Vidyasagar University

Curriculum for B.Sc. Honours in Microbiology [Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	**C1T:** Introduction to Microbiology and Microbial diversity	Core Course-1		4	0	0	6	75
	C1P: Introduction to Microbiology and Microbial Diversity	Core Course-1(Practical)		0	0	4		
C2	**C2T:** Bacteriology	Core Course-2		4	0	0	6	75
	C2P: Bacteriology	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	50
				Total Credits = 20				

L= Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language

Interdisciplinary/Generic Elective (GE) from other Department

[**Four papers are to be taken and each paper will be of 6 credits**]:

[Papers are to be taken from any of the following discipline (GE-**1 Preferably Chemistry**):

Chemistry/Physics/Computer Sc/Statistics/Botany/Zoology/Physiology/Nutrition/Geology/Mathematics

Semester-1

Core Courses

Core Course -1

CC-1: Introduction to Microbiology and Microbial Diversity

Credits 06

C1 T: Introduction to Microbiology and Microbial Diversity (Theory)

(Each unit carries equal mark)

UNIT 1

Historical Developments and Scope **(10 Periods)**

An overview of Scope of Microbiology for human welfare; Development of microbiology as a discipline: Contribution of Anton von Leeuwenhoek, Louis Pasteur, Joseph Lister, Alexander Fleming, Robert Koch; Germ theory of disease, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky work of Paul Ehrlich and Elie Metchnikoff,

UNIT 2

Microbial Classification **(10 Periods)**

Systems of classification Binomial Nomenclature, Whittaker's five kingdom: Protista and Monera, Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms, General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria) with emphasis on distribution, economic importance.

UNIT 3

Algae and fungi **(14 Periods)**

General characteristics, Classification, ultra structure: thalllus organization, Pigments reproduction, life cycles in micro algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles, General characteristics and Classification, nutritional types, fungal cell ultra-structure: thallus organization, reproduction, heterokaryosis, heterothallism and parasexual mechanism.

UNIT 4

Protozoa **(08 Periods)**

Classification, General characteristics and significance with special reference to *Amoeba, Paramecium, Plasmodium and Giardia.*

Books Recommended

1. Microbiology: An Introduction. 9th edition. Pearson Education. Tortora GJ, Funke BR and Case CL. (2008).
2. Brock Biology of Microorganisms.14th edition. Pearson International Edition. Madigan MT, Martinko J.M, Dunlap P.V and Clark D.P. (2014).
3. Prescott's Microbiology. 9th Edition. McGraw Hill International.
4. Principles of Microbiology. 2nd edition. WM.T.Brown Publishers. Atlas RM. (1997).
5. Microbiology. 5th edition. McGraw Hill Book Company. Pelczar MJ, Chan ECS and Krieg NR. (1993).
7. General Microbiology. 5th edition, McMillan. Stanier R.Y, Ingraham J.L, Wheelis M.L, and Painter P.R. (2005).

C1 P: Introduction to Microbiology and Microbial Diversity (Practical)

(Credits – 2)

General Experiments:

1. To study the principle and applications of important instruments (Autoclave, incubator, Colony counter, Electronic balance, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
2. Preparation of culture media for bacterial cultivation.
3. Sterilization of medium using Autoclave and assessment for sterility
4. Sterilization of glassware using Hot Air Oven and assessment for sterility
5. Demonstration of the presence of microbes by exposing nutrient agar plates to air.
6. Isolation of fungus from different natural samples.
7. Study of *Penicillium* and *Aspergillus* using temporary mounts
8. Study of *Chlamydomonas and Volvox* using permanent Mounts/Photographs.
9. Study of the following protozoans (atleast any two) using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Books Recommended

1.Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino. J and Sherman N. (2010).
2.Practical Microbiology, 1st edition, S. Chand. R. C. Dubey and D. K. Maheswari (2010)

Core Course -2

CC-2: Bacteriology — Credits 06

C2T: Bacteriology (Theory) — Credits 04

(Each unit carries equal mark)

UNIT 1

Cell organization **(10 periods)**

Cell size, shape and arrangement, capsule, cilia, flagella and motility, fimbriae and pili, Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative bacteria, Achaea: Archaebacterial cell wall, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms.

