| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 1** |
| **Type of Course** | Ability Enhancement Compulsory Courses | |
| **Prerequisite** | | |
| **Course Objective** | 1. To provide an overview of Prerequisites to Communication.<br>2. To put in use the basic mechanics of Grammar.<br>3. To provide an outline to effective Organizational Communication.<br>4. To underline the nuances of Business communication. | |

| **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 | 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** | **English grammar**<br>• Parts of speech<br>• Clauses<br>• Formation of sentence<br>• Tenses | **8** | **25** |
| **2** | **Business Communication**<br>• Concept of business communication & business correspondences<br>• Classification of communication – interpersonal, intrapersonal, Oral, written, non-verbal, etc.<br>• Principles of effective writing<br>• Introduction to business letters | **7** | **25** |
| **3** | **Introduction To Soft Skills**<br>• Meaning, introduction to soft skills & hard skills<br>• Interdependence and differences between soft skills & hard skills<br>• Merits of possessing soft skills<br>• Significant Soft skills and ways to develop Soft skills such as Time Management & Stress Management | **8** | **25** |
| **4** | **Presentation Skill**<br>• Presentation styles<br>• Structure and guideline for making a presentation<br>• Common flaws and overcoming them<br>• Body language and tips for giving a presentation & Presentation tips<br>• Personality development<br>• Interview Skills: Gestures, Body Languages, Pre-interview preparation, Do & Don't at Interview | **7** | **25** |
| | **Total** | **30** | **100** |

| **Suggested Distribution Of Theory Marks Using Bloom's Taxonomy** | | | | |
|---|---|---|---|---|
| **Level** | Remembrance | Understanding | Analyze | Create |
| **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 | Apply Verbal and Non-Verbal Communication Techniques in the Professional Environment. |
| CO2 | Write correctly and properly with special reference to Letter writing. |
| CO3 | Prepare and present effective presentations aided by ICT tools. |
| CO4 | Contribute positively to the overall growth of the organization. |

**Reference Books**

| | |
|---|---|
| 1. | **High School English Grammar & Composition**<br>By Wren & Martin \| Blackie |
| 2. | **High School English Grammar & Composition**<br>By Wren Martin \| Tata McGraw Hill |
| 3. | **Learn English vocabulary at a Glance**<br>By Dr. RakeshBharadwaj \| Evincepub Publishing |
| 4. | **High School English Grammar & Composition**<br>By Wren & Martin \| Blackie |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 1** |
| **Type of Course** | Ability Enhancement Compulsory Courses | |
| **Prerequisite** | | |
| **Course Objective** | To enable the students to make use of the tools of biostatistics to solve microbiological problems.<br>To describes the basic theory in central value measure.<br>To perform test of significance and find how much significant a value.<br>To deal correlation and regression analysis. | |

| **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 | 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 | **Basic definitions and applications, Sampling**<br>Basic definitions and applications, Sampling: Representative sample, sample size, sampling bias and sampling techniques, Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, Graphical representation by histogram, polygon, Curves and pie diagram. | **10** | **20** |
| 2 | **Measures of central tendency**<br>Mean, Median, Mode. Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of Karl-Parsons co-efficient of correlation. Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. | **10** | **15** |
| 3 | **Tests of significance**<br>Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poison and normal (only definitions and problems). Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test, correlation coefficient. | **10** | **15** |
| 4 | **Correlation**<br>Introduction, Types of Correlation, Simple Correlation Coefficient for ungrouped data, Properties and Interpretation of Correlation Coefficient, Coefficient of determination, Scatter diagram, Standard Error, Probable error of Correlation Coefficient. Rank correlation, Definition, Regression lines and Regression Coefficients, Properties of Regression Coefficients. | **15** | **20** |
| | **Total** | **45** | **70** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| **Level** | Understanding | Application | Analyze |
|---|---|---|---|
| **Weightage** | 20 | 25 | 25 |

