VIDYASAGAR UNIVERSITY

Curriculum for 3-Year BSc (HONOURS)
in
Microbiology

Under Choice Based Credit System (CBCS)
w.e.f 2017-2018

VIDYASAGAR UNIVERSITY

B Sc (Honours) in Microbiology

[Choice Based Credit System]

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
							CA	ESE	TOTAL
	Semester-I								
1	I	Core-1		CT1: Introduction to microbiology and Microbial Diversity	6	4-0-0	15	60	75
				CP1: Introduction to microbiology and Microbial Diversity - Lab		0-0-4			
		Core-2		CT2: Bacteriology	6	4-0-0	15	60	75
				CP2: Bacteriology - Lab		0-0-4			
		GE-1		TBD	6	4/5	15	60	75
				TBD		2/1			
		AECC-1		English/MIL	2	1-1-0	10	40	50
	Semester –I: total				**20**				**275**
	Semester-II								
	II	Core-3		CT3: Biochemistry	6	4-0-0	15	60	75
				CP3: Biochemistry - Lab		0-0-4			
		Core-4		CT4: Virology	6	4-0-0	15	60	75
				CP4: Virology - Lab		0-0-4			
		GE-2		TBD	6	4/5	15	60	75
				TBD		2/1			
		AECC-2		ENVS	4		20	80	100
	Semester-II : total				**22**				**325**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
							CA	ESE	TOTAL
	Semester-III								
2	**III**	Core-5		CT5: Microbial Physiology and Metabolism	6	4-0-0	15	60	75
				CP5: Microbial Physiology and Metabolism - Lab		0-0-4			
		Core-6		CT6: Cell Biology	6	4-0-0	15	60	75
				CP6: Cell Biology - Lab		0-0-4			
		Core-7		CT7: Molecular Biology	6	4-0-0	15	60	75
				CP7: Molecular Biology - Lab		0-0-4			
		GE-3		**TBD**	6	4/5	15	60	75
						2/1			
		SEC-1		SEC1T:Biofertilizers and Biopesticides	2	1-1-0	10	40	50
		Semester – III : total			**26**				**350**
	Semester-IV								
	IV	Core-8		CT8: Microbial Genetics	6	4-0-0	15	60	75
				CP8: Microbial Genetics - Lab		0-0-4			
		Core-9		CT9: Environmental Microbiology	6	4-0-0	15	60	75
				CP9: Environmental Microbiology - Lab		0-0-4			
		Core-10		CT10: Food and Dairy Microbiology	6	4-0-0	15	60	75
				CP10: Food and Dairy Microbiology - Lab		0-0-4			
		GE-4		**TBD**	6	4/5	15	60	75
						2/1			
		SEC-2		SEC2T:Food Fermentation Techniques	2	1-1-0	10	40	50
		Semester – IV : total			**26**				**350**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
							CA	ESE	TOTAL
		Semester-V							
3	**V**	Core-11		CT11: Industrial Microbiology	6	4-0-0	15	60	75
				CP11: Industrial Microbiology - Lab		0-0-4			
		Core-12		CT12:Immunology	6	4-0-0	15	60	75
				CP12 : Immunology - Lab		0-0-4			
		DSE-1		DSE1T: Microbial Biotechnology	6	4-0-0	15	60	75
				DSE1P: Microbial Biotechnology		0-0-4			
		DSE-2		DSE2T:Plant Pathology	6	4-0-0	15	60	75
				DSE2P:Plant Pathology		0-0-4			
		Semester –V : total			**24**				**300**
		Semester-VI							
	VI	Core-13		CT13: Medical Microbiology	6	4-0-0	15	60	75
				CP13: Medical Microbiology - Lab		0-0-4			
		Core-14		CT14: Recombinant DNA Technology	6	4-0-0	15	60	75
				CP14: Recombinant DNA Technology - Lab		0-0-4			
		DSE-3		DSE3T:Microbes in Sustainable Agriculture and Development	6	4-0-0	15	60	75
				DSE3P: Microbes in Sustainable Agriculture and Development		0-0-4			
		DSE-4		DSE-4: Project Work	6	0-0-12	15	60	75
		Semester – VI : total			**24**				**300**
Total in all semester:					**142**				**1900**

