Course	Bachelor of Science (B.Sc.)	**Semester - 1**
Type of Course	Core Courses	
Prerequisite		
Course Objective	1. To develop basic concepts of microbiology and the practical skills and techniques required in microbiological analysis. 2. To study about the basic structure and functional properties of microorganism. 3. To provide a variety of practical laboratory experiences where students can apply their theoretical knowledge to practical situations. 4. To study about the application of organism in our daily life. 5. To get the knowledge of disease in eukaryotic and prokaryotic cells	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**History of microbiology and introduction to the microbial world.** Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Contributions of Antonyvon Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister,Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky,Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and EdwardJenner.	**12**	**20**
2	**Physiochemical and biological characteristics of microorganisms** Physiochemical and biological characteristics of microorganisms (including viruses); Baltimore classification. Binomial Nomenclature,Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of Cellular microorganisms, wall-less forms - MLO (mycoplasma and spheroplasts) with emphasis on distribution and occurrence,morphology, mode of reproduction and economic importance.	**12**	**20**
3	**General concept of phytoplanktons and zooplanktons.** General concept of phytoplanktons and zooplanktons. General characteristics, structure, mode of reproduction and economic importance of actinomycetes with special reference to its application in medicine and industry. General characteristics, occurrence, structure, reproduction and importance of protozoa.	**12**	**20**
4	**Methods of studying microorganism; Staining techniques** Methods of studying microorganism; Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining. Sterilization techniques (physical & chemical sterilization). Culture media & conditions for microbial growth. Pure culture isolation: Streaking, serial dilution and plating methods; cultivation,maintenance and preservation of pure cultures.	**12**	**20**
5	**Beneficial and harmful microbes and their role in daily life.** Beneficial and harmful microbes and their role in daily life. Concept of disease in plant and animal caused by microorganism.	**12**	**20**
		Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy			
Level	Remembrance	Understanding	Application

Weightage	20	60	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Develop a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
CO2	Have good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.
CO3	Explain the useful and harmful activities of the microorganisms.
CO4	Perform basic experiments to grow and study microorganisms in the laboratory
CO5	Differentiate the different types of organism and their application in daily life

Reference Books

1.	**Fundamentals of Microbiology** By Alcomo, I.E. | VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts. Pub. Year 2001
2.	**General Microbiology** By Pelzar, M. J., Chan, E. C. S., & Noel, R. K., Pub. Year 1986
3.	**Brock biology of microorganisms.** By Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J. | Prentice-Hall, Pub. Year 2003
4.	**A Text Book of Microbiology (TextBook)** By P. Chakraborthy
5.	**Agricultural Microbiology (TextBook)** By Rangaswamy, G. "Bagyaraj | 2nd, Pub. Year 1993
6.	**Burrows Textbook of Microbiology (TextBook)** By Bob A freeman | W.B. Saunders | 21, Pub. Year 1979
7.	**Fundamentals of Microbiology (TextBook)** By Edward Cartwright
8.	**Essentials of Practical Microbiology (TextBook)** By Purba Sankar Sastry, Sandhya Bhat K, Pub. Year 2018
9.	**Laboratory Manual of Agricultural Microbiology (TextBook)** By Dr. Ravindra Soni and Dr. Deep Chandra Suyal | Scripown publication, Pub. Year 2021
10.	**Laboratory Practice of Microbiology (TextBook)** By Nirmal Majumdar | Agrotech Press, Pub. Year 2012

List of Practical

1.	Microbiology Good Laboratory Practices and Bio-safety
2.	To study the principle and applications of important instruments
3.	Preparation of culture media (liquid & solid) for bacterial cultivation.
4.	Handling and care of laboratory equipment - autoclave, hot air oven, incubator, and laminar airflow.
5.	Sterilization of media using autoclave and assessment of sterility.
6.	Sterilization of glassware using hot air oven.
7.	Sterilization of heat-sensitive material by membrane filtration.
8.	Demonstration of the presence of micro flora in the environment by exposing nutrient agar plates to air.

9.	Observation of microorganisms - bacteria, cyanobacteria protozoa, fungi, yeasts, and algae from natural habitats.
10.	Study of common fungi, algae and protozoan using temporary / permanent mounts.

Useful Links
https://archive.nptel.ac.in/courses/102/103/102103015/ https://www.coursera.org/learn/bacterial-infections

Course	Bachelor of Science (B.Sc.)	**Semester - 1**
Type of Course	Core Courses	
Prerequisite		
Course Objective	1. To understand the basic concept of bacterial cell 2. To know the knowledge of Gram Positive and Gram Negative bacterial cell 3. To illustrate the different type of culture media for bacterial growth 4. To explain about the classification and taxonomy of bacteria. 5. To categorize the different type of bacterial cell on the basis of phylogenetic relationship.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction to Microbiology** Cell size, shape and arrangement, capsule, flagella, fimbriae and pili. Cel wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, archaebacterial cell wall, Gram and acid-faststaining mechanisms, lipopolysaccharide (LPS), sphaeroplasts,protoplasts, and L-forms. Effect of antibiotics and enzymes on the cellwall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cellmembranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies,nucleoid. Endospore: Structure, formation, stages of sporulation.	**12**	**20**
2	**Gram negative and Gram positive bacteria** Gram negative and Gram positive bacteria: characteristics and examples. Study of typical eubacteria (*Bacillus*, *Clostridium*, *Staphylococcus*, *Streptococcus*, *Corynebacterium*, *Mycobacterium*,*Escherichia*, *Salmonella*, *Shigella*, *Vibrio*, *Helicobacter*,*Meningococcus*, Spirochetes, *Rickettsia*, *Mycoplasma* and *Chlamydia*.	**12**	**20**
3	**Nutritional requirements in bacteria and nutritional categories. Culture media** Nutritional requirements in bacteria and nutritional categories. Culture media: components of media, natural and synthetic media, chemically define media, complex media, selective, differential, 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. Asexual methods of reproduction, logarithmic representation of and bacterial populations, phases of growth, calculation of generation time and specific growth rate.	**12**	**20**
4	**Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain** 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 and its importance.. Differences between eubacteria and archaebacteria.	**12**	**20**
5	**General characteristics, phylogenetic overview of archaebacteria.** General characteristics, phylogenetic overview of archaebacteria. Introduction to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota(*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens(*Methanobacterium*, *Methanocaldococcus*), thermophiles(*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles(*Halobacterium, Halococcus*).	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy				
Level	Remembrance	Understanding	Application	Analyze
Weightage	25	40	25	10

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Explain the characteristics of internal and external structure of bacterial cells.
CO2	Differentiate a large number of common bacteria by their salient characteristics and classify bacteria into groups.
CO3	Use the knowledge of the nutritional requirements of bacteria for growth.
CO4	Use the knowledge of nutritional requirements of bacteria for growth.
CO5	Explain the phylogenetic overview of bacterial cell.

Reference Books

1.	**Fundamentals of Microbiology** By Edward Cartwright
2.	**Fundamentals of Microbiology** By Alcomo, I.E. | VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts,, Pub. Year 2001
3.	**A Text Book of Microbiology (TextBook)** By P. Chakraborthy
4.	**Brock biology of microorganisms. (TextBook)** By Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J. | Prentice-Hall, Pub. Year 2003
5.	**Burrows Textbook of Microbiology (TextBook)** By Bob A freeman | W.B. Saunders | 21, Pub. Year 1979
6.	**Prescott, Harley and Klein's Microbiology. (TextBook)** By Willey JM, Sherwood LM, and Woolverton CJ. (2008). | McGraw Hill Higher Education | 7th edition
7.	**Essentials of Practical Microbiology (TextBook)** By Purba Sankar Sastry, Sandhya Bhat K, Pub. Year 2018
8.	**Experimental Microbiology (TextBook)** By Rakesh J Patel

List of Practical

1.	To study the preparation of different media: synthetic media, complex media- Nutrient agar, McConkey agar, EMB agar.
2.	To perform the simple staining
3.	To perform the negative staining
4.	To perform the gram staining
5.	To study the acid-fast staining by using the permanent slide.
6.	To perform the capsule staining
7.	To perform endospore staining.
8.	To perform the isolation of pure cultures of bacteria by streaking method.
9.	To study the preservation of bacterial cultures by various techniques.

10.	To perform the estimation of CFU count by spread plate method/pour plate method.
11.	To perform the motility by hanging drop method.

Course	Bachelor of Science (B.Sc.)	**Semester - 1**
Type of Course	Discipline Specific Elective Courses	
Prerequisite		
Course Objective	1) To learn and understand the microbial diversity in the living world. 2) To know the various physical and chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement. 3) To understand, learn and gain skills of isolation, culturing and maintenance of pure culture 4) To know various Culture media and their applications. 5) To acquaint students with basic concepts of microbial diversity and how the microbe concept emerged.	

Teaching Scheme (Contact Hours)				Examination Scheme				
				Theory Marks		Practical Marks		
Lecture	Tutorial	Lab	Credit	External Mark (T)	Internal Marks (T)	External Mark (P)	Internal Marks (P)	Total Marks
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
1	**Introduction to microbial world** Physiochemical and biological characteristics; Characteristics of Acellular microorganisms (Viruses); Baltimore classification, general structure with special reference to viroid's and prions. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.	12	20
2	**General characteristics of Cellular microorganisms** Types - archaebacteria,eubacteria, wall-less forms - MLO (mycoplasma and spheroplasts) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. Structure, reproduction and economic importance of Mycoplasma.	12	20
3	**General concept of Phytoplankton's and Zooplanktons** Characteristics,Occurrence, thallus organization and classification of Algae. Cyanobacteria -Occurrence, thallus organization, cell ultra-structure, reproduction and economic importance. Applications of algae in agriculture, industry,Environment and food.	12	20
4	**Historical developments in the field of Mycology** Including significant Contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, mode of reproduction and Economic importance of fungi with examples in agriculture, environment, Industry, medicine and food.	12	20
5	**Importance of Actinomycetes and Protozoa** General characteristics, structure, mode of reproduction and economic importance of Actinomycetes with special reference to its application in Medicine and industry. General characteristics, occurrence, classification structure, reproduction and economic importance of Protozoa.	12	20
	Total	60	100

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Understanding	Application	Analyze
Weightage	60	20	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Appreciate the significance of microbes in shaping and maintaining our planets ecosystem.
CO2	Understanding of diverse group of cellular microorganisms including bacteria, archaea, fungi and protozoa.
CO3	Differentiate between phytoplankton and zooplankton based on their biological characteristics, life cycles and ecological roles.
CO4	Impact of microbes on earth atmosphere, health and technology development.
CO5	Understand the characteristics, structure, identification, reproduction, and classifications to comprehend the various approaches of microbial taxonomy.