UNIT 2

Bacteriological techniques **(10 periods)**

Pure culture isolation: Streaking, serial dilution and plating methods (spread plate and pour plate); maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, Microscopy**:** Bright Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Scanning and Transmission Electron Microscope, Bacterial staining: Gram and acid fast staining, Negative-staining.

UNIT 3

Bacterial growth, reproduction and control **(12 periods)**

Nutritional requirements in bacteria and nutritional types; Culture media: natural media, synthetic media, complex media, selective and differential media, enriched and enrichment media, phases of growth, logarithmic representation of bacterial populations, calculation of generation time and specific growth rate. Reproduction in bacteria: Asexual methods of reproduction, Parasexual reproduction (conjugation and transduction), Physical methods of microbial control: high and low temperature, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action.

UNIT 4

Bacterial Systematics **(12 period)**

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches for bacterial taxonomy, Phylogenetic classification, rRNA oligonucleotide sequencing and

protein sequences. Differences between eubacteria and archaebacteria; Important archaeal and eubacterial groups and their characteristics and significance: Thermophiles, Methanogens, Halophiles, Chemoautotrophic bacteria, Photosynthetic bacteria (Cyanobacteria), Mycoplasma.

Books Recommended

1. Principles of Microbiology. 2nd edition. WM.T.Brown Publishers. Atlas RM. (1997).
2. Microbiology: Principles and Explorations. 7th edition. Prentice Hall Black JG. (2008).
3. Understanding Bacteria. Kluwer Academic Srivastava S and Srivastava PS. (2003). Publishers, Dordrecht
4. General Microbiology. 5th edition McMillan. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005).
5. Microbiology: An Introduction. 9th edition Pearson Education. Tortora GJ, Funke BR, and Case CL. (2008).
6. Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. Willey JM, Sherwood LM, and Woolverton CJ. (2013).

C2P: Bacteriology (Practical) Credits 02

General Experiments:

1. Demonstration of Negative staining
2. Demonstration of Gram's staining
3. Demonstration of Acid fast staining-permanent slide only.
4. Demonstration of Fungal staining.
5. Demonstration of algal staining.
6. Isolation of pure cultures of bacteria by pour plate and streaking method from soil sample.
7. Study of the culture characteristic of bacteria on nutrient agar surface.
8. Preservation of bacterial cultures by application of low temperature.
9. Estimation of cfu and bacterial population by spread plate method from water sample.

Books Recommended

1. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino. J and Sherman N. (2010).
2. Practical Microbiology, 1st edition, S. Chand. R. C. Dubey and D. K. Maheswari (2010)

Generic Elective

GE-1 [Interdisciplinary for other department]

GE-1: Introduction and Scope of Microbiology Credits 06

GE-1T: Introduction and Scope of Microbiology (Theory) Credits 04

(Each unit carries equal mark)

UNIT 1

History and Development of Microbiology (8 periods)

Scope of Microbiology, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Joseph Lister, Alexander Fleming, Robert Koch, Germ theory of disease, Development of various microbiological techniques, Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Contribution of Paul Ehrlich, Elie Metchnikoff and Edward Jenner

UNIT 2

Diversity of Microorganisms (8 periods)

Microorganism's position in Whittaker's five kingdom and Carl Woese's three kingdom classification systems, General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa), Definitions and citing examples of Protozoa ; Methods of nutrition, locomotion & reproduction - Amoeba, and *Plasmodium*

UNIT 3

Instrumentation (8 periods)

Bright Field Microscope, Principles and application Electron Microscope (TEM and SEM), Phase contrast microscope, Flouroscence microscope, Sterilization process: Autoclave, Tyndallization, Hot Air Oven, Filteration.