*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.*

RAI UNIVERSITY AHMEDABAD

| **Course Outcomes** | |
|---|---|
| **At the end of this course, students will be able to:** | |
| CO1 | Apply the basic scientific knowledge behind the statistical analysis in problems. |
| CO2 | To illustrate the principles behind advanced biostatics manual and computational techniques forstudying microbiological problems. |
| CO3 | To solve problems related to unknown variable using regression analysis. |
| CO4 | Systematically test scientific problems related specifically to test significance using various testmethods. |
| CO5 | Competent to compare a correlation and regression analysis with examples. |

| **Reference Books** | |
|---|---|
| 1. | **Fundamental of Biostatistics**<br>By Khan \| Ukaaz Publications |
| 2. | **Biostatistics**<br>By Daniel \| John Wisley and sons |
| 3. | **Introduction to biostatistics and research methods**<br>By PSS Sundar Rao and J Richard |
| 4. | **Biostatistical Methods**<br>By Lachin \| Willey |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 1** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | | |
| **Course Objective** | 1) To understand the scope, history and role of microorganisms.<br>2) To provide students with an understanding of general microbiology, contribution of microbiology to human life for various daily needs.<br>3) To use in health care for prevention of diseases, diagnosis, sterilization methods and controlling agents.<br>4) To extend the knowledge into bioremediation, production of alcohol, agriculture, bio pesticides.<br>5) To provide knowledge about morphology, reproduction, and characteristics of microbes. | |

| **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 | 4 | 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** | **The Discovery of Microorganisms**<br>The Discovery of Microorganisms. The Conflict over Spontaneous Generation. The Role of Microorganisms in Disease. Members of the Microbial World. The Scope and Relevance of Microbiology. The Future of Microbiology. | **10** | **20** |
| **2** | **General features of microorganisms**<br>General features of microorganisms- Bacteria, Algae, Fungi and Protozoa. Classification of bacteria; Bacterial growth and metabolism. Microbes in Extreme Environment – Special features of the thermophilic, methanogenic and halophilic achaea; Photosynthetic bacteria, Cyanobacteria; microbes in other extreme conditions – deep ocean, and space. | **15** | **30** |
| **3** | **Control of microorganisms by physical and chemical agents**<br>Definition of frequently used terms. Conditions influencing the effectiveness of antimicrobial agent activity. The use of physical methods in control: heat, low temperatures, filtration, radiation. The use of chemical agents in control: phenolic, alcohols, halogens, heavy metals, aldehydes, sterilizing gases. | **20** | **25** |
| **4** | **Scope of Microbiology**<br>Cycle of matter in nature. Microbial interactions- mutualism, symbiosis, commensalisms, predation, parasitism, ammensalism, competition. Microbes in composting, bio pesticides, bioremediation, bioleaching, SCP, microbial enzymes and fermented foods. Human diseases and their causative agents. Definition of aero-microbiology, airborne pathogens and allergens. | **15** | **25** |
| | **Total** | **60** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| **Level** | Remembrance | Understanding | Analyze |
|---|---|---|---|
| **Weightage** | 20 | 20 | 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.*

RAI UNIVERSITY AHMEDABAD

| Course Outcomes | |
|---|---|
| **At the end of this course, students will be able to:** | |
| CO1 | Outline the historical development of microbiology, from its earliest beginnings to the current state. |
| CO2 | Identify and describe the different structures and organs that contribute to the organisms form and function. |
| CO3 | Evaluate the effectiveness of different antimicrobial agents and methods under various conditions. |
| CO4 | Categorize of industrial uses of microorganisms in bioremediation, bioleaching and bio pesticides. |
| CO5 | Understanding of interactions between microorganisms, including symbiosis, competition and predation. |

| Reference Books | |
|---|---|
| 1. | **Principles of Microbiology**<br>By R.M.Atlas, , Wm.C \| Brown Publications |
| 2. | **Foundations in Microbiology**<br>By K.Talaro and A.Talaro. Wm.C \| Brown Publications |
| 3. | **Fundamentals of Microbiology**<br>By Alcomo, I.E. \| VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts. Pub. Year 2001 |
| 4. | **Microbiology-Principles and Applications**<br>By J.G.Black, John Wiley & Sons \| Newyork |
| 5. | **Microbiology : an introduction**<br>By Tortora Gerard J \| Pearson \| 9th, Pub. Year 2008 |

