SYLLABUS FOR

B.SC. HONOURS IN MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM

DEPARTMENT OF MICROBIOLOGY

RAMAKRISHNA MISSION

VIVEKANANDA CENTENARY COLLEGE,

RAHARA

New course implemented and modified = 100%, as per the meeting of the Board of studies in Dept. of Microbiology, R.K.M.V.C. College, Rahara on 22.05.2018.

2018

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New course implemented and modified = 100%, as per the meeting of the Board of studies in Dept. of Microbiology, R.K.M.V.C. College, Rahara on 22nd May, 2018.

Programme Name: BSc with Honors in Microbiology

Programme Code: UGMCB

Programme Outcome:

After completion of the B.Sc degree program, the students will be able to

PO No.	Program Outcomes	Cognitive Level
PO 1	Recognize the scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace.	R
PO 2	Understand scientific knowledge and exchange ideas with other stakeholders; make people aware about sustainable utilization of resources with ethical approach.	U
PO 3	Understand and apply the issues of environmental contexts and sustainable development as a basic interdisciplinary concern.	U, Ap
PO 4	Create the ability to perform experiments and to analyse & interpret the obtained accurate results and thus gain the ability to solve problems; to involve in critical, independent, and creative thinking.	An, E, C
PO 5	Possess expertise to apply and formulate ideas which will provide them competitive advantage in pursuing higher studies from India or abroad; and seek jobs in academia, research or industries.	Ap, E
PO 6	Assemble the acquired in-depth knowledge of applied subjects towards the inculcation of professional and employment skills so that students can make a career and become an entrepreneur in diverse fields.	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Programme Specific Outcome for B.Sc (Hons) in Microbiology:

After completion of the B.Sc (Hons) in Microbiology, the students will be able to

PSO No.	Program Specific Outcomes	Cognitive Level
PSO 1	Explain the concept of Microbiology starting from history, basic laboratory techniques, safety measures and relate fundamental knowledge about the diverse groups of microorganisms.	R, U
PSO 2	Compare several allied subject areas including biochemistry, cell biology, immunology, virology, molecular biology, recombinant DNA technology and apply the knowledge in research and industrial processes.	Ap
PSO 3	Take part in proper collection, forwarding of microbiological and parasitological specimens to the laboratory, examine various parameters and interpret maintaining the ethical guidelines.	An, E
PSO 4	Interpret the integral role of microorganisms associated with specific disease, vital role of microorganisms in agriculture, environmental remediation, biotechnology, fermentation, medicine, food, dairy, pharmaceutical and other industries important to human well-being.	U
PSO 5	Design basic experiment plan on Microbiology and related fields, estimate the required parameters using modern techniques and instruments, solve problems to improve current understanding or develop alternative solutions to current problems.	C

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Credit Distribution across the Course

Course Type	Total Papers	Credit		Total Credit
		Theory	Practical	
CC	14	$14 \times 4 = 56$	$14 \times 2 = 28$	$56 + 28 = 84$
DSE	4	$4 \times 4 = 16$	$4 \times 2 = 8$	$16 + 8 = 24$
GE	4	$4 \times 4 = 16$	$4 \times 2 = 08$	$16 + 8 = 24$
SEC	2	$2 \times 2 = 4$		$= 04$
AECC	2	$2 \times 2 = 4$		$= 04$
Grand Total Credit				**=140**

Abbreviations used:

CC = CORE COURSES
DSE = DISCIPLINE SPECIFIC ELECTIVES
GE = GENERIC ELECTIVES
AECC = ABILITY ENHANCEMENT COMPULSORY COURSES
SEC = SKILL ENHANCEMENT COURSES

List of Core Courses (14 Papers for the Students of Microbiology Honours)		Semester
UGMCBCC01	Introduction to Microbiology and Microbial Diversity	I
UGMCBCC02	Bacteriology	
UGMCBCC03	Biochemistry	II
UGMCBCC04	Virology	
UGMCBCC05	Microbial Physiology and Metabolism	III
UGMCBCC06	Cell Biology	
UGMCBCC07	Molecular Biology	
UGMCBCC08	Microbial Genetics	IV
UGMCBCC09	Environmental Microbiology	
UGMCBCC10	Food and Dairy Microbiology	
UGMCBCC11	Industrial Microbiology	V
UGMCBCC12	Immunology	
UGMCBCC13	Medical Microbiology	VI
UGMCBCC14	Recombinant DNA Technology	

Choices for DSE (4 Papers to be selected by the Students of Microbiology Honours)	
UGMCBDSE01	Inheritance Biology
UGMCBDSE02	Microbial Biotechnology
UGMCBDSE03	Project work
UGMCBDSE04	Instrumentation and Biotechniques
UGMCBDSE05	Advances in Microbiology

Choices for GE (4 Papers to be selected by the Students of Microbiology Honours)	
UGMCBGE01	Bacteriology and Virology
UGMCBGE02	Microbes in Environment
UGMCBGE03	Industrial and Food Microbiology
UGMCBGE04	Genetic Engineering and Biotechnology
UGMCBGE05	Microbial Genetics and Molecular Biology

SEC	
UGMCBSEC01	Value Education & Indian Culture
UGMCBSEC02	Online course

AECC	
UGAECC01	English Communication
UGAECC02	Environmental Science (ENVS)

Structure of B. Sc. Honours Microbiology under CBCS

Core Course

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

Discipline Specific Elective (Any Four)

DSE-1: Inheritance Biology
DSE-2: Microbial Biotechnology
DSE-3: Project Work
DSE-4: Instrumentation and Biotechniques
DSE-5: Advances in Microbiology

Generic Electives (Any Four)

GE-1: Bacteriology and Virology
GE-2: Microbes in Environment
GE-3: Industrial and Food Microbiology
GE-4: Genetic Engineering and Biotechnology
GE-5: Microbial Genetics and Molecular Biology

CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

SEMESTER –I

Course code: UGMCBCC01 Revision = 100 %.

Course objectives: Students should

- Learn about history and development of Microbiology.
- Understand diverse microbial groups and their basic features
- Handle the basic instruments and microbial specimen

CC-1 (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 History of Development of Microbiology **No. of Hours: 15**

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

Unit 2 Diversity of Microbial World **No. of Hours: 40**

A. Systems of classification

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

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

• Algae

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

• Fungi

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• Protozoa

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

Unit 3 An overview of Scope of Microbiology **No. of Hours: 5**

CC-1 (PRACTICALS)

TOTAL HOURS: 45 **CREDITS: 2**

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility

5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
9. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary Mounts
10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Course Outcomes:

At the end of this course, students should be able to:

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Explain historical development of Microbiology	U	PO 2, PSO 1
CO-2	Analyze the differences and relationships between diverse microbial groups	An	PO 4
CO-3	Use the basic instruments in Microbiology Lab	Ap	PO 5, PO 6, PSO 1
CO-4	Identify certain microscopic specimen	R	PO 6, PSO 3
CO-5	Design basic experiment for assessing asepticity	C	PO 1, PO 4, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

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

CC-2: BACTERIOLOGY

SEMESTER –I

Course code: UGMCBCC02 Revision = 100%.