UNIT 4

Bacteriological techniques (16 periods)

Culture media: natural media, synthetic media, complex media, selective and differential media, enriched and enrichment media, Pure culture isolation: Streaking, serial dilution and plating methods (spread plate and pour plate); maintenance and preservation/stocking of pure cultures; Bacterial staining: Gram and acid fast staining, Negative-staining, Physical methods of microbial control: high and low temperature, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action

Books Recommended

1. Microbiology: An Introduction. 9th edition. Pearson Education. Tortora GJ, Funke BR and Case CL. (2008).
2. Brock Biology of Microorganisms. 14th edition. Pearson International Edition. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). .
3. Principles of Microbiology. 2nd edition. WM.T.Brown Publishers, Atlas RM. (1997).
4. Microbiology. 5th edition. McGraw Hill Book Company. Pelczar MJ, Chan ECS and Krieg NR. (1993).
5. General Microbiology. 5th edition. McMillan. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005).

GE-1P: Introduction and Scope of Microbiology (Practical) Credits 02

General Experiments

1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory
2. Preparation of culture media for bacterial cultivation
3. Sterilization of medium using Autoclave and assessment for sterility
4. Sterilization of glassware using Hot Air Oven and assessment for sterility
5. Demonstration of presence of micro flora in the environment by exposing nutrient agar plates to air.
6. Demonstration of Gram's staining procedure.
7. Demonstration of sub culturing techniques.
8. Preservation of bacterial culture at low temperature.

Books Recommended

1. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino J and Sherman N. (2010).
2. Practical Microbiology, Dubey and Maheshwari ,S.Chand Publication, First edition 2002

Vidyasagar University

Curriculum for B.Sc. Honours in Microbiology [Choice Based Credit System]

Semester-II

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C3	**C3T:** Biochemistry	Core Course-3		4	0	0	6	75
	C3P: Biochemistry (Practical)	Core Course-3(Practical)		0	0	4		
C4	**C4T:** Virology	Core Course-4		4	0	0	6	75
	C4P:Virology (Practical)	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AEC C-2	Environmental Studies	AECC					4	100
				Total Credits = 22				

L= Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.

Interdisciplinary/Generic Elective (GE) from other Department

[**Four papers are to be taken and each paper will be of 6 credits**]:

[Papers are to be taken from any of the following discipline : **Chemistry/Physics/Computer Sc/Statistics/Botany/Zoology/Physiology/Nutrition/Geology/Mathematics**

Semester-II

Core Courses

Core -3

CC-3: Biochemistry Credits: 06

C3T : Biochemistry (Theory) **Credits: 04**

Unit 1 Bioenergetics (8 Periods)

Thermodynamics : First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

Unit 2 Carbohydrates (12 Periods)

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

Unit 3 Lipids (12 Periods)

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

Unit 4 Proteins (12 Periods)

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

structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Unit 5 Enzymes (12 Periods)

Enzyme : Definition ,Structural component of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors,. Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

Unit 6 Vitamins (4 Periods)

Classification and characteristics with suitable examples, sources and importance

C3P: Biochemistry (Practical) Credits: 02

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

Suggested Reading

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

Core-4

CC-4 : Virology **Credits : 06**

C4 T: Virology (Theory) **Credits : 04**

Unit 1 Nature and Properties of Viruses **(12 Periods)**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses. Purification and assay of viral particles.

Viral taxonomy: Classification and nomenclature of different groups of viruses, LTH system and modern classification (Baltimore) of viruses.

Unit 2 Bacteriophages **(10 Periods)**

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

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication
(20 Periods)

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 Animal viruses and plant Viruses **(11 periods)**
Taxonomy of animal viruses, Reproduction of vertebrate viruses (pox viruses, Para viruses, Hepadna viruses, Herpes viruses, Retro viruses, Picornaviruses) Cytopathic effects, Plant viruses (Details on TMV), Viruses of Fungi, Cyanophages.