Reference Books	
1.	**General Microbiology (TextBook)** By Singh,R.P | KalyaniPublishers, NewDelhi (2007)
2.	**Experiments in Microbiology,Plant pathology and Biotechnology** By Aneja, K.R | NewAge International publishers. | Fourth edition
3.	**Burrows Textbook of Microbiology (TextBook)** By Bob A freeman | W.B. Saunders | 21, Pub. Year 1979
4.	**Fundementals of Microbiology (TextBook)** By D.E. Alcamo, Jones and Bartiett, Boston | Jones & Bartlett
5.	**Laboratory Manual of Agricultural Microbiology (TextBook)** By Dr. Ravindra Soni and Dr. Deep Chandra Suyal | Scripown publication, Pub. Year 2021
6.	**Experimental Microbiology (TextBook)** By Rakesh J Patel
7.	**Laboratory Practice of Microbiology (TextBook)** By Nirmal Majumdar | Agrotech Press, Pub. Year 2012

List of Practical	
1.	Microbiology Good Laboratory Practices and Bio-safety
2.	To study the principle and applications of important instruments
3.	Preparation of culture media (liquid & solid) for bacterial cultivation
4.	Handling and care of laboratory equipment - autoclave, hot air oven, incubator, and laminar airflow.
5.	Sterilization of media using autoclave and assessment of sterility.
6.	Sterilization of glassware using hot air oven
7.	Sterilization of glassware
8.	Sterilization of heat-sensitive material.
9.	Demonstration of the presence of microflora
10.	Observation of microorganisms.
11.	Study of common microorganisms.

Useful Links
1)https://archive.nptel.ac.in/courses/102/103/102103015/ 2)https://www.slideshare.net/phylogenomics/bis2c-lecture-9-microbial-diversity 3)https://www.vedantu.com/biology/actinomycete

Course	Bachelor of Science (B.Sc.)	**Semester - 1**
Type of Course	Ability Enhancement Compulsory Courses	
Prerequisite		
Course Objective	1 To make aware of the issue and understand the reasons behind environmental degradation. 2 To encourage for seek out knowledge about the environment and all of its components. 3 To develop a sense of responsibility and perspective necessary for progressive actions towards the environment. 4 To impart critical skills to solve issues related to the environment. 5 To develop the ability to draw accurate conclusions and unbiased inferences.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction to Environment science** The multidisciplinary nature of environmental studies. Environmental Science – definition, scope & importance, Evolution of the universe, origin of the earth; solar system; atmosphere of the primitive earth, abiotic component of environment, Environmental balance**,** balance in O2 and CO2 in air; thermal balance; balance in predator and prey population.	**15**	**25**
2	**Ecology** Ecology & its branches, scope of Ecology and its relation to other divisions of sciences; autecology and synecology, Concept and structure of ecosystem, functions of ecosystem, Types of Ecosystems, Concept of habitat; Significance of ecological adaptation; ecological adaptation in plants and animals.	**15**	**25**
3	**Ecosystem and its concept** Ecosystem concept and scope of environmental chemistry, chemical toxicology, hazardous chemicals, carcinogens, occupier, effluent etc. The natural cycles of the environment, Ozone depletion –causes and effects; Global warming – major greenhouse gases, causes and effects; Acid rain –causes and effects, Acid – base reactions in water.	**15**	**25**
4	**Biogeochemical cycles and Environmental Pollution** Biogeochemical cycles, Carbon cycle, Nitrogen cycle, Oxygen cycle, Water cycle Environmental Pollution, Types of Environmental Pollution, Water Pollution, Air Pollution, Land and Noise Pollution Current Issues in environment sciences	**15**	**25**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application
Weightage	20	60	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Get knowledge about various environmental factors and components.
CO2	Acknowledge concepts and methods from ecological and physical sciences and their application in environmental problem solving.
CO3	Understanding of issues related to environment and their impact on the human life.
CO4	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
CO5	Understand key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.

Reference Books	
1.	**Textbook of Environmental (TextBook)** By Erach Bharucha | Universities Press (India) Private Ltd, Hyderabad. | Second edition, Pub. Year 2013
2.	**Environmental Sciences (TextBook)** By Daniel B Botkin & Edward A Keller | John Wiley & Sons.
3.	**Environmental Science: Toward A Sustainable Future** By Dorothy F. Bourse and Richard T. Wright.
4.	**Principles of Environmental Science** By William P. Cunningham and Mary Ann Cunningham
5.	**Environmental Science: Systems and Solutions** By Michael L. McKinney, Robert M. Schoch, Logan Yonavjack and Grant A. Mincy

Useful Links

1 https://onlinecourses.nptel.ac.in/noc23_hs155/preview
2 https://onlinecourses.swayam2.ac.in/cec20_ge24/preview
3 www.nsta.org
4 www.earthforce.org

Course	Bachelor of Science (B.Sc.)	**Semester - 1**
Type of Course	Ability Enhancement Compulsory Courses	
Prerequisite		
Course Objective	1. To apply the soft skills in theoretical and practical ways and also to develop the effective communication skills among students 2. Learning about the essential factors for personality development and bringing them into practice. 3. Apply and demonstrate knowledge of personal belief 4. To analyze the time management	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Fundamentals of grammar and Tense** **Fundamentals of grammar:** Parts of Speech (Noun, Pronoun, Adjective, Verb, Adverb, Conjunction, Preposition, Interjection)Article **Tense:** Application of tenses with respect to time, All tenses & their Sub-divisions	**11**	**25**
2	**Fundamentals of grammar** Forming of Sentences & Clauses, "WH's Concepts, Understanding Sentences, Punctuation I, Degree of comparison I (Positive, Comparative & Superlative), Tenses (Introduction & Usage)	**11**	**25**
3	**Fundamentals of grammar** Modal Verbs Auxilaries Vocabulary (Roots, Prefix, Sufix, Homonyms, Synonyms &Antonyms)	**11**	**25**
4	**Self-improvement And Analyzing the body language** **Self-improvement** Self Confidence Self-Management **Analyzing the body language** Body gestures Analyzing body languages Do's and Don'ts Impacts of body language	**12**	**25**
	Total	**45**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Analyze	Evaluate
Weightage	30	30	10	10

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Develop soft skill for real life situations

CO2	Evaluate language skill i.e. reading, listening, speaking, writing.
CO3	Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment
CO4	Analyze and develop accurate sense of Self Management

Reference Books	
1.	**High School English grammar and composition (TextBook)** By P. C. Wren and H. Martin | S.Chand
2.	**High School English Grammar &Composition (TextBook)** By Wren & Martin | Blackie

Course	Bachelor of Science (B.Sc.)	**Semester - 2**
Type of Course	Core Courses	
Prerequisite	05010101-T - MICROBIAL WORLD AND PRINCIPLES OF MICROBIOLOGY	
Course Objective	1. To study the molecular architecture of eukaryotic cells and organelles, including membrane structure and dynamics. 2. To get the knowledge of catalytic activity of enzyme and principles of bioenergetics. 3. To analyze the chemical nature of biological macromolecules, their three dimensional construction, and the principles of molecular recognition. 4. To understand the metabolism of dietary and endogenous carbohydrate, lipid, and protein. 5. To explain the mechanisms of metabolic control and of molecular signaling by hormones.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction to biochemistry** Concept of bio-molecules - Building blocks of life, Macromolecules. Concept of Bioenergetics - 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, ATP, amino acids the building blocks of proteins. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. General formula of amino acid and concept of zwitterion. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, Dalanine and D-glutamic acid.	**12**	**20**
2	**Carbohydrates** Carbohydrate: 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. 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	**12**	**20**
3	**Proteins**	**12**	**20**

	Protein: Primary, secondary, tertiary and quaternary structures. Enzymes: 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, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.		
4	**Lipids**	**12**	**20**

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
	Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, general structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals,cofactors, prostaglandins, Introduction to lipid micelles, monolayers, bilayers		
5	**Nucleic acids and vitamins** Nucleic acids and vitamins. Biosynthesis of nucleotides. Base composition. A+T and G+C rich genomes. Structure and functions of DNA and RNA. Basic concept of nucleic acids protein interactions. Concept and types of vitamins and their role in metabolism.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application	Analyze
Weightage	30	30	30	10

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Developed a very good understanding of various biomolecules which are required for development and functioning of a bacterial cell.
CO2	Have developed how the carbohydrates make the structural and functional
CO3	components such as energy generation and as storage food molecules for the bacterial cells
CO4	Well conversant about multifarious function of proteins; are able to calculateenzyme activity and other quantitative and qualitative parameters of enzyme kinetics;
CO5	Apply the Knowledge about lipids and nucleic acids and kinetics

Reference Books	
1.	**A Textbook of Biochemistry by A.V.S.S. Rama Rao (TextBook)**
2.	**Biochemistry (TextBook)** By Satyanarayana,U. | Elsevier | 6th, Pub. Year 1999
3.	**Biochemistry (TextBook)** By Rastogi, S. C. | Tata Mcgraw Hill, Pub. Year 2004
4.	**Practical Biochemistry for Medical students (TextBook)** By Rajagopal and Ramakrishna. | Orient Black Swan
5.	**Biochemistry (TextBook)**

List of Practical	
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 Vmax , Km, Kcat values.
8.	Study effect of temperature, pH and heavy metals on enzyme activity.
9.	Estimation of any one vitamin.

Course	Bachelor of Science (B.Sc.)	**Semester - 2**
Type of Course	Core Courses	
Prerequisite	05010103-T - MICROBIAL WORLD AND MICROBIAL DIVERSITY	
Course Objective	1. To develops the concepts of methodology involved in studying the different components of microbial cell and various techniques and instruments involved in product analysis. 2. To learn different types of techniques 3. To analyze the preparation of different types of media for bacterial growth. 4. To study about the different types of microscopic techniques 5. To analyze the chromatographic techniques	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Microbial techniques** Microbial techniques: 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. Buffers in culture medium. Cultivation of fungi, actinomycetes, yeasts, algae. Cultivation of anaerobes.	**12**	**20**
2	**Sterlization** Sterilization, Disinfection, Antiseptic, Germicide, Sanitizer, Fungicide, Virucide, Bacteriostatic and Bactericidal agent. Chemical Disinfectants. Sterilization by Physical Agent, Heat: Moist Heat, Dry heat, Boiling, Tyndallization, Pasteurisation, Steam under pressure (Autoclave), Incineration, Hot-air Oven. Radiations: Ionizing and Non-ionizing radiations. Inoculation and incubation, Principle and application of Laminar airflow.	**12**	**20**
3	**Microscopy** Microscopy: Principle, mechanism,, and application of photo-optical instruments (different types of Microscopes), Phase contrast microscope, Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence microscopy, Confocal microscopy, Scanning and Transmission Electron Microscopy. Micrometry. Principles of Centrifugation and Ultracentrifugation techniques and its applications.	**12**	**20**
4	**Chromatography** Chromatography: Principle and techniques with applications (Partition, adsorption, ion exchange, exclusion and affinity chromatography). Electrophoretic technique (agarose and polyacrylamide gel) its Components, working and applications	**12**	**20**
5	**Principle, mechanism and application of instruments**	**12**	**20**