CC = Core Course , **AECC** = Ability Enhancement Compulsory Course , **GE** = Generic Elective , **SEC** = Skill Enhancement Course , **DSE** = Discipline Specific Elective , **CA**= Continuous Assessment , **ESE**= End Semester Examination , **TBD**=To be decided , **CT** = Core Theory, **CP**=Core Practical , **L** = Lecture, **T** = Tutorial ,**P** = Practical , **MI**L = Modern Indian Language , **ENV**S = Environmental Studies ,

List of Core Course (CC)

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

Discipline Specific Electives (DSE)

DSE-1: Microbial Biotechnology
DSE-2: Plant Pathology
DSE-3: Microbes in Sustainable Agriculture and Development
DSE-4: Project Work

Skill Enhancement Course (SEC)

SEC-1: Biofertilizers and Biopesticides
SEC-2: Food Fermentation Techniques

Generic Electives (GE)

GE-1: Introduction and Scope of Microbiology
GE-2 : Bacteriology and Virology
GE-3: Applied Microbiology I
GE-4: Applied Microbiology II

Core Courses

CC-1 : **Introduction to Microbiology and Microbial Diversity** **Credits 06(4+2)**

C1- T: **Introduction to Microbiology and Microbial Diversity (Theory)** **Credits 04**

(Each unit carries equal mark)

UNIT 1

Historical Developments and Scope

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

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

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

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

Suggested Readings :

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 02**

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*

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-2: Bacteriology — Credits 06(4+2)

C2T: Bacteriology (Theory) **Credits-04**

(Each unit carries equal mark)

UNIT 1

Cell organization

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

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

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

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.

Suggested Readings:

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.

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-3 : Biochemistry **Credits: 06(4+2)**

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

Unit 1: Bioenergetics

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

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

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

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

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

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,

CC-4 : Virology **Credits : 06(4+2)**

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

Unit 1: Nature and Properties of Viruses

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

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

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

Unit 6 : Prevention & control of viral diseases
Antiviral compounds and their mode of action
Interferon and their mode of action
General principles of viral vaccination

Unit 6 : Applications of Virology
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.

CC-5: Microbial Physiology and Metabolism **Credits 06(4+2)**

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(4+2)**

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(4+2)**

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)

CC-8: Microbial Genetics — Credits 06(4+2)

C8T: Microbial Genetics — Credits 04

Theory

(Each unit carries equal mark)

UNIT -1

Genome Organization (12 periods)

Genome organization: *E. coli, Saccharomyces,* Mutation and mutagenesis: Definition and types of mutations; Physical and chemical mutagens; Molecular basis of mutations; Uses of mutations: Reversion and suppression; True Revertants; Intra and Inter genic suppression; Ames Test; Mutator genes.

UNIT -2

Change and structure of genetic material (10 periods)

Types Plasmids: F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast – 2µ plasmid, Plasmid replication, Plasmid incompatibility, Plasmid amplification, Regulation of copy number

UNIT -3

Mechanisms of Genetic Exchange (12 periods)

Transformation- Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Bacterial recombination (Homologous), Recombination in fungi.

UNIT -4

Transposable elements (10 periods)

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

Suggested Readings:

1. Concepts of Genetics, 10th Ed. Benjamin Cummings Klug WS, Cummings MR, Spencer, C, Palladino, M (2011).
2. Genetics: A Conceptual Approach, 4th Ed. Macmillan Higher Education Learning Pierce BA (2011)
3. Principles of Genetics. 8th Ed. Wiley-India. Gardner EJ, Simmons MJ, Snustad DP (2008).
4. Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings. Russell PJ. (2009).

5. Microbial Genetics 2nd EDITION. Jones and Barlett Publishers Maloy SR, Cronan JE and Friefelder D(2004).
6. Genetics, Monroe W. Strickburger, PHI publication.