| List of Practical | |
|---|---|
| 1. | Familiarity with equipment and apparatus |
| 2. | Methods of isolation, purification and maintenance of microorganisms |
| 3. | Staining techniques in bacteria |
| 4. | To study cultivation and isolation of yeast. |
| 5. | Study of cultural and morphological characteristics of microorganisms. |
| 6. | Effect of physical agents on microorganisms |
| 7. | Effect of chemical agents on microorganisms |
| 8. | Degradation of para nitro phenol. |
| 9. | To study settling plate technique for air micro flora |
| 10. | Isolation and identification of extremophiles |

| Useful Links |
|---|
| 1) https://dth.ac.in/medical/courses/Microbiology/block-1/1/index.php<br><br>2) https://onlinecourses.swayam2.ac.in/cec19_bt11/preview |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 1** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | 05010202-T - MICROBIAL TECHNIQUES & INSTRUMENTS | |
| **Course Objective** | 1) To understand detail concept of microscopy, types of microscopes and application.<br>2) To understanding of techniques used in identification of various types of microorganisms<br>3) To understand different instruments and methods used in microbiology branch.<br>4) To implement knowledge of the various techniques used in field of microbiology. | |

| **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 | **Unit No.1**<br>General knowledge of principles involved in various types of microscopy. The Light Microscope: The Bright-Field Microscope, Microscope Resolution, The Dark-Field Microscope, The Phase-Contrast Microscope, The Fluorescence Microscope, Electron Microscopy: The Transmission Electron Microscope, Specimen Preparation, The Scanning Electron Microscope. Newer Techniques in Microscopy: Confocal Microscopy, Scanning Probe Microscopy | **10** | **20** |
| 2 | **Unit No.2**<br>Methods of sterilization: principles and their limitations, Concept of containment facility, sterilization at industrial level. Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Microscopic identification characteristics, staining methods – simple staining, differential staining, structural staining and special staining methods. Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropic media: basal, defined, complex, enrichment, selective, differential, maintenance and transport media Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, drying, glycerol cultures, freeze-drying (lyophilization). Advantages and disadvantages of each method. Bacterial nutrition and growth kinetics | **20** | **40** |
| 3 | **Unit No.3**<br>Principles, Laws of absorption and radiation. Visible, ultraviolet, infrared and mass spectrophotometry. Absorption spectra, fluorescence flame photometry, NMR, ESR, Principles of colorimetry, Turbidometry, Viscometry. Determination of size, shape and molecular weight of macromolecules – osmotic pressure, flow birefringence, optical rotatory dispersion. Light scattering, diffusion, sedimentation and X-ray diffraction. | **15** | **20** |
| 4 | **Unit No.4**<br>Principles of Centrifugation – Centrifugation techniques-preparative and analytical methods, density gradient centrifugation. General principles and applications of chromatography – Paper, Column, Thin layer, Gas, Ion exchange, Affinity chromatography, HPLC, FPLC and Gel filtration. Electrophoresis – moving boundary, zone (Paper Gel) electrophoresis. Immunoelectrophoresis. Immunoblotting. Isoelectric focusing, 2-D electrophoresis | **15** | **20** |
| | **Total** | **60** | **100** |

| Suggested Distribution Of Theory Marks Using Bloom's Taxonomy | | | |
|---|---|---|---|
| **Level** | Remembrance | Understanding | Application |
| **Weightage** | 20 | 40 | 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 | Understand general knowledge of principles involved in various types of microscopy |
| CO2 | Apply knowledge of methods like sterilization, culture methods and staining methods inmicrobiology. |
| CO3 | Apply knowledge of media, preservation of cultures and nutrition and growth kinetics of bacteria. |
| CO4 | Define the principles of absorption, radiation and their techniques and determination of size,shape and molecular weight of molecules. |
| CO5 | Explain concept of centrifugation, chromatography and electrophoresis methods used inmicrobiology. |