Course objective: Students should

- Understand bacterial morphology, growth, reproduction.
- Culture, visualize and monitor bacterial cells in Microbiology lab.

CC-2: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 14**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell

membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological techniques **No. of Hours: 5**

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

Unit 3 Microscopy **No. of Hours: 6**

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

Unit 4 Growth and nutrition **No. of Hours: 8**

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

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

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

Unit 6 Bacterial Systematics **No. of Hours: 8**

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

Unit 7 Important archaeal and eubacterial groups **No. of Hours: 16**

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:

- Non proteobacteria: General characteristics with suitable examples
- Alpha proteobacteria: General characteristics with suitable examples
- Beta proteobacteria: General characteristics with suitable examples
- Gamma proteobacteria: General characteristics with suitable examples
- Delta proteobacteria: General characteristics with suitable examples
- Epsilon proteobacteria: General characteristics with suitable examples
- Zeta proteobacteria: General characteristics with suitable examples

Gram Positive:

- Low G+ C (Firmicutes): General characteristics with suitable examples
- High G+C (Actinobacteria): General characteristics with suitable examples

***Cyanobacteria*:** An Introduction

CC-2: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.

8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

Course Outcomes: At the end of this course, students should be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Recognize, identify and differentiate the internal and external structures of procaryotic cells.	R, U	PO 1, PO 4, PSO 1
CO-2	Describe the basic principles, components and optics of different microscopic techniques.	U	PO 5, PSO 1, PSO 2
CO-3	Explain the basic stages of microbial growth, reproduction and apply different methods to control them.	U, Ap	PSO 2, PSO 4
CO-4	Estimate microbial growth under lab conditions.	An	PO4, PSO 1
CO-5	Demosntrate culturing and staining bacteria from different sources and characterization.	Ap	PO 4, PSO 1, PSO 3

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SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition **Pearson Education.**
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. **McGraw** Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. **Pearson Education** Limited

CC-3: BIOCHEMISTRY (THEORY)
SEMESTER –II
Course code: UGMCBCC03

Revision = 100%.

Course objective: Students should

- Understand the concept of pH, buffer and biomolecules.
- Learn the assay procedures of different biomolecules.

CC-3: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

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

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

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

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. 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 **No. of Hours: 12**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids 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 **No. of Hours: 12**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, 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 **No. of Hours: 4**

Classification and characteristics with suitable examples, sources and importance

CC-3: (PRACTICALS)

TOTAL HOURS: 45 **CREDITS: 2**

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

Course Outcomes:

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Define buffer and its role to bioactive molecules	R	PSO 1, PSO 2
CO-2	Describe the salient characteristics of biomolecules	U	PSO 2
CO-3	Compare the level of structure of biomolecules	An	PO 1, PSO 2
CO-4	Demonstrate qualitative and quantitative estimation	Ap	PO2, PO4, PSO 2
CO-5	Construct models to study protein structures	C	PO 5, PO 6, PSO 5

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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 (THEORY)

SEMESTER –II

Course code: UGMCBCC04 Revision = 100%

Course objectives: Students should

- Learn about virus, subviral particles and their classification
- Understand their role in disease transmission
- Learn the methods used for laboratory culture and manipulation of viruses.

CC-4: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

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

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

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication **No. of Hours: 20**

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

Unit 4 Viruses and Cancer **No. of Hours: 6**

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

Unit 5 Prevention & control of viral diseases **No. of Hours: 8**

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

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

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

CC-4: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

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

Course Outcomes: At the end of this course, students will be able to:

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	List general properties of viruses and categorize different viral groups	R	PSO 1
CO-2	Explain salient features of viral nucleic acid and its replication strategies.	U	PSO 2
CO-3	Interpret general principles of viral disease transmission, control and vaccination.	E	PO 1, PSO 4
CO-4	Explain oncogenic nature of certain viruses.	U	PO 2, PSO 4
CO-5	Compare and contrast methods used for laboratory manipulation of viruses.	An	PO 4, PO 5, PSO 3

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SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, 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

SEMESTER –III

Course code: UGMCBCC05

Revision = 100%.

Course objectives: Students should

- Understand microbial metabolism and growth
- Study progress of metabolic procedures
- Learn the diversity and utility of microbial metabolism

CC-5: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

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

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

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration **No. of Hours: 16**

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

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation **No. of Hours: 6**

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

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

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

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

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

CC-5: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Define the patterns of microbial growth	R	PSO 2
CO-2	Describe the effect of environment on microbial growth	U	PO 3, PSO 2
CO-3	Explain the nutrient uptake mechanisms of microbes	U	PO 4
CO-4	Classify the microbes based on their mode of metabolisms	An	PSO 2
CO-5	Assess the metabolism procedures of microbes	E	PO 5, PSO 3, PSO 5.

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

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

CC-6: CELL BIOLOGY

SEMESTER –III

Course code: UGMCBCC06

Revision = 100%

Course Objectives: Students should

- Understand eukaryotic cellular structure and its difference from prokaryotes.
- Correlate the cell molecular pathway with cell cycle and cell death
- Learn the different stages of cell division

CC-6: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structure and organization of Cell **No. of Hours: 18**

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

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

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

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

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

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

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

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

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

CC-6: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Illustrate the basic cellular structure	Ap	PSO 2
CO-2	Relate Central Dogmatic pathway with organelles	U	PO 1, PSO 2
CO-3	Compile the possible outcomes of cellular signalling	C	PO 2, PO 4
CO-4	Correlate the cell molecular pathway with cell cycle and cell death	An	PO 1, PSO 2, PSO 4
CO-5	Assess the different stages of cell division	E	PO 4, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

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

CC-7: MOLECULAR BIOLOGY

SEMESTER –III

Course code: UGMCBCC07

Revision = 100%

Course Objectives: Students should

- Understand structure and types of nucleic acids.
- Learn the isolation of genomic DNA and assess the content.
- Understand the central dogma and the regulatory aspects.