C8P: General Experiments **Credits 02**
Practical

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of DNA from given sample.
5. Quantification of DNA.
6. Study the conformations of plasmid DNA through Agaraose gel electrophoresis.
7. Demonstration of AMES test

Suggested Readings:

1) Molecular biology and biotechnology: basic experimental protocols – M. P. Bansal
2) Practical Methods in Molecular Biology - Robert F. Schleif, Pieter C. Wensink

CC-9: Environmental Microbiology **Credits 06(4+2)**

C9T: Environmental Microbiology **Credits 04**
Theory

(Each unit carries equal mark)

UNIT -1

Microorganisms and their Habitats

Soil as a habitat for microorganisms, Aquatic Environment: Microflora of fresh water and marine habitats, Atmosphere: Aero-microflora and dispersal of microbes, Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter.

UNIT -2

Microbial Interactions Biogeochemical cycle

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation, Microbe-Plant interaction: Symbiotic and non symbiotic interactions, Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin, Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction.

UNIT -3

Solid Waste Management and Bioremediation

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill), Principles and microbial degradation of

common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.

UNIT -4

Liquid Waste Management and Water Potability

Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: standard qualitative procedure- presumptive test/MPN test, confirmed and completed tests for faecal coliforms.

Suggested Readings :

1. Microbial Ecology: Fundamentals & Applications. 4th edition. Atlas RM and Bartha R. (2000). Benjamin/Cummings Science Publishing, USA
2. Environmental Microbiology. 2nd edition, Academic Press. Maier RM, Pepper IL and Gerba CP. (2009).
3. Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York. Okafor, N (2011).

C9P: General Experiments **Credits 06**

Practical

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

Suggested Readings :

1) Environmental Microbiology: A Laboratory Manual - Ian L. Pepper
2) A Practical Manual of Environmental Microbiology - Upendra Thapa Shrestha

CC-10: Food and Dairy Microbiology **Credits 06(4+2)**

C10T: Food and Dairy Microbiology **Credits 04**

Theory

(Each unit carries equal mark)

UNIT -1

Foods as an ideal growth medium and Microbial Preparations

Food types, Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, fermented dairy products: yogurt, koumiss, kefir, and cheese, other fermented foods sauerkraut, soy sauce and tampeh.

UNIT -2

Microbial spoilage of various foods and diagnosis

Sources of contamination of foods, General Principles of food Spoilage of: Spoilage of different types of foods: vegetables, fruits, meat, eggs, milk and canned Foods, HACCP, Indices of food sanitary quality and sanitizers, Cultural and rapid detection methods of food borne pathogens in foods .

UNIT -3

Principles and methods of food preservation

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

UNIT -4

Food borne illness and Control (10 periods)

Food intoxications : *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Aflatoxin, Food infections by: *Bacillus cereus*, *Escherichia coli*, *Salmonella*, *Listeria monocytogenes* and *Campylobacter jejuni.*

Suggested Readings :

1. Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India. Adams MR and Moss MO. (1995).
2. Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India. Banwart JM. (1987).
3. Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. Frazier WC and Westhoff DC. (1992).

C10P: General Experiments **Credits 02**

Practical

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/ Curd.
7. Isolation of *Lactobacillus* from curd.

Suggested Readings :

1) Laboratory Manual of Food Microbiology Paperback - Neelima Garg
2) Practical Food Microbiology – J. P. Soman

CC-11: Industrial Microbiology Credits 06(4+2)

C11T: Industrial Microbiology Credits 04

Theory

(Each unit carries equal mark)

UNIT -1

History and development of industrial microbiology

Brief history and developments in industrial microbiology; 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.

UNIT -2

Fermentation processes, bio-reactors and fermentation parameters

Types of fermentation processes - stationary and submerged fermentations; batch and continuous fermentations; Designing of a typical bio-reactor and its components, Batch fermenter and constantly stirred tank fermenters; Fermentation parameters - pH, temperature, foaming and aeration

UNIT -3

Down-stream processing

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

UNIT -4

Microbial production of industrial products and Enzyme immobilization

Microbial production: Citric acid, glutamic acid, ethanol, penicillin, Vaccine, Vitamin B12, Enzymes (amylase, protease), steroid; Enzyme immobilization: Definition, Methods of immobilization, advantages and applications of immobilization.

Suggested Readings :

1. Industrial Microbiology. 1st edition, Macmillan India Limited. Patel A.H. (1996).
2. Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA. Okafor N. (2007).
3. Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001).

4. Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company Glaze A.N. and Nikaido H. (1995).
5. Industrial Microbiology. 1st edition. Wiley Eastern Limited. Casida LE. (1991).
6. Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi. Crueger W and Crueger A. (2000).
7. Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd. Stanbury PF, Whitaker A and Hall SJ. (2006).

C11P: General Experiments **Credits 02**

Practical

1. Study of different parts of fermenter by photograph/field visit to an industry
2. Microbial activity study on (qualitative) analysis of: Enzymes: Amylase
3. Microbial activity study on (qualitative) analysis of: Enzymes: Protease
4. Microbial activity study on (qualitative) analysis of: Amino acid: Tryptophan utilization
5. Microbial activity study on (qualitative) analysis of: Substrate: Citrate test (carbon)
6. A visit to any educational institute/industry to see industrial fermenter and other downstream processing operations (Assignment)

Suggested Readings :

1. Practical Manual on Fermentation Technology Paperback - S. Kulandaivelu
2. Basic Practical Manual on Industrial Microbiology - Basanta Kumar Rai

CC-12: Immunology Credits 06(4+2)

C12T: Immunology Credits 04

Theory

(Each unit carries equal mark)

UNIT -1

Immune Cells and Organs

Concept of Innate and Adaptive immunity; Structure, Functions and Properties of: Immune Cells – Hematopoietic stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil , Basophil, Mast cell, Dendritic cell; and Primary lymphoid Organs: Bone Marrow, Thymus, Secondary lymphoid organs: Lymph Node, Spleen, GALT, MALT, CALT.

UNIT -2

Antigens and Antibodies

Characteristics of an antigen ; Haptens; Epitopes (T & B cell epitopes); Adjuvants; Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies; Structure and Functions of MHC I & II molecules.

UNIT -3

Immune Response and Immunological Disorders

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

UNIT -4

Immunological Techniques

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

Suggested Readings :

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

C12P: General Experiments — Credits 02

Practical

1. Identification of human blood groups.
2. Demonstration of agglutination reaction of unknown bacterial culture by slide agglutination technique.
3. Perform Total Leukocyte Count of the given blood sample.
4. Perform Differential Leukocyte Count of the given blood sample.
5. Separate serum from the blood sample (demonstration).
6. Perform immune electrophoresis.

Suggested Readings :

1. Practical Immunology- A Laboratory Manual – Senthilkumar Balakrishnan
2. Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg. Peakman M, and Vergani D. (2009).

CC-13: Medical Microbiology — Credits : 06(4+2)

C13T: Medical Microbiology — **Credits : 04**

Theory

(Each unit carries equal mark)

UNIT -1

Normal microflora of the human body and host pathogen interaction

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract, Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity.

UNIT -2

Sample collection, transport and diagnosis

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

UNIT -3

Microbes and Human diseases

Diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Bacterial-*Mycobacterium tuberculosis*, *Salmonella typhi*, *Vibrio cholerae*, *Bacillus anthracis,* Viral- Rabies, Dengue and swine flu. Protozoan- Malaria, Fungal- Candidiasis.

UNIT -4

Antimicrobial agents

Antibacterial agents: Five modes of action with one antibiotics example in each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Antiviral agents: Mechanism of action of Acyclovir, Antibiotic resistance.

Suggested Readings :

1. Textbook of Microbiology. 8th edition, University Press Publication. Ananthanarayan R. and Paniker C.K.J. (2009)
2. Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013)

3. Mims' Medical Microbiology. 4th edition. Elsevier. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007)
4. Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education. Willey JM, Sherwood LM, and Woolverton CJ. (2013)
5. Brock Biology of Microorganisms. 14th edition. Pearson International Edition Madigan MT. Martinko JM, Dunlap PV and Clark DP. (2014).

C13P: General Experiments **Credits 02**
Practicals

1. Identify bacteria (any one of *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 catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar.
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, AIDS (candidiasis), dermatomycoses (ring worms)

Suggested Readings :

1. Diagnostic Medical Microbiology - Abdelraouf A. Elmanama
2. Medical Microbiology Lab Manual - Nafiseh Nafissi

CC-14: Recombinant DNA Technology Credits 06(4+2)

C14T: Recombinant DNA Technology **Credits 04**
Theory

(Each unit carries equal mark)

UNIT -1

Molecular Cloning- Tools

Cloning Tools; Applications of Type II restriction enzymes in genetic engineering; Applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases, Cloning Vectors: Definition and Properties, Plasmid vectors: pBR ; Cosmids, BACs, YACs, Use of linkers and adaptors, Genomic and cDNA libraries.