Unit 5 Viruses and Cancer **(6 Periods)**
Introduction to oncogenic viruses
Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 6 Prevention & control of viral diseases **(8 Periods)**
Antiviral compounds and their mode of action
Interferon and their mode of action
General principles of viral vaccination

Unit 6 Applications of Virology **(4 Periods)**

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

C4 P : VIROLOGY (Practical) **Credits: 02**

Total Hours: 60

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

Suggested Readings :

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

Generic Elective

GE-2 [Interdisciplinary for other department]

GE-2: Bacteriology and Virology **Credits 06**

GE 2 T: Bacteriology and Virology (Theory) **Credits 04**

Total Hours: 60

Unit 1 Cell organization **(10 Periods)**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

Unit 2 Bacterial growth and control **(8 Periods)**

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media
Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria
Growth: Binary fission, phases of growth

Unit 3 Bacterial Systematics and Taxonomy **(12 Periods)**

Taxonomy, nomenclature, systematics, types of classifications Morphology, ecological significance and economic importance of the following groups:
Archaea: methanogens, thermophiles and halophiles
Eubacteria: Gram negative and Gram positive
Gram negative:
Non-proteobacteria– *Deinococcus, Chlamydiae,* Spirochetes
Alpha proteobacteria- *Rickettsia, Rhizobium, Agrobacterium*
Gamma proteobacteria –*Escherichia,Shigella,Pseudomonas*
Gram positive: Low G+C: *Mycoplasma*, *Bacillus, Clostridium, Staphylococcus* High G+C: *Streptomyces, Frankia*

Unit 4 Introduction to Viruses **(8 Periods)**

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

Unit 5 Structure, and multiplication of viruses **(12 Periods)**

Morphological characters: Capsid symmetry and different shapes of viruses with examples
Viral multiplication in the Cell: Lytic and lysogenic cycle
Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses)

Unit 6 Role of Viruses in Disease and its prevention **(10 Periods)**

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

GE-2P: Bacteriology and Virology (Practical) **Credits: 02**

Total Hours: 60

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform simple staining and Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate
7. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs
8. Study of the methods of isolation and propagation of plant viruses
9. Study of cytopathic effects of viruses using photographs

Suggested Readings:

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Contro*l*.2nd edition.ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK

Vidyasagar University

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[Choice Based Credit System]

Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		**C5T:**Microbial Physiology and Metabolism	Core Course - 5	4	0	0	6	75
		C5P: Microbial Physiology and Metabolism		0	0	4		
CC-6		**C6T:**Cell Biology	Core Course - 6	4	0	0	6	75
		C6P: Cell Biology		0	0	4		
CC-7		**C7T:**Molecular Biology	Core Course - 7	4	0	0	6	75
		C7P: Molecular Biology		0	0	4		
GE-3		TBD	Generic Elective -3				4/5	75
							2/1	
SEC-1		**SEC-1:**Biofertilizers and Biopesticides	Skill Enhancement Course-1	1	1	0	2	50
Semester Total							**26**	**350**

L=Lecture, **T=** Tutorial, **P=**Practical, **CC =** Core Course, **GE**= Generic Elective, **SEC** = Skill Enhancement Course, **TBD =** to be decided

Generic Elective (GE)(Interdisciplinary) from other Department [**Four papers are to be taken and each paper will be of 6 credits**]:
Papers are to be taken from any of the following discipline: **Chemistry/Physics/Computer Sc/Statistics/Botany/Zoology/Physiology/Nutrition/ Geology/ Mathematics**

Modalities of selection of Generic Electives (GE): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

Semester-III
Core Course (CC)

CC-5: Microbial Physiology and Metabolism **Credits 06**

C5T: Microbial Physiology and Metabolism **Credits 04**

UNIT -1
Microbial Growth and Effect of Environment on Microbial Growth

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

UNIT -2
Nutrient uptake and Transport

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

UNIT -3
Chemoheterotrophic and Phototrophic Metabolism

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, Anaerobic respiration with special reference to dissimilatory nitrate reduction, Fermentation - Alcohol fermentation; Lactate fermentation (homofermentative and heterofermentative pathways**,** Photosynthesis with reference to photosynthesis in cyanobacteria.