CC-7: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

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

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

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

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

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

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

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

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

Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes **No. of Hours: 12**

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

CC-7: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Discuss the structures of nucleic acid	U	PSO 2
CO-2	Demonstrate the isolation of genomic DNA	Ap	PO 4, PO 5
CO-3	Analyze transcription and post transcriptional event	An	PO 4, PSO 3
CO-4	Assess the content of DNA and RNA	E	PO 6, PSO 5
CO-5	Construct various models of DNA replication	C	PO 5, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

CC-8: MICROBIAL GENETICS
SEMESTER –IV
Course code: UGMCBCC08

Revision = 100%

Course Objectives: Students should

- Understand bacterial and viral genetic system.
- Analyze the different mechanisms of genetic exchange, mutation and roles in gene evolution.
- Handle the instruments and demonstrate experiments on microbial genes.

CC-8: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

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

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

Unit 3 Mechanisms of Genetic Exchange **No. of Hours: 12**

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

Unit 4 Phage Genetics **No. of Hours: 8**

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

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

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

CC-8: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Define mutation and its effect on microbial genome	R	PO 2, PSO 4
CO-2	Categorize and compare different mechanisms of genetic exchange	An	PSO 2, PSO 4
CO-3	Demonstrate the use of transposons in gene evolution	Ap	PO 3
CO-4	Explain the features of bacteriophage genetic system	U	PSO 2
CO-5	Define plasmids and deduce their different conformation	R, E	PO 4, PO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

CC-9: ENVIRONMENTAL MICROBIOLOGY

SEMESTER –IV

Course code: UGMCBCC09

Revision = 100%

Course Objectives: Students should

- Understand microbial habitat, different components and interaction of living organisms.
- Learn to apply the concept for sustainable rural & urban development.
- Assimilate the concept of waste management and the basis of environmental monitoring.

CC-9: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats, Atmosphere: Aeromicroflora and dispersal of microbes, Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

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

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation, Microbe-Plant interaction: Symbiotic and non symbiotic interactions, Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

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

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

Unit 4 Waste Management **No. of Hours: 12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill), Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation **No. of Hours: 5**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

Unit 6 Water Potability **No. of Hours: 5**

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

CC-9: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
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 (dehydrogenase,amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Identify various microbial habitat	R	PO 2, PO 3
CO-2	Compare different microbial interactions	U	PO 2, PO 3
CO-3	Demonstrate the function of microbes on environment	Ap	PO 1, PSO 4
CO-4	Assess the efficacy of waste management	An	PO 2, PO 3, PO 4, PO 5, PSO 5
CO-5	Develop programming for sustainable rural & urban development	C	PO 6, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing,
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication,
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

CC-10: FOOD AND DAIRY MICROBIOLOGY

SEMESTER –IV

Course code: UGMCBCC10

Revision = 100%

Course Objectives: Students should

- Understand the conditions and mechanism of food spoilage and food intoxication by microorganisms.
- Learn the methods of food preservation.
- Conceptualize the methods of food fermentation and preparation of fermented food.

CC-10: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

Unit 2 Microbial spoilage of various foods **No. of Hours: 10**

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

Unit 3 Principles and methods of food preservation **No. of Hours: 12**

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 4 Fermented foods **No. of Hours: 10**

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

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

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

Unit 6 Food sanitation and control **No. of Hours: 5**

HACCP, Indices of food sanitary quality and sanitizers

Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. **No. of Hours: 5**

CC-10: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

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/Dahi.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Identify the different factors that affect the microbial growth in foods.	R	PO 1, PSO 1
CO-2	Explain the mechanisms of various food spoilage by microorganisms	U	PO 2, PSO 1
CO-3	Illustrate the methods of food preservation	Ap	PO 3, PO 5, PSO 4
CO-4	Inspect the food intoxications and food infections and their preventive measure	An	PO 4, PO 5, PSO 3, PSO 4
CO-5	Assess the level of food sanitation, control measures and detection of foodborne pathogens	E	PO 6, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

CC-11: INDUSTRIAL MICROBIOLOGY

SEMESTER –V

Course code: UGMCBCC11

Revision = 100%.

Course Objectives: Students should

- Learn the history and development of industrial microbiology.
- Understand the fermentation parameters and choose the best fermentation processes, bio-reactors etc.
- Conceptualize the upstream and downstream processing

CC-11: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to industrial microbiology **No. of Hours: 4**

Brief history and developments in industrial microbiology

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

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

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameters **No. of Hours: 14**

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations, Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit 4 Down-stream processing **No. of Hours: 8**

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

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) **No. of Hours: 18**

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

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

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

CC-11: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:

(a) Enzymes: Amylase and Protease
(b) Amino acid: Glutamic acid
(c) Organic acid: Citric acid
(d) Alcohol: Ethanol

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

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Summarize the history of industrial microbiology	U	PO 1, PSO 1
CO-2	Isolate industrially important microbial strains and design the fermentation media	C	PO 4, PO 5, PO 6, PSO 5
CO-3	Assess the fermentation parameters and choose the best fermentation processes, bio-reactors etc	E	PO 4, PO 5, PO 6, PSO 2, PSO 4
CO-4	Compare different down-stream processing steps	An	PO 3, PO 6, PSO 5
CO-5	Demonstrate enzyme immobilization methods and microbial production of certain industrial products	Ap	PO 3, PO 4, PSO 2, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

CC-12: IMMUNOLOGY
SEMESTER –V
Course code: UGMCBCC12

Revision = 100%.

Course Objectives: Students should

- Learn the functions of different immune cells in generation of immune response.
- Understand the characteristics of antigen, antibody and their interaction.
- Conceptualize about different immunological disorders and their consequences.

CC-12: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

No. of Hours: 4

Unit 1 Introduction

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

Unit 2 Immune Cells and Organs **No. of Hours: 7**

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

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

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

Unit 4 Antibodies **No. of Hours: 6**

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

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

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

Unit 6 Complement System **No. of Hours: 4**

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

Unit 7 Generation of Immune Response **No. of Hours: 10**

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

Unit 8 Immunological Disorders and Tumor Immunity **No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit 9 Immunological Techniques **No. of Hours: 10**

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

CC-12: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

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

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Recognize important contributions of several scientists in immunology	R	PO 1, PSO 1
CO-2	Describe the functions of different immune cells in generation of immune response	U	PSO 2
CO-3	Illustrate the characteristics of antigen, antibody and their interaction	Ap	PO 2, PSO 2
CO-4	Compile different immunological disorders and their consequences	C	PO 2, PSO 3
CO-5	Analyze the principle of some important immunological techniques on experimental basis	An	PO 4, PO 5, PO 6, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

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

CC-13: MEDICAL MICROBIOLOGY
SEMESTER –VI
Course code: UGMCBCC13 Revision = 100%

Course Objectives: Students should

- Learn the importance of normal microflora of human body.
- Understand pathogenicity of causative agents for various infectious diseases and management.
- Assimilate the activities of antimicrobial agents and resistant mechanisms.