**Reference Books**


| | |
|---|---|
| 1. | **Prescott, Harley and Klein's Microbiology.**<br>By Willey JM, Sherwood LM, and Woolverton CJ. (2008). \| McGraw Hill Higher Education \| 7th edition |
| 2. | **Microbiology**<br>By Michel J Pelczar Jr. \| Tata MacGraw Hill, New Delhi 1991 |
| 3. | **Brock biology of microorganisms.**<br>By Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J. \| Prentice-Hall, Pub. Year 2003 |
| 4. | **General Microbiology**<br>By Singh,R.P \| KalyaniPublishers, NewDelhi (2007) |
| 5. | **A Text Book of Microbiology (TextBook)**<br>By P. Chakraborthy |
| 6. | **Microbiology**<br>By G.J.Tortora, B.R.Funke and C.L. Case, Addison Wesley Longman Inc. \| Harlow : Pearson |
| 7. | **Principles of Microbiology**<br>By R.M.Atlas, , Wm.C. \| Brown Publications |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 1** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | Basic knowledge regarding different microorganisms and their morphological, metabolical features. \| 06010101-T - GENERAL MICROBIOLOGY | |
| **Course Objective** | 1 To provide knowledge of virology and taxonomy.<br>2 To Aware viral infection, vectors and different virion particles.<br>3 To design different list of symptoms regarding viral infections for precaution.<br>4 To meet the industrial requirement for prevention of viral infection in materials.<br>5 By analyzing structure and morphology, students can make strategy for research on vaccine development. | |

| **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 | 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** | **The Viruses: Introduction and General Characteristics**<br>Early Development of Virology. General Properties of Viruses. Isolation, identification and determination of titer of viruses. Structural organization and chemistry of viruses: Virion Size, General Structural Properties, Helical Capsids, Icosahedral Capsids, Nucleic Acids, Viral Envelopes and Enzymes. Principles of Virus Taxonomy | **25** | **15** |
| **2** | **The Viruses: Bacteriophages**<br>Classification of Bacteriophages. Reproduction of Double-Stranded DNA Phages: The Lytic Cycle. Reproduction of Single-Stranded DNA Phages. Reproduction of RNA Phages. Temperate Bacteriophages and Lysogenic | **25** | **15** |
| **3** | **The Viruses: Viruses of Eukaryotes**<br>Classification of Animal Viruses. Reproduction of Animal Viruses. Cytocidal Infections and Cell Damage. Persistent, Latent, and Slow Virus Infections. Viruses and Cancer. Plant Viruses. Viruses of Fungi and Algae. Viroid and Prions. | **25** | **15** |
| **4** | **Viral Diseases**<br>Airborne Diseases: Chickenpox (Varicella) and Shingles (Zoster), Influenza (Flu), Measles (Rubella), Smallpox (Variola). Arthropod-Borne Diseases: Colorado Tick Fever, Yellow Fever. Direct Contact Diseases: Acquired Immune-Deficiency Syndrome (AIDS), Cold Sores, Common cold, Rabies, Viral Hepatitis's. Food-Borne and Waterborne Diseases: Gastroenteritis (Viral), Hepatitis A, Hepatitis E, Poliomyelitis. Slow Virus and Prion Diseases. Other Diseases: Warts | **25** | **15** |
| | **Total** | **100** | **60** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| **Level** | Remembrance | Understanding | Analyze | Create |
|---|---|---|---|---|
| **Weightage** | 20 | 20 | 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 | Create an original homework by listing different symptoms of viral infection for diagnosis. |
| CO2 | Differentiate different pattern of virus infection. |
| CO3 | Relate virology with other subjects like medical microbiology in context of mode of infection of virus. |
| CO4 | Illustrate classification of different phages. |
| CO5 | Determine transmission and cultivation of virus. |