UNIT -2

Methods in Molecular Cloning and techniques

Transformation of DNA: Chemical method, Gene delivery: Electroporation, *Agrobacterium* - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, SDS-PAGE, Southern - and Northern – blotting techniques, DNA microarray analysis, Western blotting, PCR, DNA sequencing.

UNIT -3

Construction and Screening of Genomic and cDNA libraries

Steps of Gene cloning: Isolation of genomic DNA and Plasmid DNA, Cutting & Insertion, Introduction of chimera, Screening and selection of transformants.

UNIT -4

Applications of Recombinant DNA Technology

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

Suggested Readings :

1. Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA. Clark DP and Pazdernik NJ. (2009)
2. Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K. Primrose SB and Twyman RM. (2006)
3. Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education. Wiley JM, Sherwood LM and Woolverton CJ. (2008).
4. Genomes-3. Garland Science Publishers. Brown TA. (2007).
5. Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K. Primrose SB and Twyman RM. (2008).

C14: General Experiments **Credits 02**

Practicals

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

Suggested Readings :

1. Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K. Brown TA. (2010).

2. Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press. Sambrook J and Russell D. (2001).

Discipline Specific Electives (DSE)

DSE-1: Microbial Biotechnology — Credits 06(4+2)

DSE1T: Microbial Biotechnology — Credits 04
Theory

(Each unit carries equal mark)

UNIT -1

Therapeutic and Industrial Biotechnology

Recombinant microbial production processes in pharmaceutical industries -recombinant vaccines (Hepatitis B vaccine); Genetically engineered microbes for industrial application: Bacteria and yeast, Microbial polysaccharides and polyesters, Microbial production of Bio-pesticides and Bioplastics; Microbial biosensors.

UNIT -2

Applications of Microbes in Biotransformation

Microbial based transformation of steroids and sterols, Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

UNIT -3

Microbial Products and their Recovery

Microbial product purification: filtration, ion exchange & affinity chromatography techniques, Down streaming process, Immobilization methods and their application.

UNIT -4

Microbes for Bio-energy and Environment

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.

Suggested Readings :

1. Basic Biotechnology, 2nd Edition, Cambridge University Press. Ratledge, C and Kristiansen, B. (2001).9th edition, Mc Graw Hill Publishers.
2. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014),
3. Elements of Biotechnology 2nd edition, Rastogi Publications. Gupta PK (2009)
4. Microbial Biotechnology, 2nd edition, Cambridge University Press. Glazer AN and Nikaido H (2007)
5. Molecular Biotechnology 4th edition, ASM Press. Glick BR, Pasternak JJ, and Patten CL (2010)

6. Principles of Fermentation Technology 2nd edition.,Elsevier Science. Stanbury PF, Whitaker A, Hall SJ (1995)
7. Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc. Crueger W, Crueger A (1990).

DSE1P: General Experiments Credits 02

Practical

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*).
4. Isolation of xylanase or lipase producing bacteria.
5. Study of algal Single Cell Proteins.
6. Demonstration of fermentation by using yeast.
7. Cultivation of edible mushrooms.

Suggested Readings :

1. Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press. Demain, A. L and Davies, J. E. (1999).
2. Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201. Swartz, J. R. (2001).

DSE-2: Plant Pathology Credits 06(4+2)

DSE2T: Plant Pathology Credits 04

Theory

(Each unit carries equal mark)

UNIT -1

Introduction and History of plant pathology

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation, Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, E. Smith, Adolph Mayer, Ivanowski, Koch's postulates,

UNIT -2

Host Pathogen Interaction

Microbial Pathogenicity: Virulence factors of pathogens: enzymes, toxins (host specific and non specific).; Effects of pathogens on host physiological processes, Genetics of Plant Diseases: Concept of resistance (R) gene and avirulence (avr) gene; Defense Mechanisms in Plants*:* Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histologicalcork layer, abscission layer, tyloses, gums), inducible biochemical

defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, phenolics, quinones,].