	Principle, mechanism, and application of instruments used in Spectrophotometric techniques (UV and visible).Radiobiological techniques Characters of radioisotopes, autoradiography, Radioisotope dilution technique, and pulse chase experiments. Basic principles & Law of absorption and radiation and its application.		
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy		
Level	Understanding	Application
Weightage	60	40

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Apply knowledge of culture isolation methods and their preservation.
CO2	Apply various sterilization methods & their applications.
CO3	Understand various types of microscopy and their working mechanisms.
CO4	Explain the concept of various chromatographic and electrophoretic techniques.
CO5	Describe the concept of spectrophotometric and radiobiological techniques

Reference Books

1.	**A textbook of microbiology (TextBook)** By R C Dubey | Sultan Chand, Pub. Year 2012
2.	**Experiments in microbiology (TextBook)** By Aneja K R | New Age International Publishers | 4th, Pub. Year 2011
3.	**Fundamentals of Microbiology (TextBook)** By Alcamo, I. E, Pub. Year 1994
4.	**Fundamentals of Microbiology (TextBook)** By Probisher, Hinsdill et al | 9th ed. Japan
5.	**Laboratory Practice of Microbiology (TextBook)** By Nirmal Majumdar | Agrotech Press, Pub. Year 2012
6.	**Microbiology (TextBook)** By R. Ananthnarayan & CK Jayram Panikar
7.	**Principles of Microbiology (TextBook)** By R.M.Atlas, , Wm.C. | Brown Publications

List of Practical

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 absorption max 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	Bachelor of Science (B.Sc.)	**Semester - 2**
Type of Course	Discipline Specific Elective Courses	
Prerequisite	05010102-T - BACTERIOLOGY AND SYSTEMATICS	
Course Objective	1. To provide the students with the basic information about microorganisms 2. To learn and understand the mode of life of microorganisms. 3. To distinguish between bacteria and virus. 4. To provide information about pathogenic, non-pathogenic and useful microbes. 5. To understand the taxonomy of bacterial cells	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Cell organization** Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram-negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation	**12**	**20**
2	**Bacterial growth and control** Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria Growth: Binary fission, phases of growth	**12**	**20**
3	**Bacterial Systematics and Taxonomy** Taxonomy, nomenclature, systematics, types of classifications Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles Eubacteria: Gram negative and Gram positive Gram negative: Non-proteobacteria– Deinococcus, Chlamydiae, Spirochetes Alpha proteobacteria- Rickettsia, Rhizobium, Agrobacterium Gamma proteobacteria –Escherichia,Shigella,Pseudomonas Gram positive: Low G+C: Mycoplasma, Bacillus, Clostridium, Staphylococcus High G+C: Streptomyces, Frankia	**12**	**20**
4	**Viruses**	**12**	**20**

	Properties of viruses; general nature and important features Subviral particles; viroids, prions and their importance, Isolation and cultivation of viruses, Morphological characters: Capsid symmetry and different shapes of viruses with examples. Viral multiplication in the Cell: Lytic and lysogenic cycle Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses		
5	**Classification, systematics and taxonomy**	**12**	**20**

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
	Aim and principles of classification,systematics and taxonomy,concept of species,taxa,strain;conventional, molecular and recent approaches to polyphonicbacterialtaxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing,Signature sequences, and protein sequences. Differences between eubacteriaand archaebacteria. Eubacteria**:** Morphology, metabolism,ecological significance and economic importance of Gram negative and Grampositive bacteria		
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Analyze
Weightage	40	40	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

	At the end of this course, students will be able to:
CO1	Has acquired a fairly good understanding of the different types of bacteria and viruses.
CO2	Has acquired a fairly good describing of the structure and other salient characteristics of bacteria and viruses.
CO3	Has acquired skills of visualizing bacteria by staining, using a microscope and culturing bacteria in microbiological media to describe the features of bacterial colonies.
CO4	Has acquired knowledge about the pathogenic and non-pathogenic nature of microbes.
CO5	Understand the taxonomy of bacterial cells

Reference Books

1.	**Basic Virology (TextBook)** By Wagner EK, Hewlett MJ. (2004) | Blackwell Publishing | 2nd edition
2.	**Bergeys manual of systematic bacteriology (TextBook)** By Williams and Wilkins- A Waverly company
3.	**Introduction to bacteriology (TextBook)** By DPTripathi | Kalyani Publishers, Pub. Year 2014
4.	**Plant bacteriology (TextBook)** By Kalyan K Mondal | Kalyani Publishers | 1, Pub. Year 2015
5.	**Textbook of Bacteriology (TextBook)** CALLISTO REFERENCE, Pub. Year 2019

List of Practical

1.	Preparation of different media: synthetic media, Complex media Nutrient- agar, McConkey agar, EMB agar.
2.	Gram staining
3.	Acid fast staining-permanent slide only.
4.	Isolation of pure cultures of bacteria by streaking method.
5.	Preservation of bacterial cultures by various techniques.

6.	Estimation of CFU count by spread plate method/pour plate method.
7.	Motility by hanging drop method.
8.	Study of the structure of important animal viruses (rhabdo, influenza, paramyxohepatitis B and retroviruses)using models, videos, and electron micrographs
9.	Study of the structure of important plant viruses (caulimo, Gemini, tobacco ringspot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
10.	Study of the structure of important bacterial viruses (ϕX174,T4,3) using electron micrograph.
11.	Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
12.	Study of cytopathic effects of viruses using photographs

Course	Bachelor of Science (B.Sc.)	**Semester - 2**
Type of Course	Ability Enhancement Compulsory Courses	
Prerequisite		
Course Objective	1. To apply the soft skills in theoretical and practical ways and also to develop the effective communication skills among students 2. Learning about the essential factors for personality development and bringing them into practice. 3. Apply and demonstrate knowledge of personal belief 4. To analyze the time management.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction to soft skill** Meaning and introduction to soft skill, Types of soft skill (communication, empathy, leadership, time management, observation, conflict resolution, listening skill,) Difference between soft skill and hard skill, IQ,SQ,EQ and emotion competence	**15**	**25**
2	**Habits** Guiding Principles, Identifying Good And Bad Habits, Habit Cycle; Breaking Bad Habits, Using The Zeigarnik Effect For Productivity And Personal Growth, Forming Habits of Success	**15**	**25**
3	**Personality development** Meaning of personality, elements of personality Determents of personality Personal development plan	**15**	**25**
4	**Self-management skill** Time management (planning, scheduling and meeting)	**15**	**25**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application	Analyze
Weightage	30	40	10	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Develop soft skill for real life situations
CO2	Evaluate language skill i.e. reading, listening, speaking, writing
CO3	Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment
CO4	Analyze and develop accurate sense of Self Management

Reference Books	
1.	**High School English grammar and composition (TextBook)** By P. C. Wren and H. Martin | S.Chand
2.	**High School English Grammar &Composition (TextBook)** By Wren & Martin | Blackie

Course	Bachelor of Science (B.Sc.)	**Semester - 2**
Type of Course	Ability Enhancement Compulsory Courses	
Prerequisite	05000102-T - ENVIRONMENTAL SCIENCE	
Course Objective	• To study about the management techniques and control of various disasters. • To study the behavior of natural disasters and their impacts on human health. • To study the behavior of man-made disasters and their impacts on human health • To understand the transnational character of environmental problems and their direct indirect impact as disaster. • To apply knowledge of different laws and policies regarding disaster management.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

SEE *- Semester End Examination,* ***CIA*** *- Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Disasters in India - An Overview:** Introduction, Definition, Disasters not new to Mankind, Disasters – Global Scenario, Vulnerability Profile of India, Climate Profile, Cause and Effect of Disasters, Types of Disasters	**15**	**25**
2	**Institutional Framework:** Evolution of Disaster Management in India, Disaster Management during British Administration and Post-Independence, Emergence of Institutional Arrangement in India, Organization and Structure of Disaster Management, Disaster Management Framework, Present Structure for Disaster Management in India, Disaster Management Act, 2005, Different committees and authority associated with disaster management	**15**	**30**
3	**Prevention and Mitigation; Preparedness and Response** Introduction, Prevention and Mitigation; Preparedness and Response regarding different disasters	**15**	**30**
4	**Policy and Guidelines** Introduction, National Policy on Disaster Management (NPDM), National Plan on Disaster Management, Focus and Objectives of Guidelines, Management of Droughts, National Action Plan on Climate Change, Rules notified under the Disaster Management Act, 2005	**15**	**15**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application	Analyze
Weightage	20	30	30	30

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Explain disaster management theory (cycle, phases, risk, crisis, emergency, disasters, resilience)
CO2	Compare hazards, disasters and associated natural phenomena and their interrelationships, causes and their effects - developing humanitarian Assistance before and after disaster
CO3	Compare anthropogenic hazards, disasters and associated activities and their interrelationships of the subsystems - Green House Effect, Global warming, Causes and their effects and development of humanitarian assistance before and after disaster
CO4	Apply knowledge about existing global frameworks and existing agreements and role of community in successful Disaster Risk Reduction.
CO5	Remember the different laws and policies regarding disaster management.

Reference Books	
1.	**Disaster Management (TextBook)** By Harsh K. Gupta | Universities Press, Pub. Year 2003
2.	**Disaster Management (TextBook)** By K. Palanivel J. Saravanavel S. Gunasekaran | Allied Publishers Pvt. Ltd
3.	**Disaster Science and Management (TextBook)** By Tushar Bhattacharya | McGraw Hill Education (India) Pvt. Ltd.
4.	**Earth and Atmospheric Disaster Management : Nature and Manmade (TextBook)** By C. K. Rajan, Navale Pandharinath | B S Publication

Course	Bachelor of Science (B.Sc.)	**Semester - 3**
Type of Course	Core Courses	
Prerequisite	Basic knowledge of virology | 05010203-T - BACTERIOLOGY AND VIROLOGY	
Course Objective	1 To evaluate the classification of viruses. 2 To understand bacteriophage and its life cycle. 3 To Able to write the Pathogenesis of viral infections 4 To Explain vaccine strategies and mechanisms of antiviral drugs 5 To get knowledge about viral vectors.	

Teaching Scheme (Contact Hours)				Examination Scheme				
				Theory Marks		Practical Marks		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
1	**Nature and Properties of Viruses**	**18**	**20**
	Nature and Properties of Viruses Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses		
2	**Bacteriophages**	**9**	**20**
	Bacteriophages Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage		
3	**Modes of viral transmission**	**22**	**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.		
4	**Introduction to oncogenic viruses**	**5**	**20**
	Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes		
5	**Antiviral compounds and their mode of action**	**6**	**20**
	Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination, Use of viral vectors in cloning and expression, Gene therapy and Phage display		
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy		
Level	Remembrance	Understanding

Weightage	40	60

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Understand the architecture of viruses, their classification and the methods used in their study.
CO2	Able to understand the replication strategies of representative viruses from the seven Baltimore classes and comprehend the intricate interaction between viruses and host cells.
CO3	Comprehend the role of viruses in onco genesis, and ways of preventing/ treating viral infections..
CO4	Know how viruses can be used as tools to study biological processes, as cloning vector sand for gene transfer.
CO5	Get knowledge about viral vectors and anti-viral components.