CC-13: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

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

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

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

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

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

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

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

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

Unit 6 Fungal diseases **No. of Hours: 5**

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

Unit 7 Antimicrobial agents: General characteristics and mode of action **No. of Hours: 8**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin

Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

CC-13: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Identify bacteria (any three 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, Mannitol salt agar, Deoxycholate citrate agar, TCBS
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, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	List the normal microflora of human body	R	PO 2, PSO 1
CO-2	Explain sample collection and diagnosis processes of microbial diseases	U	PO 3, PSO 3
CO-3	Compare various bacterial, viral, fungal, protozoan diseases	An	PO1, PO 2, PSO 4
CO-4	Perform antibacterial sensitivity tests	Ap	PO 4, PO 5, PO 6, PSO 3, PSO 5
CO-5	Assess different antimicrobial agents based on their modes of action and developing resistance	E	PO 3, PO 5, PSO 3, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

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

CC-14: RECOMBINANT DNA TECHNOLOGY
SEMESTER –VI
Course code: UGMCBCC14

Revision = 100%

Course Objectives: Students should

- Learn the concept of cloning and genetic engineering.
- Prepare recombinant DNA, develop the concept of DNA amplication and library construction.
- Understand the scope and application of the techniques in human welfare.

CC-14: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

No. of Hours: 2

Unit 1 Introduction to Genetic Engineering

Milestones in genetic engineering and biotechnology

Unit 2 Molecular Cloning- Tools and Strategies **No. of Hours: 20**

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering

DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

Cloning Vectors: Definition and Properties

Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs, Use of linkers and adaptors

Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 3 Methods in Molecular Cloning **No. of Hours: 16**

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

Unit4 DNA Amplification and DNA sequencing **No. of Hours: 10**

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

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

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

Unit 6 Applications of Recombinant DNA Technology **No. of Hours: 6**

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

CC-14: (PRACTICAL)

TOTAL HOURS: 45

CREDITS: 2

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

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	List the main breakthroughs in the field of genetic engineering	R	PO 1, PSO 1
CO-2	Evaluate the different strategies and methods in molecular cloning	E	PO 5, PO 6, PSO 2
CO-3	Illustrate the idea about Genomic and cDNA libraries and apply the technologies in human welfare	U, Ap	PO 2, PO 4, PSO 2
CO-4	Analyze the outcome of DNA amplification and sequencing experiments	An	PO 4, PO 5, PSO 3, PSO 5
CO-5	Validate the basic methods of cloning and formulate standardized protocol to prepare recombinant DNA	E, C	PO 6, PSO 4, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press,
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford,

DSE-1: INHERITANCE BIOLOGY
Course Code: UGMCBDSE01

Revision = 100%

Course Objectives: Students should

- Learn about Principles of inheritance
- Understand the scope of quantitative genetics and its application
- Be able to solve the problems related to heredity.

DSE-1: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Genetics **No. of Hours: 5**

Historical developments, Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae*, *Neurospora crassa*, *Caenorhabditis elegans Drosophila melanogaster*, *Arabidopsis thaliana*

Unit 2 Mendelian Principles **No. of Hours: 13**

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

Unit 3 Linkage and Crossing over **No. of Hours: 9**

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

Unit 4 Extra-Chromosomal Inheritance **No. of Hours: 9**

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

Infectious heredity - Kappa particles in *Paramecium*

Unit 5 Characteristics of Chromosomes **No. of Hours: 15**

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

Unit 6 Recombination **No. of Hours: 3**

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

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

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

Unit 8 Quantitative genetics **No. of Hours: 3**

Polygenic inheritance, heritability and its measurements, QTL mapping.

DSE-1: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying *Rhoeo* translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	List the basic principles of Mendelian inheritance at the molecular and cellular levels.	R	PO 1, PSO 2
CO-2	Explain the inheritance of linked genes, its physical basis and construct genetic map from the recombination data.	U, C	PO 2, PO 5
CO-3	Illustrate chromosomal structure and extra-chromosomal inheritance	U	PO 5
CO-4	Determine relationship between organism-level patterns of heredity ("classical" genetics) and molecule level phenomena ("modern" genetics)	An	PO 2, PO 4
CO-5	Apply the principles of inheritance to solve problems regarding human heredity	Ap	PO 2, PO 6, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett . Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

DSE-2: MICROBIAL BIOTECHNOLOGY

Course Code: UGMCBDSE02

Revision = 100%.

Course Objectives: Students should

- Learn about various scopes of microbial biotechnology.
- Handle different techniques of biotechnology and apply them for mankind.
- Understand the ethical guidelines and intellectual property rights.

DSE-2: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microbial Biotechnology and its Applications **No. of Hours: 10**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications.

Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology **No. of Hours: 10**

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

Unit 3 Applications of Microbes in Biotransformations **No. of Hours: 8**

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 4 Microbial Products and their Recovery **No. of Hours: 10**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization

Unit 5 Microbes for Bio-energy and Environment **No. of Hours: 12**

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

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

Unit 6 RNAi **No. of Hours: 6**

RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

Unit 7 Intellectual Property Rights **No. of Hours: 4**

Patents, Copyrights, Trademarks

DSE-2: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

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

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Define the microbial biotechnology and list its scope	R	PO 1, PO 2, PSO 2
CO-2	Utilize the microbial biotransformation procedures and apply the microbial product recovery process	Ap	PO 3, PO5, PO 6, PSO 4
CO-3	Assess the role of microbes in bioremediation an bio-energy production	Ev	PO 2, PO 3, PO 4, PSO 4
CO-4	Analyze and categorize the various application of RNAi	An	PO 4, PO 5, PSO 5
CO-5	Apply the intellectual property rights in scientific works and communication.	Ap	PO 5, PSO 3

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SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.

3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

DSE-3: PROJECT WORK

Course Code: UGMCBDSE03

Revision = 100%.

Course Objectives: Students should

- Learn to address scientific problems and look for solution.
- Critically analyze obtained data and express with proper scientific terminology.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Undertake problem identification, formulation and solution through sustained critical investigation	U	PO 1, PO 2
CO-2	Explain and relate the basics of the study with recent research and available literature	Ap	PO 2, PO 4
CO-3	Analyze and summarize the important features of the study.	An	PO 4, PO 5
CO-4	Develop strong writing skills & ability to deliver a presentation on the topic of his subject	C	PO 5, PO 6
CO-5	Evaluate critical thinking & communication skills needed in professional spheres.	E	PO 6, PSO 5

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DSE-4: INSTRUMENTATION AND BIOTECHNIQUES

Course Code: UGMCBDSE04

Revision = 100%.