| Reference Books | |
|---|---|
| 1. | **Principles of Virology, Molecular biology, Pathogenesis and Control.**<br>By Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). \| ASM press Washington DC \| 2nd edition. |
| 2. | **Introduction to Modern Virology:**<br>By Dimmock et al. \| Blackwell Sci.Publication \| 5th edition |
| 3. | **Basic Virology**<br>By Waginer and Hewelett \| Black Well Science Publication 2009 |
| 4. | **Medical Virology**<br>By D.O. White & F.J. Fenner, \| Academic press. \| 4th Edition, |
| 5. | **Encyclopedia of Virology Vol I, II, III,**<br>By R.G.Webster and Allan Granoff \| Academic Press, Pub. Year 1994 |
| 6. | **Plant viruses.**<br>By M.V.Nayudu \| Prentice Hall Publication, Pub. Year 2006 |

**Useful Links**

1 https://onlinecourses.swayam2.ac.in/cec21_bt18/preview
2 https://alison.com/course/basics-of-virology
3 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7150003/
4 https://niv.icmr.org.in/

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 1** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | Knowledge about microbes | |
| **Course Objective** | 1) To develop in depth knowledge of microbial diversity, population and community<br>2) To learn about air and water microorganisms and their Sampling techniques.<br>3) To get knowledge of analysis of wastewater and their treatment<br>4) To understand role of Microorganisms in geochemical cycle, bioremediation, bio-degradation, bio deterioration | |

| **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 | - | 2 | 4 | 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 Diversity**<br>Introduction, abundance, ecological niche. Conventional and molecular methods of studying microbial diversity. Microbial population and community interactions. Culturable and Unculturable bacteria. Extremophiles. | **10** | **20** |
| **2** | **Microbiology of Air and water**<br>Sources and types of microorganisms in air. Sampling techniques for microbial populations. Air pollution. Significance of air borne microorganisms in human and plant diseases. Water environment Types of microorganisms in water. Sampling techniques for microbial population in water. Water pollution. Algal blooms, eutrophication, indicators of excreted pollutants. Important water borne diseases of man | **15** | **40** |
| **3** | **Waste water**<br>Definition of waste water. Types of wastewater. Bacteriological analysis of wastewater. Chemical tests for dissolved oxygen, chloride, BOD and COD. Primary, secondary and tertiary treatment of waste-water. | **10** | **20** |
| **4** | **Microbial Ecology**<br>Microorganisms and transformations involved in the major geochemical cycles in marine, freshwater and terrestrial ecosystem. Bioremediation. Bio-degradation. Bio-deterioration | **10** | **20** |
| | **Total** | **45** | **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 concept of microbial diversity, population and community |
| CO2 | Apply the concept of air microorganisms and their Sampling techniques. |
| CO3 | Apply the concept of microorganisms in water and their sampling technique. |
| CO4 | Apply the knowledge of analysis of wastewater and their treatment |
| CO5 | Understand role of Microorganisms in geochemical cycle, bioremediation, bio-degradation, bio deterioration |

## Reference Books


| | |
|---|---|
| 1. | **Text Book of Environmental Biotechnology**<br>By Mohapatra, P. K \| I K International. Pub. Year 2006 |
| 2. | **Environmental Biotechnology. Principles and applications.**<br>By Rittman, B. E., and McCarty, P. L. \| McGraw-Hill, Pub. Year 2001 |
| 3. | **Environmental Biotechnology**<br>By Scragg, A. H. \| Oxford University of Press., Pub. Year 2005 |
| 4. | **An introduction to environmental biotechnology**<br>By Wainwright, M. \| Springer Verlag, New York. Pub. Year 1999 |
| 5. | **Biodegradation and Bioremediation,**<br>By Alexander, M. \| Academic Press. Pub. Year 1994 |


## List of Practical

| | |
|---|---|
| 1. | Isolation of acidophiles |
| 2. | Isolation of alkaliphiles |
| 3. | Isolation of psychrophiles |
| 4. | Isolation of thermophiles |
| 5. | Study of air borne microorganisms using various methods |
| 6. | Study of microbial contaminants from water and waste water |
| 7. | Estimation of DO |
| 8. | Estimation of BOD |
| 9. | Estimation of COD |
| 10. | Actinomycetes isolation for lingo-cellulose degradation |
| 11. | Fungal/ bacterial isolation for pesticides degradation |