Reference Books	
1.	**Virology: Principles and Applications (TextBook)** By Carter J and Saunders V (2007) | John Wiley and Sons
2.	**Virology. (TextBook)** By Levy JA, Conrat HF, Owens RA. (2000), | Prentice Hall publication, New Jersey. | 3rd edition
3.	**Principles of Virology, Molecular biology, Pathogenesis and Control. (TextBook)** By Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004) . | ASM press Washington DC | 2nd edition.
4.	**Plant Viruses** By Nayudu MV. (2008) | Tata McGraw Hill, India
5.	**Plant Virology** By Mathews. (2004) | Hull R. Academic Press, New York.
6.	**Basic Virology** By Wagner EK, Hewlett MJ. (2004) | Blackwell Publishing | 2nd edition

List of Practical	
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.
8.	Virus Isolation in Embryonated Eggs.
9.	Virus Purification
10.	Samples Processing for Virus Isolation.

Useful Links
1 https://alison.com/course/basics-of-virology 2 https://www.coursera.org/learn/virology-epidemiology 3 https://onlinecourses.swayam2.ac.in/cec23_bt08/preview

Course	Bachelor of Science (B.Sc.)	**Semester - 3**
Type of Course	Core Courses	
Prerequisite	Knowledge of microbes and classification | 05010103-T - MICROBIAL WORLD AND MICROBIAL DIVERSITY	
Course Objective	1. To outline the basic characters, structure of algae and fungi. 2. To understand the life cycle of algae and fungi. 3. To discuss the classification scheme of algae and fungi. 4. To construct the knowledge of economic importance of various algal and fungal classes.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Classification of fungi** (a). General classification and economic importance of fungi with examples in agriculture, environment, industry, medicine, food, bioremediation (of wood, paper, textile, leather), mycotoxins (b). Life cycle, structure and occurrence – Cellular slime molds , True slime mold	**15**	**25**
2	**Detailed characteristics of fungi** (a). Oomycetes, Chytridiomycetes , Zygomycetes (b).Ascomycetes, Basidiomycetes , Deuteromycetes	**15**	**25**
3	**Algae** (a). General classification and economic importance of algae with examples in agriculture, environment, industry and food (b). Life cycle, thallus organisation and occurrence -Chlorophyceae ,Charophyceae	**15**	**25**
4	**Diatoms and Cyanobacteria** (a).Diatoms , Xanthophyceae (b). Phaeophyceae Rhodophyceae: Cyanobacteria	**15**	**25**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application
Weightage	40	20	40

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Student will able to describe habit and habitat, mode of nutrition and criteria for classification of algae and fungi
CO2	Student will describe and illustrate the life cycles of fungi

CO3	Student will describe and illustrate the life cycles of algae
CO4	Student will understand the economic importance of algae
CO5	Student will identify the ecological importance of fungi, highlight the significance of fungi in industry and human welfare.

Reference Books

1.	**Introductory mycology** By Alexopoulos, C. J. | LWW, Pub. Year 1952
2.	**Textbook of medical mycology** By Chander, J | JP Medical Ltd
3.	**Introduction to fungi** By Webster, J., & Weber, R. | Cambridge university press., Pub. Year 2007
4.	**An introduction to fungi** By Dube, H. C. | Scientific Publishers, Pub. Year 2013
5.	**Algae** By Vashishta, D. R | S. Chand
6.	**Experimental Microbiology (TextBook)** By Rakesh J Patel

List of Practical

1.	Morphological study of representative members of fungi
2.	Morphological study of representative members of algae
3.	Isolation of different fungi from soil sample
4.	Isolation and identification of different fungal strain
5.	Identification of algae from sample -water
6.	Identification of algae from sample - soil
7.	Isolation and identification of algae from water.
8.	Symptomology of some diseased specimens
9.	Identification of fungal spores
10.	Observation of Nostoc or Anabaena

Useful Links

https://nptel.ac.in/courses/102105087
https://www.coursera.org/learn/algae
https://onlinecourses.swayam2.ac.in/nos23_ge06/preview

Course	Bachelor of Science (B.Sc.)	**Semester - 3**
Type of Course	Discipline Specific Elective Courses	
Prerequisite		
Course Objective	1) To understanding basic knowledge of biosafety, biological safety cabinets & biosafety levels of specific microorganisms. 2) To learn biosafety guidelines and regulation, biosafety committees and protocol & various agencies, treaties and international organizations associated with IPR. 3) To understand what is meant by intellectual property and its importance, knowledge of patents, trademarks, copyright, and geographical indications & WIPO. 4) To implement the basics related to grant of patent and patenting authorities, types of patent applications & patent filing procedures.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction of Biosafety** Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms	**8**	**20**
2	**Biosafety Guidelines** Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.	**16**	**20**
3	**Introduction to Intellectual Property** Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).	**12**	**20**
4	**Patent Grant** Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	**12**	**20**
5	**Agreements and Treaties** Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy			
Level	Remembrance	Understanding	Application
Weightage	40	40	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Apply knowledge of biosafety for handling hazardous material.
CO2	Recognize biosafety guidelines and institutional biosafety committees
CO3	Describe different types of intellectual property right and its importance.
CO4	Discuss different types of patent applications & patent filing procedures
CO5	Identify different agreements and treaties related to intellectual property right.

Reference Books

1.	**Bioethics and Biosafety in Biotechnology by v.c krishna**
2.	**Intellectual Property and Bioethics – An Overview Consultation Draft**
3.	**WIPO INTELLECTUAL PROPERTY HANDBOOK**
4.	**Biotechnology and Intelectual Property Rights: Legal and Social Impliocations.Singh K K (2015)**

Course	Bachelor of Science (B.Sc.)	**Semester - 3**
Type of Course	Generic Elective Courses	
Prerequisite	To understand the techniques and instruments related to microbial diversity. | 05010202-T - MICROBIAL TECHNIQUES & INSTRUMENTS	
Course Objective	1) To remember and develops the concepts of methodology involved in studying the different components of microbial cell ,various techniques and instruments involved in product analysis. 2) To summarize different techniques and instruments used in Microbiology. 3) To focuses on imparting the principles of measurement which includes the working mechanism of various sensors and devices. 4) To detect amino acids with help of chromatography. 5) To get brief knowledge of principles and applications of electrophoresis.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Microscopy** Microscopy**:** Bright field and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy)	**20**	**20**
2	**Chromatography** Chromatography**:** Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion- exchange chromatography and affinity chromatography, GLC, HPLC.	**20**	**20**
3	**Electrophoresis** Electrophoresis: Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis	**20**	**20**
4	**Spectrophotometry** Spectrophotometry**:** Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry	**20**	**20**
5	**Centrifugation** Centrifugation: Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation	**20**	**20**
	Total	**100**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy			
Level	Understanding	Application	Analyze
Weightage	60	20	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Understand about different instruments use in lab.
CO2	Enumerate the applications and principles of chromatography and microscopy.
CO3	Summarize about the principle, working and applications of commonly used instruments in microbiology.
CO4	Preparing learning applications of different separation techniques such as electrophoresis, centrifugation, etc.
CO5	Students will be able to handle, calibrate and use the instruments.

Reference Books

1.	**Guide to microbiological control in pharmaceuticals and medical devices (TextBook)** By Denyer, S. P. and Baird, R. M. | CRC Press, Boca Raton (2008). | 2nd edition
2.	**Encyclopedia of Bioprocess Technology. (TextBook)** By Flickinger, M. C. and Drew, S. W. | Wiley- Interscience, New Jersey. (1999).
3.	**Microbial Processes and Products** By Barredo, J. L. | Humana Press, New Jersey. (2005)
4.	**Handbook of Pharmaceutical Biotechnology. (TextBook)** By Gad, S. C. | Wiley-Interscience, New Jersey. (2007)
5.	**Pharmaceutical Microbiology** By W.B. Hugo and A.D. Russel: | Blackwell Scientific publications, Oxford London.
6.	**Pharmaceurcal Biotechnolog- Concepts and Applications (TextBook)** By Walsh, G. | Wiley. (2007)

List of Practical

1.	Introduction ,principle and working of microscopy
2.	Separation of components by HPLC
3.	Demonstration of Electrophoresis
4.	Introduction ,principle and working of Spectrophotometer
5.	Introduction ,principle and working of Centrifuge
6.	To study Thin layer chromatography
7.	Demonstration of SDS
8.	To study Paper chromatography
9.	To study glucose estimation by help of spectrophotometer
10.	Introduction, principle and working of Colorimeter.

Useful Links

1) https://nptel.ac.in/courses/108102191
2) https://www.sanfoundry.com/best-reference-books-instrumentation-instrumental-analysis/
3)https://theinstrumentguru.com/instrumentation-books-pdf-instrumentation-e-books/

Course	Bachelor of Science (B.Sc.)	**Semester - 3**
Type of Course	Ability Enhancement Compulsory Courses	
Prerequisite		
Course Objective	- To develop necessary writing skills used in academics and job - To understand the writing skills for communication - To examine the cv writing and types of letter - To write up the notice agenda and minutes of meetings	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Academic & research writing** Introduction; Importance of academic writing; Basic rules of academic writing, English in academic writing I & II; Styles of research writing	**10**	**25**
2	**Plagiarism** Plagiarism: Introduction; Tools for the detection of plagiarism; Avoiding plagiarism, Literature review: Introduction, Source of literature; Process of literature review, Online literature databases; Literature management tools, referencing and citations	**12**	**25**
3	**Writing** Report writing for an event, CV writing, Job Application, Types of letters- Business letters, Cover letter	**11**	**25**
4	**Notice** Memo, Notice, Agenda, Minutes of Meeting, Business correspondence, How to write emails- do's and don'ts	**11**	**25**
	Total	**44**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Analyze
Weightage	40	40	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Differentiate between various kinds of academic writings.
CO2	enable writing skills for communication
CO3	Build up the cv writing and letter types

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CO4	Analyze the preparation of notice, agenda and minutes of minutes

Reference Books

1.	**Academic Writing, Anti- Plagiarism And Citations (TextBook)** By Vinod Kumar Kanvaria | Shipra Publications
2.	**Academic Writing: A Handbook for International Students (TextBook)** By Stephen Bailey | Routledge
3.	**High School English grammar and composition (TextBook)** By P. C. Wren and H. Martin | S.Chand

Course	Bachelor of Science (B.Sc.)	**Semester - 4**
Type of Course	Core Courses	
Prerequisite	05010102-T - BACTERIOLOGY AND SYSTEMATICS	
Course Objective	• To deliver strong foundation on cell theories, cell types and cellular diversity. • To enable the students to acquire fundamental knowledge about cytoskeleton and organellar function. • To understand the concept of cell division and cell signaling and communication. • To introduce the students to the basics of central dogma of molecular biology and significance of its study. Students understand the chemical and molecular processes that occur in and between the cells • To provide the information about molecular Events of Replication, Transcription and processing of transcripts	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Structure and organization of Cell** Cell Organization –Prokaryotic and eukaryotic (Plant and animal cells) 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 Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus, Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids, Golgi apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes.	**12**	**20**
2	**Cell Signaling and Cell Cycle, Cell Death and Cell Renewal** Signaling molecules and their receptors, Function of cell surface receptors, Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway, 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.	**10**	**20**
3	**Structures and Replication of DNA and RNA / Genetic Material**	**20**	**20**

	DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, and 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. 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.		
4	**Transcription and translation in Prokaryotes and Eukaryotes**	**6**	**20**

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
	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. 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		
5	**Translation (Prokaryotes and Eukaryotes)** 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.	**8**	**20**
	Total	**56**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Understanding	Application
Weightage	40	60

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Understand knowledge of cellular structure and cell organization
CO2	Apply basic knowledge of cell signaling and cell cycle
CO3	Explain the structure of genetic material and its replication process
CO4	Apply basic knowledge of the transcription process in various cell types.
CO5	Apply basic knowledge of translation processes in various cell types.