UNIT -3

Specific Plant diseases

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control: Important diseases caused by fungi- Late blight of potato - *Phytophthora infestans,* Ergot of rye -*Claviceps purpurea*, Important diseases caused by phytopathogenic bacteria- bacterial leaf blight of rice, bacterial cankers of citrus, Important diseases caused by viruses- banana bunchy top, rice tungro.

UNIT -4

Control of Plant Diseases

Management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, Biological - suppressive soils, antagonistic microbes-bacteria and fungi; Engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Suggested Readings :

1. Plant Pathology. 5th edition. Academic press, San Diego. Agrios GN. (2006).
2. Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford. Lucas JA. (1998).
3. Plant Pathology. Tata McGraw-Hill Limited. Mehrotra RS. (1994).

DSE2P: General Experiments **Credits 02**

Practicals

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections/permanent mount of infected plant material – a) Rhizoctonia
3. Study of important diseases of crop plants by cutting sections/permanent mount of infected plant material – b) Pythium
4. Study of important diseases of crop plants by cutting sections/permanent mount of infected plant material – c) Aspergillus
5. Study of important diseases of crop plants by cutting sections/permanent mount of infected plant material – d) Fusarium
6. Study of important diseases of crop plants by cutting sections/permanent mount of infected plant material – e) Alternaria
7. Study of important diseases of crop plants by cutting sections/permanent mount of infected plant material – f) Xanthomonas
8. Study of available diseased plant material.

Suggested Readings :

1. Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi. Rangaswami G. (2005).

2. Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi. Singh RS. (1998)

DSE-3: Microbes in Sustainable Agriculture and Development Credits 06(4+2)

DSE3T: Microbes in Sustainable Agriculture and Development Credits 04
Theory

(Each unit carries equal mark)

UNIT -1

Soil Microbiology

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

UNIT -2

Microbial Activity in Soil

Methane – production and control, Microbial mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

UNIT -3

Microbial Control of Soil Borne Plant Pathogens

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

UNIT -4

Microbial application in crop production

Plant growth promoting bacteria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, Phosphate solubilizers, algae), PGPRs, Secondary Agriculture Biotechnology: Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters, GM crops: Bt crops, golden rice

Suggested Readings :

1. Plant Pathology. 5th edition. Academic press, San Diego. Agrios GN. (2006).
2. Molecular Biotechnology 4th edition, ASM Press. Glick BR, Pasternak JJ, and Patten CL (2010)
3. Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA. Atlas RM and Bartha R. (2000).
4. Environmental Microbiology. 2nd edition, Academic Press. Maier RM, Pepper IL and Gerba C.P. (2009).
5. Microbial Ecology. 1st edition, Wiley Blackwell, USA. Barton LL & Northup DE (2011).
6. Microbial Ecology. Blackwell Scientific Publication, Oxford, England. Campbell RE. (1983).
7. Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning. Coyne MS. (2001.).

8. Agriculture Biotechnology, Ist edition, Marcel decker Inc. Altman A (1998).
9. Hand Book of Microbial Biofertilizers, the Haworth Press, Inc. New York. Mahendra K. Rai (2005).
10. Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers. Reddy, S.M. *et. al.* (2002).

DSE 3P: General Experiments **Credits 02**
Practical

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter* as soil inoculants characteristics and field application
5. Field study on functioning of biogas plant
6. Isolation of cellulose degrading organisms

Suggested Readings :

1. Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi. Singh RS. (1998)
2. Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH. KG Saleem F and Shakoori AR (2012).

DSE-4: Project Work **Credits (0+6)**

The Topic for Dissertation will be assigned to the students by the concerned guide at the beginning of the 6th Semester:

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

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).

SEC-2: Food fermentation techniques Credits 02

SEC-2T: Food fermentation techniques

Theory

(Each unit carries equal mark)

UNIT -1

Fermented Foods

Definition, types, advantages and health benefits, Probiotic Foods : Definition, types, microorganisms and health benefits

UNIT -2

Fermented milk and cereals

Yogurt, and cheese: Preparation of inoculums, types of microorganisms and production process, Soy sauce, Bread: Microorganisms and production process

UNIT -3

Vegetable Based Fermented Foods

Pickels, Saeurkraut: Microorganisms and production process

UNIT -4

Fermented Meat and Fish

Types, microorganisms involved in fermentation process in meat and fish.