## Useful Links

https://onlinecourses.nptel.ac.in/noc21_bt41/preview
https://www.coursera.org/learn/industrial-biotech
https://archive.nptel.ac.in/courses/102/103/102103015/

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 2** |
| **Type of Course** | Ability Enhancement Compulsory Courses | |
| **Prerequisite** | | |
| **Course Objective** | - To develop and integrate the use of the four language skills, i.e. reading, listening, speaking, writing.<br>- To understand the uses and the basic Business vocabulary.<br>- To understand the utilizations of several preparation for interviews.<br>- To provide the knowledge of Critical Thinking and Decision-Making techniques for further work field. | |

| **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 | - | - | 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** | **Written communication**<br>• Types of written communication<br>• Terms related to Formal communication<br>• Informal communication | **10** | **25** |
| **2** | **Vocabulary**<br>• Understanding terms<br>• idioms | **9** | **25** |
| **3** | **Interview**<br>• Types of Interview<br>• Preparation before the interview<br>• Do's and Don'ts of interview | **8** | **25** |
| **4** | **Critical Thinking and Decision Making**<br>• Characteristics of critical thinker<br>• How to make decisions<br>• Decision making techniques | **8** | **25** |
| | **Total** | **35** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| **Level** | Remembrance | Understanding | Application | Analyze |
|---|---|---|---|---|
| **Weightage** | 30 | 30 | 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 | Use English effectively for study purpose across the curriculum. |
| CO2 | Communicate effectively and appropriately in real-life situation. |
| CO3 | Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection. |
| CO4 | Students will analyze and develop accurate sense of self Management |
| CO5 | Students can make proper decision line according to the requirements and resources by their actualization. |

| Reference Books | |
|---|---|
| 1. | **Learn English vocabulary at a Glance**<br>By Dr. RakeshBharadwaj \| Evincepub Publishing |
| 2. | **High School English Grammar & Composition**<br>By Wren & Martin \| Blackie |
| 3. | **High School English Grammar & Composition**<br>By Wren & Martin \| Blackie |
| 4. | **Learn English vocabulary at a Glance**<br>By Dr. Rakesh Bharadwaj \| Dr. Rakesh Bharadwaj |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 2** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | 06010101-P - GENERAL MICROBIOLOGY(P) | |
| **Course Objective** | • To give overview of genes and the allelic variations.<br>• To describe the inheritance pattern of genes to chromosomes and the genetic disorders<br>• To explain the chromosome mapping techniques and the genetic distance.<br>• To explain the allelic frequency and concepts of population genetics and genetic drift.<br>• To explain the effects of inbreeding and the genetic analysis of inbreeding and measuring the genetic relationships | |

| 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 | - | 2 | 4 | 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 | **Bacterial Mutants and mutations**<br>Bacterial mutants and mutations Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations(base pair changes; frame shift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test) Gene transfer in bacteria History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr | 10 | 30 |
| 2 | **Bacteriophage and Plasmids**<br>Bacteriophages and Plasmids Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid Restriction-modification systems History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications | 10 | 30 |
| 3 | **Mendelian Genetics**<br>Mendelian Genetics Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases. Non Mendelian inheritance patterns Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic. Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits | 5 | 15 |
| 4 | **Cytogenetics**<br>Cytogenetics Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH). Developmental genetics Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules. Immunogenetics Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system. | 7 | 20 |
| 5 | **Genetic Variation** | 3 | 5 |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | Genetic variation Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism. Gene mapping and human genome project Physical mapping; linkage and association Population genetics and evolution Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups. | | |
| | **Total** | **35** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Understanding | Analyze | Evaluate |
|---|---|---|---|
| **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 | Analyze the effect of crosses and the principles in heredity |
| CO2 | Identify the allelic variation and the gene functions such as of multiple alleles |
| CO3 | Differentiate normal and abnormal combustion gene and gene functions. |
| CO4 | Evaluate the linkages and the chromosomes mapping and evaluations. |
| CO5 | Apply the population genetics, genetic influences and the mutation drift |