Reference Books

1. **Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA (TextBook)**

2.	**Cell and molecular biology (TextBook)** By Sheeler Philip | John Wiley | 3rd, Pub. Year 2002
3.	**Cell and Molecular Biology (TextBook)** By Rastogi , S. C | New Age International | 3rd, Pub. Year 2012
4.	**Cell and molecular biology : Concepts and experiments (TextBook)** By Karp, Gerald | 5th, Pub. Year 2006
5.	**Cell Biology (TextBook)** By Singh , S . P | RASTOGI PUBLICATIONS | 10th, Pub. Year 2014
6.	**Cell biology : organelle structure and function (TextBook)** By Sadava David | Panima Publishing Corporation, Pub. Year 2004

List of Practical

1.	Mitosis and the Cell Cycle in Onion Root-Tip Cells
2.	Mitochondria isolation
3.	Preparation of microscope slide for Dicot leaf section
4.	Extraction of Genomic DNA from Rat Blood
5.	Genomic DNA Extraction from Plant Tissue
6.	Characterization of DNA by Spectrophotometric Assay and Melting Temperature (Tm)
7.	Agarose Gel Electrophoresis
8.	Polymerase Chain Reaction (PCR)
9.	Digestion of DNA with Restriction Enzymes
10.	Sanger Sequencing

Course	Bachelor of Science (B.Sc.)	**Semester - 4**
Type of Course	Core Courses	
Prerequisite	05010203-T - BACTERIOLOGY AND VIROLOGY	
Course Objective	1. To Describe the genomic organization of model organization and mutation process 2. To create good knowledge of genetic exchange mechanism 3. To understand the different types of plasmids 4. To do experiment of isolation of DNA and visualization process 5. To define the mapping process by use of recombination method	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Genome Organization and Mutations** Genome organization: E. coli, Saccharomyces 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	**10**	**25**
2	**Plasmids** Plasmids, Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids	**12**	**25**
3	**Mechanisms of Genetic Exchange** 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	**11**	**25**
4	**Transposable elements** 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	**11**	**25**
	Total	**44**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy	
Level	Understanding
Weightage	100

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

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Course Outcomes	
At the end of this course, students will be able to:	
CO1	Understand the organization of genomes in E. coli/Saccharomyces and the types and molecular basis of mutations.
CO2	Classify plasmids, their genetic map, replication and application.
CO3	Discover host range, plasmid-incompatibility and plasmid amplification.
CO4	Discover transformation, conjugation (Hfr and F' strains) and transduction.
CO5	Determine different types of prokaryotic and eukaryotic transposable elements and their mechanisms of transposition.

Reference Books	
1.	**Genetics (TextBook)** By Strickberger Monroe W | PHI Learning | 3rd, Pub. Year 2008
2.	**Genetics (TextBook)** By singh, B.D, | kalyani Publishers | 3ed, Pub. Year 2019
3.	**Genetics (TextBook)** By Gupta P K | 3rd, Pub. Year 2004
4.	**Objective Genetics (TextBook)** By Singh, Phundan | Kalyani Publishers | 4ed.
5.	**A textbook of microbiology (TextBook)** By R C Dubey | Sultan Chand, Pub. Year 2012

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

Course	Bachelor of Science (B.Sc.)	**Semester - 4**
Type of Course	Discipline Specific Elective Courses	
Prerequisite	05010101-T - MICROBIAL WORLD AND PRINCIPLES OF MICROBIOLOGY	
Course Objective	To define antimicrobial agents and their properties To understand the types of disinfectants and antiseptics To explain the cell culture technique To design the aspect area of microbiology To develop practical skills for pharmaceutical products	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	20	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Microbiological assay for pharmaceutical analysis** Antibiotics and Synthetic antimicrobial agents microbial resistance; therapeutic, prophylactic usage and adverse reactions; Antibiotic and Synthetic antimicrobial agents: Mechanism of action of antibiotics Inhibition of cell wall synthesis, nucleic acid and protein synthesis. Β-lactam, aminoglycosides, tetracyclines, macrolides. Antifungal antibiotics: Griseofulvin. Antiviral drugs: Amantidines; Nucleoside analogues, interferons. Peptide antibiotics. Synthetic antibiotics: Sulphonamides Chloramphenicol; Quinolone Bacterial resistance to antibiotics; Penetration of antimicrobial agents (cellular permeability barrier, cellular transport system and drug diffusion).	**15**	**25**
2	**Monitoring microbiological quality** Sources /types of microbial contaminants, assessment of microbial contamination and spoilage. Preservation of pharmaceutical products using antimicrobial agents, and evaluation of microbial stability of formulations.	**5**	**10**
3	**Microbial aspects of pharmaceutical processing** Classification and mode of action of disinfectants. Factors influencing disinfection, antiseptics and their evaluation. For bacteriostatic and bactericidal actions Evaluation of bactericidal & Bacteriostatic agents. Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.	**10**	**20**
4	**Pharmaceutical microbiology**	**15**	**25**

	Designing of aseptic area, laminar flow equipments; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification. Principles and methods of different microbiological assay. Methods for standardization of antibiotics, vitamins and amino acids. Assessment of a new antibiotic and testing of antimicrobial activity of a new substance. Safety profile of drugs (Pyrogenecity, Toxicity –hepato, - nephro, -cardio and -neurotoxicity) ;Toxicological evaluation of drug: LD50, Acute, subacute and chronic toxicity ;Mutagenecity (Ames test, micronucleus test), Carcinogenicity and Teratogenecity		
5	**Cell Culture**	**15**	**20**

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
	Growth of animal cells in culture, general procedure for cell culture, Primary, established and transformed cell cultures. Application of cell cultures in pharmaceutical industry and research. Molecular principles of drug targeting; Drug delivery system in gene therapy.		
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Analyze	Create
Weightage	40	30	15	15

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Define antimicrobial agents, their chemical nature, and mechanism of action and basis of resistance of microbes to these antimicrobials, formulations involving different antimicrobials, stabilization of formulations.
CO2	Explain different types of disinfectants/antiseptics and their specific uses, and evaluation of their bactericidal and bacteriostatic actions; basic knowledge of cell cultures
CO3	Explain the cell culture technique and their application in pharmaceutical industry.
CO4	Design the aspect area and laminar air flow
CO5	Developed practical skills for testing pharmaceutical products for sterility testing and pyrogenicity testing using different methods

Reference Books

1.	**Pharmaceutical Microbiology (TextBook)** By W.B. Hugo and A.D. Russel: | Blackwell Scientific publications, Oxford London.
2.	**A Manual of pharmaceutical biology practical (TextBook)** By S.B.Gokhale, C.K.Kokate and S.P.Shriwastava
3.	**Pharmaceutical Microbiology (TextBook)** By Malcolm Harris, Balliere Tindall and Cox
4.	**Pharmaceutical Microbiology (TextBook)** By Kar Ashutosh. | New Age International Publishers Limited | 1st., Pub. Year 2019

List of Practical	
1.	Microbial Examination of sterile and Non Sterile Products
2.	Microbial Examination of sterile and Non Sterile Products
3.	Test for Confirmation of Labeled LAL Reagent Sensitivity (LAL Test)
4.	Antibiotic Potency Testing
5.	Bioburden Estimation for Medical Devices
6.	Determination of D value, Z value for heat sterilization in pharmaceuticals.
7.	Chemical / Microbiological methods for the determination of Penicillin, Streptomycin, Griseofulvin
8.	Prediction of binding site of macromolecules using MEDsuMo software

Course	Bachelor of Science (B.Sc.)	**Semester - 4**
Type of Course	Generic Elective Courses	
Prerequisite	05010101-T - MICROBIAL WORLD AND PRINCIPLES OF MICROBIOLOGY	
Course Objective	• To Understand the airborne microorganism • To operate the sampling process • To examine the analysis of water, air and soil • To interpret the control of environmental pollution • To understand the chemical and physical parameter of control measure	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Aero- microbiology** Aero- microbiology: Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens.	**12**	**20**
2	**Bioaerosol** Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics	**12**	**20**
3	**Water- microbiology** Water- microbiology: Water borne pathogens, water borne diseases. Sample Collection,Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests	**12**	**20**
4	**Control Measures** Control Measures: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. Precipitation, chemical disinfection, filtration, high temperature, UV light	**12**	**20**
5	**Soil- microbiology** Soil- microbiology: Soil borne pathogens, soil borne diseases, Sampling of soil, sample collection and analysis. Isolation and identification of pathogens. Soil testing methods. Soil treatment	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application	Analyze
Weightage	20	40	20	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Describe the concept of aerosol microbiology
CO2	Execute the sapling process
CO3	Good understanding and skills of the analysis of air, water and soil
CO4	Analysis of water, air and soil contribute to control of environmental pollution.
CO5	Explain the chemical and physical parameter of control measures

Reference Books	
1.	**A text book of microbiology (TextBook)** By Chakraborty P | New Central Book Agency, Pub. Year 2012
2.	**A textbook of microbiology (TextBook)** By R C Dubey
3.	**Agricultural Microbiology (TextBook)** By Rangaswamy, G. "Bagyaraj | 2nd, Pub. Year 1993
4.	**A textbook of microbiology (TextBook)** By R C Dubey | Sultan Chand, Pub. Year 2012
5.	**Experimental Microbiology (TextBook)** By Rakesh J Patel
6.	**Essentials of Practical Microbiology (TextBook)** By Purba Sankar Sastry, Sandhya Bhat K, Pub. Year 2018