Course Objectives: Students should

- Understand the principles and application of various instruments
- Handle the instruments with proper care and follow the precautions.

DSE-4: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

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

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

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

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

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

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

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

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

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

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

DSE-4: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of λmax for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Understanding density gradient centrifugation with the help of pictures.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Explain basic principle of preparative and analytical centrifugation	R, U	PO 1, PO 2, PSO 2
CO-2	Apply polyacrylamide gel electrophoresis	Ap	PSO 2
CO-3	Compare different chromatographic techniques	An	PO 5, PSO 2
CO-4	Assemble column packing in column chromatography	C	PO 5, PO 6, PSO 5
CO-5	Illustrate ray diagrams of different types of microscopy and assess their magnification	Ap, E	PO 5, PSO 5

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SUGGESTED READINGS

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

DSE-5: ADVANCES IN MICROBIOLOGY

Course Code: UGMCBDSE05

Revision = 100%

Course Objectives: Students should

- Understand metagenomic approach to address non culturable microbes.
- Case study to understand synthetic biology and networking of biological systems

DSE-5: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Evolution of Microbial Genomes **No. of Hours: 15**

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence – Genomic islands, Pathogenicity islands (PAI) and their characteristics

Unit 2 Metagenomics **No. of Hours: 15**

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

Unit 3 Molecular Basis of Host-Microbe Interactions **No. of Hours: 15**

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens,
Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

Unit 4 Systems and Synthetic Biology **No. of Hours: 15**

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

DSE-5: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Outline the idea of genome evolution and metagenomics	R	PO 1, PO 2
CO-2	Relate host pathogen relationship, HGT through evolution	U	PO 2, PO 3, PSO 2
CO-3	Estimate metagenomic DNA through practical process	E	PO 4, PO 5, PSO 3
CO-4	Perform PCR amplification of metagenomic DNA and analyze the result using algorithm.	Ap, An	PO 4, PO 5, PO 6
CO-5	Construct network of metabolic pathways for given bacteria based on Systems Biology.	C	PO 5, PO 6, PSO 5

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SUGGESTED READING

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

GE-1: BACTERIOLOGY AND VIROLOGY
Course Code: UGMCBGE01

Revision = 100%

Course objectives: Students should

- Understand bacterial and viral morphology, growth, reproduction.
- Culture, visualize and monitor bacterial cells in Microbiology lab.

GE-1: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 10**

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 **No. of Hours: 8**

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 **No. of Hours: 12**

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 **No. of Hours: 8**

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 **No. of Hours: 12**

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 **No. of Hours: 10**

Viruses as pathogens: Role of viruses in causing diseases

Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

GE-1: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

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.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Recognize, identify and differentiate the internal and external structures of prokaryotic cells and virus.	R, U	PO 1, PO 4, PSO 1
CO-2	Understand the basics of bacterial reproduction and estimate microbial growth under lab conditions.	U, E	PSO 1, PSO 3
CO-3	Determine microbial count using laboratory culture and detect bacteria by simple and differential staining	Ap, E	PO 4, PO 5, PSO 1, PSO 3
CO-4	List general properties and importance of viruses and subviral particles	R	PO 1
CO-5	Develop strategies for isolation and propagation of plant viruses	An, C	PO 2, PO 3, PO 6, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

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 Control.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-2: MICROBES IN ENVIRONMENT

Course Code: UGMCBGE02 Revision = 100%

Course Objectives: Students should

- Understand microbial habitat, different components and interaction of living organisms.
- Learn to apply the concept for sustainable rural & urban development.

GE-2: (THEORY)

TOTAL HOURS: 60

CREDITS: 4

No. of Hours: 14

Unit 1 Microorganisms and their Habitats

Structure and function of ecosystems

Terrestrial Environment: Soil profile and soil microflora

Aquatic Environment: Microflora of fresh water and marine habitats

Atmosphere: Aeromicroflora and dispersal of microbes

Animal Environment: Microbes in /on human body (Microbiomics) & animal (ruminants) body.

Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic

& osmotic pressures, salinity, & low nutrient levels.

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

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation
Microbe-Plant interaction: Symbiotic and non symbiotic interactions
Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

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

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

Unit 4 Waste Management **No. of Hours: 12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation **No. of Hours: 5**

Principles and degradation of common pesticides, hydrocarbons (oil spills).

Unit 6 Water Potability **No. of Hours: 5**

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

GE-2: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
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 (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Identify various microbial habitat	R	PO 2, PO 3
CO-2	Compare different microbial interactions	U	PO 2, PO 3
CO-3	Demonstrate the function of microbes on environment	Ap	PO 1, PSO 4
CO-4	Assess the efficacy of waste management	An	PO 2, PO 3, PO 4, PO 5, PSO 5
CO-5	Develop programming for sustainable rural & urban development	C	PO 6, PSO 5

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

GE-3: INDUSTRIAL AND FOOD MICROBIOLOGY

Course Code: UGMCBGE03 Revision = 100%

Course Objectives: Students should

- Learn the history and development of Industrial Microbiology.
- Understand the fermentation parameters, upstream processing, fermentation process, bio-reactor, downstream processing.
- Conceptualize the methods of food fermentation, food preservation, food sanitation and brief idea about food borne illness.

GE-3: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Industrial microbiology **No. of Hours: 10**

Brief history and developments in industrial microbiology, Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous, Types of fermenters – laboratory, pilot-scale and production fermenters, Components of a typical continuously stirred tank bioreactor

Unit 2 Isolation of Industrial Strains and Fermentation Medium **No. of Hours: 8**

Primary and secondary screening, Preservation and maintenance of industrial strains, Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Unit 3 Microbial fermentation processes **No. of Hours: 12**

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Unit 4 Food as a substrate for microbial growth **No. of Hours: 9**

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

Unit 5 Principles and methods of food preservation and food sanitation **No. of Hours: 9**

Physical methods - high temperature, low temperature, irradiation, aseptic packaging, Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite, Food sanitation and control – HACCP

Unit 6 Dairy products, probiotics and Food-borne Diseases **No. of Hours: 12**

Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese, Probiotics definition, examples and benefits, Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*, Food infection by *Salmonella* and *E.coli.*

GE-3: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Microbial fermentation for the production and estimation of amylase
2. Microbial fermentation for the production and estimation of citric acid
3. Microbial fermentation for the production and estimation of ethanol
4. Determination of the microbiological quality of milk sample by MBRT
5. Isolation of fungi from spoilt bread/fruits/vegetables
6. Preparation of Yogurt/Dahi

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Summarize the history and development of Industrial Microbiology	R, U	PO 1, PSO 1
CO-2	Isolate industrially important microbial strains and design the fermentation media	C	PO 4, PO 5, PO 6, PSO 5
CO-3	Compare the industrial fermentation and recovery process of certain microbial products	An	PO 4, PO 5, PO 6, PSO 2, PSO 4
CO-4	Identify different factors that affect the microbial growth, spoilage of food and food borne illness	Ap	PO 1, PSO 1, PSO 4
CO-5	Assess foods based on their fermentation process and preservation processes	E	PO 4, PO 6, PSO 4

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READING

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

GE-4: GENETIC ENGINEERING AND BIOTECHNOLOGY

Course Code: UGMCBGE04 Revision 100%.

