFermentedFoods **No of Hours:6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit4VegetableBasedFermentedFoods **No of Hours:4**

Pickels, Saeurkraut: Microorganisms and production process

Unit5FermentedMeatandFish **No of Hours:4**

Types, microorganisms involved, fermentation process

Unit 6ProbioticFoods **No of Hours:4**

Definition, types, microorganisms and health benefits

Suggested Readings

1. HuiYH,Meunier-GoddikL,JosephsenJ,NipWK,StanfieldPS(2004)Handbookoffoodand fermentation technology, CRCPress
2. HolzapfelW(2014)AdvancesinFermentedFoodsandBeverages,WoodheadPublishing.
3. YadavJS,Grover,SandBatishVK(1993)Acomprehensivedairymicrobiology,Metropolitan
4. JayJM,LoessnerMJ,GoldenDA(2005)ModernFoodMicrobiology,7th edition.Springer