List of Practical	
1.	To study the microbiological analysis of air
2.	To study the microbiological analysis of water
3.	To study the microbiological analysis of soil
4.	Isolation of bacteria from contaminated water sample.
5.	Isolation and cultivation of symbiotic and non-symbiotic nitrogen fixing bacteria, Actinomycetes and Fungi (Mucor, Rhizophus, Aspergillus and Penicillium) from soil.
6.	Isolation and cultivation of yeast

Course	Bachelor of Science (B.Sc.)	**Semester - 1**
Type of Course	Ability Enhancement Compulsory Course	
Prerequisite		
Course Objective	• To develop presentation and oratory skills to become ready for job	

Teaching Scheme (Contact Hours)				Examination Scheme				
				Theory Marks		Practical Marks		
Lecture	Tutorial	Lab	Credit	External Mark (T)	Internal Marks (T)	External Mark (P)	Internal Marks (P)	Total Marks
3	0	0	3	70	30			100

SEE *- Semester End Examination,* ***CIA*** *- Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
1	**Unit-1** Interview and Its Types, Preparation for Interview, Do's and Don'ts of Interview, Self-Introduction, Rejections Handling, Selection Tests, Different Types Of Selection Tests.	10	25
2	**Unit-2** Presentation Skills, know Your Audience, Guidelines For An Effective, Presentation, Common Flaws and Overcoming Them, Body Language, Presentation Tips, Group discussion, Debate, Telephone and Email Etiquettes.	12	25
3	**Unit-3** Essential Corporate Communication Skills, Interpersonal Skills, Life 11 25,Management Skills, Negotiation & Conflict Management, Leadership Skills, Teamwork	12	25
4	**Unit-4** Types of business meetings, Fundamentals Of Oral Communication, Ethics in Corporate Communication, Role Of Culture in National & International Communication, Persuasive Communication	11	25
	Total	45	100

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Understanding	Application	
Weightage	80	20	

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Understand the purpose and structure of interviews, grasp the importance of preparation, body language, and communication skill during an interview.

RAI UNIVERSITY AHMEDABAD

CO2	Explain effective techniques for creating and delivering presentation the ability to organize information coherently and technology to enhance presentation
CO3	Apply principle of effective corporate communication in various contexts, demonstrate negotiation skill in a corporate setting and utilize strategies for successful communication and negotiation
CO4	Evaluate the effectiveness of communication strategies in various situation and develop and implement communication plans based on an analysis of communication needs.

Course	Bachelor of Science (B.Sc.)	**Semester - 5**
Type of Course	Core Courses	
Prerequisite	05010404-T - MICROBIOLOGICAL ANALYSIS OF AIR, WATER & SOIL	
Course Objective	• To understand the key features of the physiology and behavior of bacteria. • To understand the underlying mechanisms governing various physiological and metabolic features of prokaryotes. • To provide basic knowledge to deal with the study of genetic, metabolic strategies and ecology of microorganisms. • To understand the energetics and biochemistry of metabolic pathways. • To provide the knowledge of transport mechanisms for the uptake of nutrients, bacterial growth, and the diversity of prokaryotes	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Bacterial growth** 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, facultativeanaerobe),barophilic.	**12**	**20**
2	**Microbial nutrition for growth** Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake.	**12**	**20**
3	**Microbial Physiology** Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradationpathways 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. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), conceptof linear and branched fermentation pathways.	**12**	**20**
4	**Introduction to aerobic and anaerobic chemolithotrophy** 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.	**12**	**20**

5	**Anaerobic respiration** Anaerobic respiration with special reference to dissimilatory nitrate reduction(Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy				
Level	Remembrance	Understanding	Analyze	Evaluate
Weightage	20	50	10	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Define basic concepts of microbial physiology
CO2	Describe the bacterial cell components and its function role in the cell.
CO3	Evaluate the importance of central pathways of carbohydrate metabolism for microbial physiology
CO4	Elaborate on various pathways of fermentation in microbes
CO5	Discuss the classification of chemolithotrophs and phototrophs along with mechanisms of energy production and cellular carbon synthesis.

Reference Books

1.	**Advances in microbial physiology. (TextBook)** By Poole, R. K. (1998). | Academic Press.
2.	**Microbial Processes and Products (TextBook)** By Barredo, J. L. | Humana Press, New Jersey. (2005)
3.	**Essentials of Practical Microbiology (TextBook)** By Purba Sankar Sastry, Sandhya Bhat K, Pub. Year 2018
4.	**Bacterial metabolism (TextBook)** By Gottschalk | Springer

List of Practical

1.	To 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	Bachelor of Science (B.Sc.)	**Semester - 5**
Type of Course	Core Courses	
Prerequisite	05000102-T - ENVIRONMENTAL SCIENCE	
Course Objective	1. To understand the diverse roles and environments of microbes, including soil, water, air, human and animal bodies, and extreme habitats. 2 To explore the processes and microbial involvement in various biogeochemical cycles, such as the carbon, nitrogen, phosphorus, sulfur, iron, and manganese cycles. 3. To examine the history, significance, and developments in microbial ecology, including microbial interactions and their roles in ecosystems. 4. To learn the methods of waste management and the principles of microbial degradation of common pollutants, including pesticides, hydrocarbons, metals, and biosurfactants.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	0	0	4	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction of environment and microbes** • Terrestrial Environment: Soil profile and soil microflora. • Aquatic Environment: Microflora of fresh water and marine habitats • Atmosphere: Aero microflora and dispersal of microbes. • Animal Environment: Microbes in/on human body (microbiomes) & animal (ruminants) body. • Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.	**12**	**20**
2	**Biogeochemical cycles** • 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.	**12**	**20**
3	**Microbial ecology** • History, significance and developments in the field of microbial ecology. Contributions of Beijerinck, Winogradsky, Kluyver, Van Niel, Martin Alexander, Selman A. Waksman Structure and function of ecosystems. Microbial succession in decomposition of plant organic matter. • Biological Interaction: A. Microbe– Microbe Interactions- Mutualism, Synergis, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents. • Microbe–Plant Interactions Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers) • Microbe-Animal Interactions - Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont.	**12**	**20**
4	**Waste Management**	**12**	**20**

	• 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.		
5	**Principles and degradation of common pollutant**	**12**	**20**

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
	• Pesticides • organic (hydrocarbons, oil spills) • Inroganic (metals) matter • Biosurfactants		
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application	Analyze	Create
Weightage	0	60	30	10	0

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Describe the diversity and roles of microbes in various environments, including soil, water, air, human and animal bodies, and extreme habitats.
CO2	Explain the roles of microbes in biogeochemical cycles, including the carbon, nitrogen, phosphorus, sulfur, iron, and manganese cycles.
CO3	Summarize the history, significance, and developments in microbial ecology, including microbial interactions and their roles in ecosystems.
CO4	Apply the methods and processes of solid and liquid waste management, including the stages of sewage treatment.
CO5	Describe the microbial degradation of common pollutants, including pesticides, hydrocarbons, metals, and biosurfactants.

Reference Books

1.	**An introduction to environmental biotechnology (TextBook)** By Wainwright, M. | Springer Verlag, New York., Pub. Year 1999
2.	**De, A. K. (2012), Environmental Chemistry, New Age International Pvt, Ltd, New Delhi (TextBook)** By De, A.K.
3.	**Environmental Biology , (TextBook)** By Agarwal, K.C. 2001 | Nidi Publ. Ltd. Bikaner.
4.	**Environmental Biotechnology Theory and Application (TextBook)** By GARETH M. EVANS AND JUDITH C. FURLONG | WILEY-BLACKWELL | SECOND EDITION
5.	**Environmental Engineering (TextBook)** By A.P. Sincero and G.A. Sincero, | Prentice Hall of India, New Delhi.

6.	**Text Book of Environmental Biotechnology (TextBook)** By Mohapatra, P. K | I K International., Pub. Year 2006

List of Practical	
1.	Qualitative and quantitative examination of water
2.	Qualitative and quantitative examination of sewage
3.	Estimation of soil microflora (Bacteria, yeast and Molds)
4.	Isolation of azotobacter
5.	Isolation of Rhizobium from root nodules
6.	Isolation of phosphate solubilizing microorganism
7.	Estimation of air micro flora
8.	Isolation of Xanthomonas citri from citrus canker
9.	Assessment of Antibiotic Resistance in Environmental Isolates
10.	Assessment of Heavy Metal Tolerance in Environmental Isolates

Course	Bachelor of Science (B.Sc.)	**Semester - 5**
Type of Course	Core Courses	
Prerequisite	05010304-T - ADVANCED INSTRUMENTATION: PRINCIPLES AND APPLICATIONS	
Course Objective	• To complete the module, students will be able to demonstrate a knowledge and understanding of: Antibiotics types, range and production of different types of antibiotics. • To understanding of immune system and development and production of various kinds of vaccines, vitamins and proteins. • To analyze the industry-academic perspective • To describe the various types of fermenter and its application • To learn the various application	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**intrduction of industrial microbiology** Brief history and developments in industrial microbiology. Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn- steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.	**12**	**20**
2	**Types of fermentation** Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (e.g. 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.	**12**	**20**
3	**Down-stream processing** Down-stream processing; Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying. Microbial cells as food. SCP -mushroom cultivation	**12**	**20**
4	**Microbial production of industrial products** Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)- Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12. Enzymes (amylase, protease, lipase) wine, beer.	**12**	**20**
5	**Immobilization** Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase). Role of Microbes in Medicine and textile industry.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy			
Level	Remembrance	Understanding	Application

Weightage	20	50	30

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Understand the ecological and environmental niches where these microbes can be found.
CO2	Apply knowledge of fermentation processes and bioreactor design to real-world industrial applications.
CO3	Understand the principles and applications of precipitation in downstream processing.
CO4	Explore the various uses and applications of these industrial products.
CO5	Explain the advantages of immobilization and its applications in industry.