Course Objectives: Students should

- Learn the concept of vector, cloning, recombinant DNA, DNA amplification and genetic engineering.
- Know the scope and application of the techniques in human welfare.
- Understand the ethical guidelines and intellectual property rights.

GE-4: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to genetic engineering **No. of Hours: 16**

Milestones in genetic engineering and biotechnology

Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering, DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases, Cloning: Use of linkers and adaptors, Transformation of DNA: Chemical method, Electroporation, Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

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

Cloning Vectors: Definition and Properties

Plasmid vectors: pBR and pUC series; Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs

Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors,

Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 3 DNA Amplification and DNA sequencing **No. of Hours: 10**

PCR: Basics of PCR, RT-PCR, Real-Time PCR

Genomic and cDNA libraries: Preparation and uses, Genome sequencing

Sanger's method of DNA Sequencing: traditional and automated sequencing

Unit 4 Application of Genetic Engineering and Biotechnology **No. of Hours: 14**

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viralmediated delivery, *Agrobacterium* - mediated delivery

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavo savo tomato, Gene therapy, recombinant vaccine, protein engineering

Unit 5 Intellectual Property Rights **No. of Hours: 4**

Patents, Copyrights, Trademarks

GE-4: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Isolation of Plasmid DNA from *E.coli*
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3. Ligation of DNA fragments
4. Interpretation of sequencing gel electropherograms
5. Designing of primers for DNA amplification
6. Amplification of DNA by PCR
7. Demonstration of Southern blotting

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	List the milestones in genetic engineering and biotechnology	R	PO 1, PSO 1
CO-2	Compare the different strategies and nmethods in molecular cloning	U	PO 5, PO 6, PSO 2
CO-3	Analyze the outcome of DNA amplification and sequencing experiments	An	PO 4, PO 5, PSO 3, PSO 5
CO-4	Assess the importance of genetic engineering and biotechnology in human welfare	E	PO 2, PO 6, PSO 2, PSO 4
CO-5	Apply the intellectual property rights in scientific works and communication	Ap	PO 5, PSO 3

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SUGGESTED READING

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

GE-5: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Course Code: UGMCBGE05

Revision = 100%

Course Objectives: Students should

- Understand the structure and types of nucleic acids.
- Know the central dogma and regulatory aspects.
- Analyze the different mechanisms of genetic exchange, mutation and roles in gene evolution.

GE-5: (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 10**

DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes. RNA Structure

Unit 2 Replication of DNA **No. of Hours: 6**

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication

Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends

Unit 3 Transcription **No. of Hours: 6**

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

Unit 4 Translation **No. of Hours: 6**

Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

Unit 5 Regulation of gene Expression **No. of Hours: 5**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons

Unit 6 Mutations **No. of Hours: 9**

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations, DNA repair mechanisms

Unit 7 Mechanisms of Genetic Exchange **No. of Hours: 10**

Transformation - Discovery, mechanism of natural competence
Conjugation - Discovery, mechanism, Hfr and F' strains
Transduction - Generalized transduction, specialized transduction

Unit 8 Plasmids and Transposable Elements **No. of Hours: 8**

Property and function of plasmids, Types of plasmids. Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition.

GE-5: (PRACTICAL)

TOTAL HOURS: 45 **CREDITS: 2**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
4. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
5. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
6. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
7. Study survival curve of bacteria after exposure to ultraviolet (UV) light
8. Demonstration of Bacterial Transformation and calculation of transformation efficiency.

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Discuss the structures of nucleic acid	R, U	PSO 2
CO-2	Analyze the transcription and post transcriptional events	An	PO 4, PSO 3
CO-3	Assess the DNA content, resolution and effect of mutagens	E	PO 4, PO 6, PSO 5
CO-4	Categorize and compare different mechanisms of genetic exchange	An	PSO 2, PSO 4
CO-5	Identify the contribution of transposable elements in evolution	Ap	PO 5, PSO 3

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
8. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
9. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers
10. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings

SEC-1: VALUE EDUCATION AND INDIAN CULTURE

Course Code: UGMCBSEC01 Revision 2100%.

Course Objectives: Students should

- Attain awareness about daily routine, self-evaluation & Integral Personality Development.
- Understand the educational needs, the power of thoughts and the Science of Peace, the relation between values and enlightened citizenship.
- Attain awareness about the Indian practice and culture; acquire idea about Modern India: her hopes, challenges and Swami Vivekananda.

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1: Daily Routine: **No. of Hours: 2**

A suggested daily routine

- The daily routine & the concept of Biological clock: key to a healthy and productive life
- Necessity for an all-round daily routine
- Combining Rest and Activity, Hardships and Joy in a daily routine
- The scope of developing the power of concentration and detachment through a daily routine
- Daily Routine disciplines the system but confers conviction on oneself

Unit 2: Self Evaluation & Integral Personality Development: **No. of Hours: 2**

Why is Self-Evaluation important? Because if you win yourself, you win the world

- Quantitative Self Evaluation for a qualitative change: A method
- Traits to track Personality Development: Academic Excellence, Social Compatibility, Participation in Group events, Sense of Responsibility, Role as a Consumer, Scientific Temperament, Aesthetic taste and creativity, Leisure time Activities, Concern for others, Spiritual values.
- Close and Constant Self Evaluation : a stitch in time saves nine
- The world *is* as we *are* : A minor inner change may nullify a major outer perturbation

Unit 3: Our Educational Needs **No. of Hours: 2**

- The need of a correct blend of inner and outer well-being in education
- Man-making, Character building education : growing from within , a surer foundation of progress
- The outer crust and the inner core of our personality: "What you are shouts so loudly in my ears that I cannot hear what you say."
- A 5-point training in Discipline, Cleanliness, Behaviour, Manners and Ambition
- Sharpening the sword of will: controlling its expression, a basic educational need
- How to study effectively?