Suggested Readings :

1. Handbook of food and fermentation technology, CRC Press. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004)
2. Advances in Fermented Foods and Beverages, Woodhead Publishing. Holzapfel W (2014)
3. A comprehensive dairy microbiology, Metropolitan. Yadav JS, Grover, S and Batish VK (1993)
4. Modern Food Microbiology, 7th edition. Springer. Jay JM, Loessner MJ, Golden DA (2005)

Generic Elective (GE)

[Interdisciplinary for other department]

GE-1: Introduction and Scope of Microbiology — Credits 06(4+2)

GE-1T: Introduction and Scope of Microbiology — **Credits 04**

Theory

(Each unit carries equal mark)

UNIT 1

History and Development of Microbiology

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

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

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

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

Suggested Readings :

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.

Suggested Readings:

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

GE -2 : Bacteriology and Virology — Credits: 06(4+2)

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

Total Hours: 60

Unit 1: Cell organization

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

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

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

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

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

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

GE-3: Applied Microbiology I — Credits 06(4+2)

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).

GE-4: Applied Microbiology II — Credits: 06 (4 + 2)

GE4T: Applied Microbiology II — **Credits: 04**

Theory

UNIT 1

Food Microbiology .

Food types, Intrinsic and extrinsic factors that affect growth and survival of microbes in foods; Sources of contamination of foods; Cultural and rapid detection methods of food borne pathogens in foods; Principles, physical methods of food preservation: temperature (low, high, canning, drying), Irradiation, hydrostatic pressure.

UNIT 2

Industrial Microbiology .

Brief history and developments in industrial microbiology; Types of fermentation processes - stationary and submerged fermentations; batch and continuous fermentations; Fermentation parameters - pH, temperature, foaming and aeration; Designing of a typical bio-reactor and its components; Industrial production of ethanol, penicillin, Wine.

UNIT 3

Medical microbiology

Normal microflora of the human body: Importance of normal microflora; Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity. Diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Bacterial-*Mycobacterium tuberculosis*, *Salmonella typhi*, Viral-Dengue and swine flu.

UNIT 4

Immunology

Concept of Innate and Adaptive immunity cell, B cell Characteristics of an antigen ; Haptens; Epitopes (T & B cell epitopes); Adjuvants Structure, Types, Functions and Properties of antibodies; Paratopes on antibodies (Isotypic, allotypic, idiotypic).

Suggested Readings:

1. Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India. Adams MR and Moss MO. (1995).
2. Industrial Microbiology. 1st edition, Macmillan India Limited. Patel A.H. (1996).
3. Textbook of Microbiology. 8th edition, University Press Publication. Ananthanarayan R. and Paniker C.K.J. (2009)
4. Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education. Willey JM, Sherwood LM, and Woolverton CJ. (2013)
5. . Kuby's Immunology. 6th edition W.H. Freeman and Company, New York. Goldsby RA, Kindt TJ, Osborne BA. (2007).

GE4P: Applied Microbiology II **Credits: 02**

Practical

General Experiments:

1. Microbial activity study on (qualitative) analysis of: Enzymes: Amylase
2. Microbial activity study on (qualitative) analysis of: Enzymes: Protease
3. Microbial activity study on (qualitative) analysis of: Amino acid: Tryptophan utilization
4. Microbial activity study on (qualitative) analysis of: Substrate: Citrate test (carbon)
5. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
6. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
7. Identification of human blood groups.
8. Separate serum from the blood sample (demonstration).
9. Perform immune electrophoresis.

Suggested Readings :

1. Practical Manual on Fermentation Technology Paperback - S. Kulandaivelu
2. Basic Practical Manual on Industrial Microbiology - Basanta Kumar Rai
3. Practical Immunology- A Laboratory Manual – Senthilkumar Balakrishnan
4. Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg. Peakman M, and Vergani D. (2009).
5. Practical Food Microbiology – J. P. Soman