Reference Books	
1.	**Biotechnology: a textbook of industrial microbiology (TextBook)** By Crueger, Wulf, Anneliese Crueger, Thomas D. Brock, and Thomas D. Brock, Pub. Year 1990
2.	**Basic Industrial Biotechnology (TextBook)** By Reddy SM, Reddy RS, Babu GN | New Age International Publication
3.	**Industrial Microbiology (TextBook)** By Prescott and Dunn 4th edition | , CBS Publishers & Distributors, Delhi
4.	**Industrial Microbiology (TextBook)** By A.H. Patel | Laxmi Publication | 2nd Edition
5.	**Industrial microbiology (TextBook)** By A H Patel | Macmillan Publishers, New Delhi 2012
6.	**Industrial microbiology and biotechnology. Singapore (TextBook)** By Verma, Pradeep, Pub. Year 2022
7.	**Microbiology Industrial Microbiology Tata McGraw Hill edn (TextBook)** By Tata McGraw Hill edn

List of Practical	
1.	Screening of antibiotic producing microorganism
2.	Primary screening of amylase producing microorganisms
3.	Primary screening of protease producing microorganisms
4.	Primary screening of cellulase producing microorganisms
5.	Primary screening of organic acid producing microorganisms
6.	Production of enzymes-amylase, protease and cellulase
7.	Production of ethanol
8.	Production of citric acid
9.	Sugar estimation's by cole methods
10.	Demonstration of working of fermentor

Course	Bachelor of Science (B.Sc.)	**Semester - 5**
Type of Course	Generic Elective Courses	
Prerequisite	05010402-T - MICROBIAL GENETICS	
Course Objective	• To understand the aspects of molecular biology and microbial genetics • To emphasize the concept of genetic material through various process • To understand the concepts of cellular function • To get the knowledge of gene expression • To identify the genetic regulatory mechanism at different levels	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	-	-	100

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Structures of DNA and RNA/Genetic Material** Structures of DNA and RNA/Genetic Material: DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure. Replication of DNA: Bidirectional and unidirectionalreplication,semi-conservative, semi discontinuousreplicationMechanismof DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends.	**12**	**20**
2	**Gene Expression** Gene Expression:Transcription - Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription. Translation - Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides.	**12**	**20**
3	**Regulation of gene Expression** Regulation of gene expression: Principles of transcriptional regulation, regulationat initiation withexamplesfromlacandtrpoperons.Mutation:Mutationsandmutagenesis:Definitionand types of Mutations; Physical and chemical mutagens; Uses of mutations, DNA repair mechanisms	**12**	**20**
4	**Mechanisms of Genetic Exchange** Mechanisms of Genetic Exchange:Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains Transduction - Generalized transduction, specialized transduction.	**12**	**20**
5	**Plasmids and Transposable Elements** Plasmids and Transposable Elements: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.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy				
Level	Remembrance	Understanding	Analyze	Evaluate

Weightage	30	50	20	10

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Understand the molecular aspects of the biology
CO2	Emphasize the concepts of central dogma of molecular biology spanning from DNA Replication till Protein Synthesis and Reverse transcription
CO3	Helps in understanding the concepts of cellular function
CO4	Gain knowledge in gene concepts and genetic code, gene expression, gene regulation and also learn about mutation
CO5	Identify and distinguish genetic regulatory mechanism at different levels

Reference Books	
1.	**Biotechnology-Applying the Genetic Revolution. (TextBook)** By Clark DP and Pazdernik NJ. (2009). | Elsevier Academic Press, USA.
2.	**Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA (TextBook)**
3.	**Genetics (TextBook)** By singh, B.D, | kalyani Publishers | 3ed, Pub. Year 2019
4.	**Neural Networks, Fuzzy logic and Genetic algorithms (TextBook)** By S. Rajasekaran, G. A. Vijayalakshmi Pai | PHI publication
5.	**Objective Genetics (TextBook)** By Singh, Phundan | Kalyani Publishers | 4ed.

List of Practical	
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 re agent) or UV spectrophotometer (A260measurement)
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	Bachelor of Science (B.Sc.)	**Semester - 5**
Type of Course	Core Courses	
Prerequisite		
Course Objective	• To get knowledge about good laboratory practices. • To know the about culture and microscopic methods to determining microbes in food / pharmaceutical samples. • To understand about molecular methods to determine microbes in samples. • To learn about food safety and microbial standards.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

SEE *- Semester End Examination,* ***CIA*** *- Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Microbiological Laboratory and Safe Practices** Microbiological Laboratory and Safe Practices: Good laboratory practices - Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL- 1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration	**12**	**20**
2	**Determining Microbes in Food / Pharmaceutical Samples** Determining Microbes in Food / Pharmaceutical Samples: Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products.	**12**	**20**
3	**Molecular methods to determine microbes in samples** Molecular methods to determine microbes in samples- Nucleic acid probes, PCR based detection, biosensors. Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar.	**12**	**20**
4	**Ascertaining microbial quality** Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)	**12**	**20**
5	**HACCP for Food Safety and Microbial Standards** HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Understanding	Application
Weightage	40	60

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may

vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Apply knowledge of good laboratory practices in practical
CO2	Apply knowledge of culture and microscopic methods to determining microbes in food / pharmaceutical samples.
CO3	Understand molecular methods to determine microbes in samples
CO4	Apply knowledge of by ascertaining microbial quality of milk
CO5	Explain the concept of HACCP for food safety and microbial standards.

Reference Books

1.	**Food microbiology (TextBook)** By Frazier, William C. | McGraw Hill Education (India) Pvt Ltd, New Delhi 2013
2.	**The Food Pharmacy (TextBook)** By Jean Carper, Simon & Schuster
3.	**2000 Functional Foods and Dietary Supplements: Safety, Good Manufacturing Practice (GMPs) and Shelf Life Testing in Essentials of Functional Foods (TextBook)**
4.	**Essentials of food and nutrition (TextBook)** By Swaminathan M | Bappco, Bangalore 2003
5.	**Food and beverage : Management and cost control (TextBook)** By Negi jagmohan | Kanishka, New delhi 1999

Course	Bachelor of Science (B.Sc.)	**Semester - 6**
Type of Course	Core Courses	
Prerequisite	05010404-T - MICROBIOLOGICAL ANALYSIS OF AIR, WATER & SOIL	
Course Objective	• To understand the basic knowledge of immunology with particular reference to the main differences in animal species. • Acquisition of basic knowledge of bio-security and veterinary microbiology with particular reference to the pathogenic activities of bacteria and virology. • The main microbiological and immunological techniques of classical and innovative diagnostics applied in veterinary will be presented. • The course aims to improve the student's skills and critical analysis skills, providing the basis for an experimental design in the field of veterinary microbiology and immunology	

Teaching Scheme (Contact Hours)				Examination Scheme				
				Theory Marks		Practical Marks		
Lecture	Tutorial	Lab	Credit	External Mark (T)	Internal Marks (T)	External Mark (P)	Internal Marks (P)	Total Marks
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	Topics	T	W
1	**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. Collection, transport, and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).	**10**	**20**
2	**List of diseases of various organ systems and their causative agents.** Symptoms, mode of transmission, prophylaxis and control of the diseases caused by Streptococcus pyogenes, Mycobacterium,Haemophilusinfluenzae, tuberculosis, Bacillus anthracis, Clostridium tetani, Treponemapallidum, Clostridium difficile, and the viruses causing Polio, Herpes, Hepatitis, Dengue, AIDS, influenza and Japanese encephalitis.	**10**	**20**
3	**Animal Diseases** Study of animal diseases with respect to etiology, symptoms, mode of transmission, prophylaxis and control: FMD, swine flu, bird flu, Rabies, bovine tuberculosis, Marek's, ranikhet, brucellosis, distemper.	**10**	**20**
4	**Mycoses** Cutaneous mycoses: Tineapedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis. Occurrence, habitat, morphology and reproduction of Protozoa. Structure and reproduction of important Protozoans-Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma and Plasmodium.	**10**	**20**
5	**Immune system**	**10**	**20**

	Structure and function of the cells, tissues and organs of immune system. Types of immunity - Humoral and cell-mediated, innate, acquired immunity. Complement system – function and pathways. Antigens and Antibodies: types, properties. Haptens, adjutants, Immunoglobulins: Structure types, Properties and their function - Theory of antibody production. Antigen-Antibody Interactions, Agglutination, Precipitation, Complement fixation test. Hypersensitivity reactions; IgE mediated Type I Hypersensitivity, Antibody-mediated cytotoxic (Type II) Hypersensitivity, Immune complex mediated (Type III) Hypersensitivity, DTH mediated (Type IV) Hypersensitivity.		
		Total	**50**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application	Analyze
Weightage	25	45	15	15

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Understood the basic and general concepts of causation of disease by the pathogenic microorganisms and the various parameters of assessment of their severity including the broad categorization of the methods of diagnosis.
CO2	Developed a thorough understanding of common bacterial, viral, fungal, parasitic diseases of human being including some very important diseases of the animals also.
CO3	Conceptualized the protective role of the immune system of the host and developed an understanding of the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms.
CO4	Are able to conduct experiments for growing common bacteria in different microbiological media, antibiotic sensitivity determination and antigen antibody reaction (precipitation test in the agarose).
CO5	Enlist the different types of animal diseases.Enlist the different types of animal diseases.

Reference Books

1.	**Microbiology** By Michel J Pelczar Jr. | Tata MacGraw Hill, New Delhi 1991
2.	**Microbiology** By Michel J Pelczar Jr. | Tata MacGraw Hill, New Delhi 1991
3.	**Microbiology** By Michel J Pelczar Jr. | Tata MacGraw Hill, New Delhi 1991
4.	**Immunology and immunotechnology** By Ashim K. Chakravarty | Oxford university press, New Delhi 2012
5.	**Immunology and immunotechnology** By Ashim K. Chakravarty | Oxford University Press, New Delhi 2015
6.	**Industrial microbiology** By A H Patel | Macmillan Publishers, New Delhi 2012
7.	**Industrial microbiology** By A H Patel | Macmillan Publishers, New Delhi 2012
8.	**A textbook of microbiology** By R C Dubey | Sultan Chand, Pub. Year 2012

9.	**Practical microbiology** By Dubey R C | Sultan Chand, Pub. Year 2008
10.	**Food microbiology** By Frazier, William C. | McGraw Hill Education (India) Pvt Ltd, New Delhi 2013
11.	**Basic Immunology : Functions and disorders of the immune system** By Abbas, Abul K. | Publisher Information : Elsevier, Philadelphia 2014

List of Practical

1.	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, chickenpox, HPV warts, AIDS (candidiasis), dermatomycoses (ringworms).
7.	Study of various stages of malarial parasite in RBC using permanent mounts.
8.	Blood Group test
9.	Isolation of fungus

Course	Bachelor of Science (B.Sc.)	**Semester - 6**
Type of Course	Core Courses	
Prerequisite	05010404-T - MICROBIOLOGICAL ANALYSIS OF AIR, WATER & SOIL	
Course Objective	• To get the important knowledge of food safety, production, processing, preservation, and storage. • To describe the microbes such as bacteria, molds, and yeasts are employed for the foods production and food ingredients such as production of wine, beer, bakery, and dairy products. • To understand the current trends and concepts related to Microbiology of food and other dairy products. Gives an insight into various types of food borne diseases and their prevention • To understand the current trends and concepts related to Microbiology of food and other dairy products. Gives an insight into various types of food borne diseases and their prevention	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**History of Agricultural Microbiology** History of Agricultural Microbiology; Microbes and their importance in maintenance of soil, Biogeochemical cycles, role of microbes in maintaining the fertility of soil. Bio fertilizers – Bacterial, - Azotobacter and vermiform compost. Soil microorganism -association with vascular plants- phyllosphere, Rhizobium, Rhizoplane associative nitrogen fixation. BiofertilizersCyanobacterial and Azolla.	**12**	**20**
2	**Food microbiology** Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Principles of food preservation: temperature, canning, drying, irradiation, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, citrates, benzoates,nitrite and nitrates etc.	**12**	**20**
3	**Dairy microbiology** 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. Utilization and disposal of dairy by-product – whey.	**12**	**20**
4	**Food borne diseases** Food borne diseases (causative agents, foods involved, symptoms and preventive measures)- 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.	**12**	**20**
5	**Food sanitation and control** Food sanitation and control; HACCP, Indices of food sanitary quality and sanitizers. Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. Genetically modified foods, Nutraceuticals, Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases].	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy				
Level	Remembrance	Understanding	Application	Analyze
Weightage	30	50	10	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes

At the end of this course, students will be able to:	
CO1	Developed a clear understanding of the multifarious roles of microorganisms in soil, in association with plants and thus in the field of agriculture.
CO2	Are able to describe the role of microorganisms in the production of food, its spoilage, including their role in homemade fermented foods.
CO3	Are able to identify the role of microorganisms in the causation of the diseases and how to protect against food-borne pathogens.
CO4	Developed experimental skills for testing the milk and different foods for the presence of microorganisms.