UNIT -4
Nitrogen Metabolism

Biological nitrogen fixation with special reference to *Rhizobium*, *nif*-gene expression and nitrogenase activity, Ammonification, Nitrification, Assimilatory nitrate reduction, denitrification

Suggested Readings :

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

C5P: Microbial Physiology and Metabolism **Credits 02**

Practical
General Experiments

1. Study and plot the growth curve of *E. coli* by standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of salt on growth of *E. coli*
6. Demonstration of the thermal death point of *E. coli.*
7. Effect of different chemicals on bacterial growth.

Suggested Readings:

1) Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino. J and Sherman N. (2010).
2) Practical Microbiology, 1st edition, S. Chand. R. C. Dubey and D. K. Maheswari (2010).

CC-6: Cell Biology **Credits 06**

C6T: Cell Biology **Credits 04**

Theory

UNIT -1
Structure and organization of Cell

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic (Bacterial): Structure and function Plasma membrane, Cell Wall, Mitochondria, chloroplasts and peroxisomes, Cytoskeleton; Nuclear organization (Eukaryotic and prokaryotic): Nuclear envelope, nuclear pore complex and nuclear lamina, Chromatin organization, Nucleolus.

UNIT -2
Protein sorting and Transport

Ribosome, Endoplasmic Reticulum: Structure, targeting and insertion of proteins in the ER, protein folding, processing in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

UNIT – 3
Cell signaling

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

UNIT – 4
Cell Cycle, Cell Death and Cell Renewal

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis (Molecular basis); Development of cancer, causes and types; Programmed cell death; Stem cells: Embryonic stem cell, induced pleuripotent stem cells.

Suggested Readings :

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

C6P: Cell Biology (Practical) **Credits 02**

Practical
General Experiments

1. Demonstration of the technique of microscopy.
2. Study of the electron micrographs of bacterial cell.
3. Study of the different fungal cells.
4. Study of different stages of mitosis using plant root tips.
5. Study of different stages of meiosis using plant parts.
6. Study of the structure of cell organelles through electron micrographs.
7. Study of polyploidy in Onion root tip by colchicines treatment.
8. Identification and study of cancer cells by photomicrographs.

Suggested Readings:

1. Cell and Molecular Biology : A Lab Manual, PHI. K. V. Chaitanya (2013)
2. Plant Cell Biology (A Practical Approach), Oxford University press. N. Harris and K.J. Oparka (Editor) (1994)
3. Cell Biology, Genetics, Molecular Biology, Evolution & EcologyPaperback, S.Chand. Verma P.S. and Agarwal V.K.(2004)

CC-7: Molecular Biology **Credits 06**

C7T: Molecular Biology **Credits 04**

Theory

UNIT -1
Genetic Material (DNA and RNA)

DNA structure and types, Double helical model, Evidences on DNA and RNA as genetic material, Organization of DNA in prokaryotes and Eukaryotes, Extra chromosomal DNA, Mechanism of DNA replication, various models of DNA replication: rolling circle, Θ (theta) mode of replication, Mismatch and excision repair, RNA structure and types.

UNIT -2
Transcriptional and Post-Transcriptional Processing

Transcription: Definition, promoter, RNA Polymerase and the transcription unit, Transcription: RNA polymerases, general Transcription factors, concept of introns and exons, RNA splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, mi RNA and its significance.

UNIT -3
Translation (Prokaryotes and Eukaryotes)

Mechanism of Translation: Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Inhibitors of protein synthesis in prokaryotes and eukaryote.

UNIT -4
Regulation of gene Expression in Prokaryotes and Eukaryotes

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

Suggested Readings :

1. Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008).
2. The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009).
3. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia. De Robertis EDP and De Robertis EMF (2006).
4. Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc. Karp G (2010).
5. Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning. Krebs J, Goldstein E, Kilpatrick S (2013).
6. Principles of Genetics. 8th Ed. Wiley-India . Gardner EJ, Simmons MJ, Snustad DP (2008).