**Reference Books**

| | |
|---|---|
| 1. | **Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA** |
| 2. | **Principles of Gene Manipulation and Genomics**<br>By Primrose SB and Twyman RM. (2006). |
| 3. | **Textbook of Bacteriology** |

**List of Practical**

| | |
|---|---|
| 1. | Purification of chromosomal / plasmid DNA and study of DNA profile: (a) Confirmation of nucleic acid by spectral study. (b) Quantitative estimation by diphenylamine test. (c) DNA denaturation and determination of Tm and G+C content. (d) Agarose gel electrophoresis of DNA. |
| 2. | Effect of UV radiations to study the survival pattern of E. coli/yeast. Repair mechanisms in *E. coli*/yeast (Dark and photo reactivation) |
| 3. | Isolation of antibiotic resistant mutants by chemical mutagenesis. |
| 4. | Ampicillin selection method for isolation of auxotrophic mutant. |
| 5. | Extraction and Purification of RNA from *S. cerevisiae*. |
| 6. | Studies on gene expression in *E.coli* with reference to lac operon. |
| 7. | Study of conjugation in E. coli. |
| 8. | Restriction digestion and agarose gel electrophoresis of DNA. |

| | |
|---|---|
| 9. | Generalized transduction in E. coli using P1 phage. |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 2** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | 06010101-T - GENERAL MICROBIOLOGY | |
| **Course Objective** | • To enable the students to understand the mechanism of physiology and metabolism of microbes.<br>• To study the carbohydrate metabolism<br>• To get the knowledge of protein and amino acid metabolism<br>• To provide the detail information about lipid and nucleotide regulation<br>• To study synthesis of vitamins and 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 | **Unit 1:- Microbial nutrition**<br>• Elemental nutrient requirements of microbes, nutritional groups of bacteria.<br>• The autotrophy – Photoautotrophy and bacterial photosynthesis, Chemoautotrophy and autotrophic metabolism<br>• Concept of heterotrophy – Photoheterotrophy and chemoheterotrophy. Heterotrophic metabolism in bacteria.<br>• Respiration (Aerobic and anaerobic) and fermentation<br>• Nature and properties of spores: Bacterial endospore structure, phenomenon of sporulation, biochemistry and genetics of sporulation. Induction of sporulation phenomenon. Germination of spores<br>• Toxic effect of oxygen on anaerobes.<br>• Bioluminescence in microorganisms. | **15** | **25** |
| 2 | **Unit No.2 - Microbial growth**<br>• The concept of growth and definition, formation of protoplasm, building of macromolecules from elemental nutrients, supramolecules, orgnelles of cell and cellular components.<br>• Cell cycle in microbes and generation time<br>• Growth phases of bacteria – Lag phase, exponential (logarithmic) phase, stationary (ideo) phase, decline and survival of microbial cells. Importance of each growth phase.<br>• Synchronous cultures – methods of synchronous culturing<br>• Continuous culturing methods, factors effecting growth. Methods of growth measurement. | **15** | **25** |
| 3 | **Unit No.3 – Carbohydrate metabolism in microbes**<br>• Synthesis of carbohydrates in photosynthetic, chemosynthetic and heterotrophic microbes<br>• Fermentation of carbohydrates by microorganisms –Embden-Meyerhof-Parnas pathway, Entner- Doudoroff (ED) pathway, C2-C4 split pathway. Kreb's cycle, glyoxylate cycle, hexosemonophosphate shunt (HMP), gluconeogenesis, anaplerotic reactions, synthesis of peptidoglycans and glycoproteins. | **15** | **25** |
| 4 | **Unit no.4 - Metabolism of amino acids**<br>• Biosynthesis of amino acids and their regulation with emphasis on tryptophan and histidine by microorganisms<br>Protein metabolism - Assimilation of inorganic nitrogen and sulphur, Biochemistry of nitrogen fixation. Urea cycle. Signal transduction with reference to nitrogen metabolism. Catabolism of amino acids, transamination, decarboxylation and oxidative deamination. Porphyrin biosynthesis and catabolism. | **7** | **15** |