Reference Books

1.	**Food and beverage costing** By Negi jagmohan | Himalaya Publishing House, New delhi 2001
2.	**Applied dairy microbiology.** By Marth, Elmer H | Marcel Dekker, New York 2001
3.	**Food microbiology** By Frazier, William C. | McGraw Hill Education (India) Pvt Ltd, New Delhi 2013
4.	**Food Microbiology** By Frazier, William C. | McGraw Hill Education (India) Private Limited, New Delhi 2014
5.	**Fundamentals Of Agriculture** By Katyayan, Arun, | Kushal Publications and Distributors , Varanasi: 2019
6.	**An introduction to Food and beverage Studies** By Magris Marzia | Global books, New delhi 2001
7.	**Essentials of food and nutrition** By Swaminathan M | Bappco, Bangalore 2003

List of Practical

1.	MBRT of milk samples and their standard plate count
2.	Alkaline phosphatase test to check the efficiency of pasteurization of milk
3.	Isolation of any foodborne 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	Bachelor of Science (B.Sc.)	**Semester - 6**
Type of Course	Core Courses	
Prerequisite	05010504-T - MICROBIAL GENETICS AND MOLECULAR BIOLOGY	
Course Objective	• To understand the knowledge of basics genomes • To remember the concept of basic structure of bacterial genomics, bacterial genomics , viral genomics • To analyze and predict the bacterial diversity of genome structure. • To create research work on both the Bacteria and Archaea domains as model systems and understand the physiological processes such as growth and metabolism.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

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Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Evolution of Microbial Genomes** 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.	**12**	**20**
2	**Metagenomics** Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using Metagenomics Basic knowledge of viral metagenome, meta transcriptomics, metaproteomics and metabolomics.	**12**	**20**
3	**Molecular Basis of Host-Microbe Interaction** 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.	**12**	**20**
4	**Systems and Synthetic Biology** Networking in biological systems, Quorum sensing in bacteria, Coordinated regulation of bacterial virulence factors, Basics of synthesis of polio virus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses.	**12**	**20**
5	**Microbiomes and importance of microbial communities** Microbiomes and importance of microbial communities, VBNC (viable but not culturable bacteria). Genetically modified organisms and their uses. Modern methods of rapid identification of microbes (PCR, mass spectrometry, fluorescence based techniques). CRISPR-Cas system.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy			
Level	Remembrance	Understanding	Create

Weightage	30	60	10

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Can explain salient characteristics of genomes of representative microorganisms.
CO2	Have understood the concept and importance of metagenomics.
CO3	Have developed an initial understanding of recent developments of host-microbe interactions, synthetic biology, viable but non-culturable forms of microorganism etc.
CO4	Are able to extract DNA from bacteria / soil and perform PCR for 16s Ribosomal genes using universal primers and interpret the results

Reference Books	
1.	**Advanced Accountancy** By S. N. Maheshwari | Vikas Publishing House
2.	**Advanced accountancy** By Gupta R L | S Chand, New Delhi 2003
3.	**Advanced accountancy Vol II** By Maheshwari S N | Vikas Publishing House, New Delhi 2004
4.	**Textboook of Microbiology** By Dubey R.C. Maheshwari D.K. | S. Chand, Pub. Year 2018
5.	**Advanced cost and management accounting** By Saxena V K | Sultan Chand & Sons, New Delhi 1996
6.	**Advanced economic theory** By Ahuja H L | S Chand, New Delhi 1970
7.	**Advanced engineering mathematics** By Mishra V P | V P Mishra Publishers, New Delhi 2009
8.	**Advanced learner's dictionary of management** By A Team of Experts | Anmol Publishers, New Delhi 2000
9.	**Advanced management accounting** By Kaplan Robert S | PEarson, New Delhi 1998

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

Course	Bachelor of Science (B.Sc.)	**Semester - 6**
Type of Course	Generic Elective Courses	
Prerequisite	05010402-T - MICROBIAL GENETICS	
Course Objective	• To understand the information about the tools and methods for genetic engineering • To illustrate the creative use of modern tools and techniques for the manipulation and analysis of genomic sequences. • To expose students to the application of recombinant DNA technology in biotechnological research. • To explain the cloning techniques.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	2	5	70	30	50	-	150

***SEE** - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)*

Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Introduction to genetic engineering** 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 deoxynucleotidyltransferase, kinases and phosphatases, and DNA ligases.	**12**	**20**
2	**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.	**12**	**20**
3	**Cloning Vectors** Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Expression vectors: E.colilac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.	**12**	**20**
4	**DNA Amplification and DNA sequencing** DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR Genomic and cDNA libraries: Preparation and uses, Genome sequencing Sanger'smethod of DNA Sequencing: traditional and automated sequencing.	**12**	**20**
5	**Application of Genetic Engineering and Biotechnology** Application of Genetic Engineering and Biotechnology: 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, flavosavo tomato, Gene therapy, recombinant vaccine, protein engineering.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application

Weightage	30	60	10

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Has acquired a fairly good knowledge of the tools and methods for genetic engineering.
CO2	Has acquired a fairly good understanding of how these tools and methods are employed in the laboratory for the manipulation of DNA so as to make it relevant for biotechnological uses.
CO3	Having the ability to understand the application of genetic engineering technology
CO4	Having the ability to gain knowledge of cloning techniques.

Reference Books	
1.	**Advanced engineering mathematics** By Mishra V P | V P Mishra Publishers, New Delhi 2009
2.	**Elements of engineering mathematics -I** By V P Mishra and Jyoti Mishra | S K Kataria and Sons, New Delhi 2011
3.	**Elements of engineering mathematics -III** By V P Mishra and Jyoti Mishra | S K Kataria and Sons, New Delhi 2011
4.	**Textbook of engineering thermodynamics** By Rajput, R. K. | Laxmi Publication, Bangalore 2014
5.	**A text book of elements of mechanical engineering** By Katariya H G | Books India Publications, Ahmedabad 2012
6.	**Higher Engineering Mathematics** By Dr. B. S. Grewal
7.	**Automobile engineering : vol.2Singh** By Singh, Kirpal | Standard Publishers Distributors, Delhi 2011
8.	**Automobile engineering - I** By Singh, Kirpal | Standard Publishers Dist., Delhi 2013
9.	**Mechanical engineering : Convetional and objective** By Khurmi R S | Sultan Chand, New Delhi 2014
10.	**A text book of engineering mechanics** By Khurmi R S | Sultan Chand, New Delhi 2013
11.	**Engineering Mechanics** By Rethaliya, R. P. | Atul prakashan, Ahmedabad

List of Practical	
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

Course	Bachelor of Science (B.Sc.)	**Semester - 6**
Type of Course	Skill Enhancement Courses	
Prerequisite	05010403-T - PHARMACEUTICAL MICROBIOLOGY	
Course Objective	• To describe pre-examination procedures applicable to diagnostic microbiology. • To explain post-examination procedures applicable to diagnostic microbiology. • To perform standard microbiological staining techniques. • To discuss the correct culture set up and incubation of microbial specimens. • To interpret the results of microbial cultures, stains, or tests.	

Teaching Scheme (Contact Hours)				**Examination Scheme**				
				Theory Marks		**Practical Marks**		
Lecture	**Tutorial**	**Lab**	**Credit**	**External Mark (T)**	**Internal Marks (T)**	**External Mark (P)**	**Internal Marks (P)**	**Total Marks**
4	-	-	4	70	30	-	-	100

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Course Content

T - Teaching Hours | **W** - Weightage

Sr.	**Topics**	**T**	**W**
1	**Importance of Diagnosis of Diseases:** Importance of Diagnosis of Diseases:Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.	**12**	**20**
2	**Collection of Clinical Samples** Collection of Clinical Samples :How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.	**12**	**20**
3	**Direct Microscopic Examination and Culture** Direct Microscopic Examination and Culture.Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsastained thin blood film for malaria. Preparation and use of culture media Blood agar, Chocolate agar, Lowen stein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.	**12**	**20**
4	**Serological and Molecular Methods** Serological and Molecular Methods:Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Kits forRapid Detection of Pathogens:Typhoid, Dengue andHIV, Swine flu.	**12**	**20**
5	**Testing for Antibiotic Sensitivity in Bacteria** Testing for Antibiotic Sensitivity in Bacteria: Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.	**12**	**20**
	Total	**60**	**100**

Suggested Distribution Of Theory Marks Using Bloom's Taxonomy

Level	Remembrance	Understanding	Application
Weightage	20	60	20

NOTE : This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes	
At the end of this course, students will be able to:	
CO1	Identify diseases of various human body systems & importance of diagnosis.
CO2	Understand the concept of collection of clinical samples & methods of transport.
CO3	Apply knowledge by examination of clinical samples through staining and culturing methods
CO4	Explain the concept of serological and molecular methods and antibiotic sensitivity and resistant
CO5	Describe the concept of antibiotic sensitivity and resistant.

Reference Books

1. **Catering for health**
   By Rees robert | DH, Norwich 2002
2. **The health of the nation- a policy assessed**
   By Swales john | The stationary office, London 1998
3. **Public finance**
   By Bhatia H L | Vikas Publishing House, New Delhi 2004
4. **Dianetics : the modern science of mental health**
   By Hubbard L Ron | Hubbard, Denmark
5. **Microbial ecology : fundamentals and applications**
   By Ronald M Atlas | Pearson Education, New Delhi 2009
6. **Industrial Safety**
   By Rao S.S, | Khanna Publishers, Delhi: 2019
7. **Anatomy and Physiology in Health and Illness**
   By Kathleen J.W. Wilson | Churchill Livingstone, New York
8. **Elements of Human Anatomy & Physiology & Health Education**
   By Goyal.R.K, | B.S.Shah Prakashan, Ahmedabad: 2019
9. **Management of public relations and communication**
   By sengupta sailesh | Vikas pub House, New delhi 2003