Unit 4: The Power of thoughts and the Science of Peace **No. of Hours: 3**

- Shanti Mantras: Peace can be radiated from and reflected back upon ourselves
- You can create an ambience and others can enjoy it, can be benefitted by it.
- How to create a positive, peaceful and inspiring ambience?- the aggressive exertion and the unquestioning sacrifice involved in it

Unit 5: Subhashita: The Well said **No. of Hours: 2**

- Bringing home high thoughts in nuggets of wisdom
- Pearls of Wisdom and flames of fire: simple parables and anecdotes from the great ones.

Unit 6: Values and Enlightened Citizenship **No. of Hours: 2**

- Intrinsic and Instrumental Values
- What makes a man great? A powerful will to do good born out of self-control and self-sacrifice
- Learning the art of inter-personal relations: Not I but You
- The combination of the Head, Heart and Hand: a valuable value for Enlightened Citizenship

Unit 7: Indian Practice and Culture **No. of Hours: 2**

- The idea of sacredness & its necessity
- Every aspect of life is sacred in India
- Renunciation and service the twin ideals for India
- My freedom from Nature helps me to serve nature and the world better

- I never say I am the body, I always say this body is mine : I as a master of the body-mind complex
- Weakness is death: in search of real strength of self-knowledge, reliance on God and unselfish service
- Meditation, Concentration and the silent Indian path for becoming a dynamo of power
- The Indian concept of Unity in diversity: Harmony of Religions

Unit 8: Four Yogas **No. of Hours: 3**

- The Real and Apparent Man, the science of knowing myself: Jnana Yoga
- Taming the mighty current of emotions and giving them their right food: Bhakti Yoga
- The Science of working wisely: Karma Yoga
- The Process of making my mind mine: Raja Yoga
- Selected portions from Swami Vivekananda's Karma Yoga
- Harmony of 4 Yogas: a needed balance for the modern man

Unit 9: Modern India: her hopes, challenges and Swami Vivekananda **No. of Hours: 2**

- Swami Vivekananda's method of combining the best of the East & the West: where Indian values and Western workmanship join hands
- Invigorating rationality in the field of the Indian search for the supreme joy : erasing the misconception of dogmatism
- Rousing a sense of pride in the age-long Indian discoveries in the field of inner truths as opposed to an inferiority complex posed by Western material supremacy.
- Do you feel: Service, Swami Vivekananda's acid test for modern science and traditional spirituality.

Unit 10: Students' Presentations/Project: (may be in groups) **No. of Hours: 10**

Project on Service, Teaching and Cleanliness

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Define, demonstrate and apply the daily routine, self-evaluation & Integral Personality Development	R, U, Ap	PO 1
CO-2	Demonstrate, and apply the Power of thoughts & the Science of Peace	U, Ap	PO 3, PSO 5
CO-3	Demonstrate the relation between Values and enlightened citizenship	U	PO 3, PSO 3
CO-4	Discuss the awareness about the Indian Practice and Culture	C	PO 4
CO-5	Demonstrate and practice the Four Yogas	U, Ap	PO 6
CO-6	Explain and analyse the idea about Modern India: her hopes, challenges and Swami Vivekananda	U, An	PO 4, 6

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Books for Reference:

1) Jiivan Sopan, Published by Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata
2) Swami Vivekananda : His Call to the Nation, Advaita Ashrama
3) Thoughts of Power: Swami Vivekananda, Advaita Ashrama
4) Swami Vivekananda, The Friend of all, Ramakrishna Mission Institute of Culture,Golpark, Kolkata
5) Gems, Ramakrishna Mission Institute of Culture, Golpark, Kolkata

SEC-2: ONLINE COURSE (Spoken Tutorial on CellDesigner)

SEMESTER –IV

Course Code: UGMCBSEC02

TOTAL HOURS: 30 Revision = 100% **CREDITS: 2**

Course Objectives: Students should

- Understand various aspects of CellDesigner program.
- Install and start the CellDesigner program
- Run simulation, view and create new model

Installation of CellDesigner 4.3

CellDesigner series- based on version 4.3, Startup guide for first-time users of CellDesigner, Software requirement, Download & Installation of CellDesigner, On Windows OS, Adding a protein species.

Getting Started with CellDesigner

General view of CellDesigner, The Menu & Tool Bar, Components, Species & Reaction, Creating a simple network: Name & Size of the network, Grid Visible , Grid Snap, Change size of network, Select a component, Move/Delete a component, Undo/Redo, Change the size of the component, Save the Network, Zoom.

Create and Edit Components

Open an already saved .xml file, Change the following in a Compartment- Size, shape, color and thickness of the border, Create multiple files in CellDesigner, Learn about Start-point and End-point of a Species, Change identity of Species and Reaction

Creating a new Model

Species, Add a Protein on the Canvas, Add Protein Residues, Change the Residue/Region Status, Create Reaction, Tidy up your diagram layout, Export Images / Print Images, Customizing Properties, Add Notes (e.g. literature references) and MIRIAM to Proteins/Reactions, Refer to the databases

Build and Modify Process Diagram

Use Macros, Move all components to another side of the draw area, Align a Reaction line, Extend a Reaction line, Build a Process diagram using CellDesigner

Customizing Diagram Layout

To change color, shape and width of a Reaction line, Add Anchor points to a Reaction line, Align Components, Show/hide Reaction ids, Adding notes to Components, Editing Protein or Gene, Editing information, And to get a bird's eye view of the diagram.

Course Outcomes: After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Draw gene-regulatory and biochemical networks by CellDesigner, a structured diagram editor.	Ap	PSO 2
CO-2	Design models of biochemical reaction networks in Computer-readable format.	Ap	PO 5, PSO 2
CO-3	Analyze simulation and other analysis packages.	An	PO 5, PO 6
CO-4	Relate data representation with various pictorial representations.	U	PSO 2
CO-5	Browse and modify existing SBML models with references to existing databases, simulate and view the dynamics through an intuitive graphical interface.	E, C	PO 5, PO 6, PSO 5

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SUGGESTED READING: https://www.celldesigner.org/help/CDH_QT.html

AECC-1: ENGLISH COMMUNICATION

SEMESTER –I

Course code: UGMCBAECC01

Revision = 100%.

Course Objectives: Students should

- Improve skills of Listening, Speaking, Reading and Writing in English
- Respond to diverse audiences of scholars, students, and community members.