C7P: Molecular Biology **Credits 02**
Practical

General Experiments

1. Study of different types of DNA and RNA using micrographs/model.
2. Study of semi-conservative replication of DNA through micrographs /model.
3. Estimation of calf thymus DNA using spectrophotometer (diphenylamine Reagent)
4. Estimation of RNA using spectrophotometer (orcinol reagent)
5. Gel preparation. (Agarose gel and SDS-PAGE)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE)

Suggested Readings :

1. Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc. Karp G (2010).
2. Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press. Sambrook J and Russell DW. (2001).
3 Princeples and techniques of biochemistry and molecular biology, Cambridge press. K. Wilson and J. Walker (edition 2009)
4 Gene Cloning a laboratory manual, Cold spring Harbour laboratory Press. Green and Sambrook (2012)

Skill Enhancement Course (SEC)

SEC-1: Biofertilizers and Biopesticides **Credits 02**

SEC1T: Biofertilizers and Biopesticides

Theory

UNIT -1
Symbiotic Nirogen fixers
Symbiotic N_2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants, *Anabaena azollae* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

UNIT -2
Non - Symbiotic Nitrogen Fixers

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

UNIT -3
Phosphate Solubilizers

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application. Importance of mycorrizal inoculums, types of *mycorrhizae* and associated plants, Mass inoculums, production of VAM, field applications of *mycorrhizae* and VAM.

UNIT -4
Bioinsecticides

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*: production, Field applications, Virus biocontrol, Fungal biocontrol.

Suggested Readings:

1. Bioetchnology of Biofertilizers, CHIPS, Texas. Kannaiyan, S. (2003).
2. Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York. Mahendra K. Rai (2005).
3. Bioinoculants for sustainable agriculture and forestry, Scientific Publishers. Reddy, S.M. et. al. (2002).
4. Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi. Subba Rao N.S (1995).
5. Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG. Saleem F and Shakoori AR (2012).
6. Advanced Environmental Biotechnology, APH publication. Aggarwal S.K. (2005).

Generic Elective Syllabus
GE-3 [Interdisciplinary for other department]

GE-3: Applied Microbiology I **Credits 06**

GE3T: Applied Microbiology I **Credits 04**

Theory

UNIT 1
Soil Microbiology

Soil as a habitat for microorganisms; Diversity and distribution of microorganisms in soil; Soil Microflora, bacteria, Fungus and actinomycetes.

UNIT 2
Microbial Activity in Soil and Plant-microbe interaction

Microbial degradation of cellulose, hemicelluloses, lignin and chitin**;** Microbial Pathogenicity: Virulence factors of pathogens: enzymes, toxins (host specific and non specific).; Effects of pathogens on host physiological processes.

UNIT 3
Water and Air Microbiology

Aquatic Environment: Microflora of fresh water and marine habitats, BOD and COD; Atmosphere: Aero-microflora and dispersal of microbes, sampling of air.

UNIT 4
Microbial application in crop production

Plant growth promoting bacteria; biofertilizers – symbiotic (*Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Phosphate solubilizers); Biopesticides, IPM; Weed control.

Suggested Readings :

1. Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning. Coyne MS. (2001).
2. Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England. Stolp H. (1988).
3. Agriculture Biotechnology, Ist edition, Marcel decker Inc. Altman A (1998).

GE3P: Applied Microbiology I **Credits 02**

Practical

General Experiments:

1. To study the principle and applications of important instruments (Autoclave, incubator, Colony counter, Electronic balance, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
2. Preparation of culture media for bacterial cultivation.
3. Sterilization of medium using Autoclave and assessment for sterility
4. Sterilization of glassware using Hot Air Oven and assessment for sterility
5. Demonstration of the presence of microbes by exposing nutrient agar platesto air.
6. Isolation of fungus from different natural samples.
7. Study of *Penicillium* and *Aspergillus* using temporary mounts
8. Study of *Chlamydomonas and Volvox* using permanent Mounts/Photographs.
9. Study of the following protozoans (atleast any two) using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Suggested Readings :

1. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited. Cappucino. J and Sherman N. (2010).
2. Practical Microbiology, 1st edition, S. Chand. R. C. Dubey and D. K. Maheswari (2010).