TOTAL HOURS: 30

CREDITS: 2

Unit I: Introduction to Communication

No. of Hours: 10

- Process of Communication
- Levels of Communication
- Flow of Communication
- Verbal and Non-Verbal Communication
- Barriers to Communication

Unit II: Listening and Speaking Skills

No. of Hours: 10

- Listening and its types.
- Barriers to effective listening,
- Trials of a good listener.
- Introduction to English Phonetic Symbols: Consonants and Vowels with illustrations in use.
- Dialogue
- Group Discussion
- Presentation
- Interview Technique.

Unit III: Reading and Writing Skills

No. of Hours: 10

- Techniques of Reading
- Types of Reading
- Reading Comprehension (unseen passage)
- Paragraph Writing
- Letter Writing
- Email Writing
- Report Writing
- Proposal writing
- Book Review
- Poster Making

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Recall English Phonetic Symbols and demonstrate their use with emphasis on various scientific terms.	R, U	PO 2, PSO 1
CO-2	Utilize various processes of communication	Ap	PO 2
CO-3	Compare and analyze dialogue, group discussion, presentation, interview techniques	An	PO 5
CO-4	Judge different techniques of reading and writing skills.	E	PO 5, PO 6
CO-5	Develop the skill to create original write up in the form of report, proposal, paragraph, review etc.	C	PO 4, PO 5, PSO 5

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Prescribed Books:

1. Vibrant English (New Delhi: Orient Black Swan)
2. Speak Well (New Delhi: Orient Black Swan) a compulsory supplementary Work Book for exercises on Interactions, dialogue, presentation skills, Group discussions, debates and Interviews.

Recommended Readings for advanced learning:

1. Advanced Skills in English.eds E Suresh Kumar et al..
2. Practising Writing Skills, Work Book
3. Enhancing English and Employability Skills
4. Business Communication,
5. English for Fluency
6. English Language Practice
7. Basics of Academic English- 1 and2
8. Practising English- all these are Orient Black Swan publications

AECC-2: ENVIRONMENTAL SCIENCE (ENVS)

SEMESTER –II

Course code: UGMCBAECC02

Revision = 100%

Course Objectives: Students should

- Understand the concept, components and function of natural resources and ecosystems.
- Gain knowledge on cause, effects and control measures of pollution and environmental disaster.
- Understand and apply the knowledge about the social, environmental issues and environmental legislation.

TOTAL HOURS: 30 **CREDITS: 2**

1. **Definition**, scope and importance. Need for public awareness. **No. of Hours: 1**
2. **Natural Resources: Renewable and non-renewable**: Forest, Water, Mineral, Food, Energy & Land resources – Use and associated problems. **No. of Hours: 4**
3. **Ecosystems:** Concept, Structure and function, Energy flow, Ecological succession, Food chains, food webs and ecological pyramids. Types – Forest, Grassland, Desert & Aquatic (ponds, streams, lakes, rivers, oceans, estuaries) ecosystems. **No. of Hours: 6**
4. **Environmental Pollution:**Definition, Cause, effects and control measures of - Air, Water, Soil, Noise pollution and Nuclear hazards. Solid waste Management. Role of an individual in prevention of pollution. **No. of Hours: 5**
5. **Disastersand management**: Floods, Earthquake, Cyclone and Landslides. **No. of Hours: 2**
6. **Social Issues and the Environment:** Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Urban problems related to energy. **No. of Hours: 5**
7. **Environmental legislation:** Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. **No. of Hours: 4**
8. **Human Population and the Environment:** Population growth, variation among nations; Population explosion– Family Welfare Programme;Environment and human health (including HIV/AIDS);Human Rights; Role of Information Technology in Environment and human health. **No. of Hours: 3**

Course Outcomes:

After completion of this course, the students will be able to

CO number	Course outcome (CO)	Cognitive level	PO/PSO addressed
CO-1	Define and demonstrate the concept, components and function of natural resources and ecosystems.	R, U	PO1, PSO 4
CO-2	Define, illustrate and analyse the cause, effects and control measures of various environmental pollutants.	R, U, An	PO 3, PSO 3
CO-3	Demonstrate the basic idea about the disasters and its management.	U	PO 3
CO-4	Illustrate and apply the knowledge about the social, environmental issues and environmental legislation.	U, Ap	PO 4
CO-5	Define, demonstrate and evaluate the impact of human population on the Environment	R, U, E	PO 6

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1. BharuchaErach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, Ahmedabad – 380013,India. Email: mapin@icenet.net
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3. Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).
4. Cunningham WP, Cooper TH, Gorhani E & Hepworth MT, 2001. Environmental Encyclopaedia,Jaico Publishing House, Mumbai, 1196pgs.
5. De AK, Environmental Chemistry, Wiley Eastern Ltd.
6. Down to Earth, Center for Science and Environment (R)
7. Gleick HP, 1993. Water in Crisis, Pacific Institute for Studies in Development, Environment andSecurity. Stockholm Environmental Institute, Oxford University Press, 473pgs.
8. Hawkins RE, Encyclopaedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
9. Heywood V H and Watson R T, 1995. Global Biodiversity Assessment. Cambridge University Press 1140pgs.
10. Jadhav H and Bhosale VM, 1995. Environmental Protection and Laws. Himalaya PublishingHouse, Delhi 284pgs.
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12. Mhaskar AK, Matter Hazardous, Techno-Science Publications (TB)
13. Miller TG, Jr. Environmental Science, Wadsworth Publishing CO. (TB)
14. Odum EP, 1971. Fundamentals of Ecology. WB Saunders Co. USA, 574pgs.
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Marks distribution

(For all papers, except SEC, AECC and DSE project)

- Mid sem assessment: 10
- End sem assessment (Theory): 50
- End sem assessment (Practical): 30
- Attendance (Theory): 5
- Attendance (Practical): 5
- **Total: 100**

Question pattern for End sem assessment (Theory: 50 marks)

- 10 questions (1 mark each) to be answered out of 14 questions (1X10)
- 5 questions (2 marks each) to be answered out of 8 questions (2X5)
- 6 questions (5 marks each) to be answered out of 9 questions (5X6)

Marks distribution for DSE Project paper

- Mid sem assessment: 30
- Presentation: 30
- Viva voce: 25
- Project report: 25
- Internal assessment: 5
- Regularity: 5
- **Total: 100**

Question Pattern for AECC-1 (End Semester Examination)

COMPONENT	NATURE OF THE QUESTION	MAXIMUM MARKS
Part A	Short answers	5 X1 = 5 Marks
Part B	Listening	1 X 5 = 5 Marks
Part C	Speaking (Presentation and Project submission)	1 X 15 = 15 Marks
Part C	Reading Comprehension	1 X 5 = 5 Marks
Part C	Writing	2 X 5 = 10 Marks 1 X 10 = 10 Marks

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