| | | | |
|---|---|---|---|
| 5 | Unit no.5- Metabolism of Lipid | 8 | 10 |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | • Biosynthesis of triacyl glycerols, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids.<br>• Nucleotide metabolism - Biosynthesis of purnine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides. Regulation of nucleotide synthesis, catabolism of purine and pyrimidines.<br>• Secondary metabolism - Utilization of secondary metabolites for production of vitamins,toxins (aflatoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin). | | |
| | **Total** | **60** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Understanding | Application | Analyze |
|---|---|---|---|
| **Weightage** | 20 | 40 | 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 the principles of the energy-yielding and consuming reactions, the transport systems and the mechanisms of energy conservation in microbial metabolism. |
| CO2 | Illustrate the metabolism of proteins and amino acids and their regulation in microbes. |
| CO3 | Illustrate the metabolism, catabolism and regulation of lipid and nucleotide in microbes |
| CO4 | Synthesize the vitamins, hormones, toxins and antibiotics by using secondary metabolites. |

**Reference Books**


| | |
|---|---|
| 1. | **Text book of Microbiology**<br>By M. Burrows |
| 2. | **General Microbiology**<br>By Stainier, Deudroff and Adelberg |
| 3. | **Microbial physiology**<br>By Moat and Foster |
| 4. | **An introduction to bacterial physiology**<br>By Price and Stevens |
| 5. | **An introduction to bacterial physiology**<br>By Oginsky and Umbreit |
| 6. | **Bacterial metabolism**<br>By Gottschalk |
| 7. | **Growth of bacterial cell**<br>By Ingraham, Lod and Neichardt \| Osborne, Freeman & Company |
| 8. | **Microbial energetic**<br>By Dawes |
| 9. | **Principles of Biochemistry**<br>By Lehninger, Nelson and Cox |
| 10. | **Biochemistry**<br>By Stryer |

| | |
|---|---|
| 11. | **Textbook of Microbiology**<br>By M.Burrows |
| 12. | **Laboratory Experiments in Microbiology**<br>By Gopal Reddy et al |

| **List of Practical** | |
|---|---|
| 1. | Preparation of microbiological media. Autotrophic media, minimal media, basic media, enriched media, enrichment media, and differential media. |
| 2. | Demonstration of sugar (glucose, sucrose and lactose) fermentation |
| 3. | IMViC test for enteric bacteria |
| 4. | Catalase activity for H2O2 production |
| 5. | Demonstration of carbohydrate metabolism by Hugh Leifson's test |
| 6. | Demonstration of starch hydrolysis by given bacterial culture |
| 7. | Demonstration of protein (gelatin) hydrolysis |
| 8. | Fat hydrolysis by bacterial culture. |
| 9. | Degradation of sulphur containing amino acids for H2S production |
| 10. | Demonstration of urease production |
| 11. | Measurement of bacterial growth curve |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 2** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | 06020101-T - MOLECULAR BIOLOGY | |
| **Course Objective** | 1. To get the knowledge of enzyme properties<br>2. To acquire the knowledge about how the enzyme work<br>3. To understand the kinetic aspects of enzyme<br>4. To provide the knowledge of regulatory enzymes<br>5. To distinguish the application of enzyme at industrial level | |

| 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 ENZYMES:**<br>Chemical Nature of enzymes, enzyme nomenclature, sources of enzymes, Isolation of enzymes from different sources, Screening for novel enzymes, Invivo and In-Vitro methods for selection of enzyme activity, media for enzyme production, optimization methods for enzyme production, Enzyme assay methods, purification of enzymes. | 10 | 15 |
| 2 | **ENZYME CATALYSIS**<br>Active site, substrate, transition state, activation energy, binding energy, enzyme specificity, Thermodynamics of enzyme catalysis; factors influencing enzyme activity, mechanism of enzyme action- covalent catalysis, metal ion catalysis, general acid-base catalysis, Induced-fit, proximity and orientation, factors affecting enzyme activity, Structure and activity of the enzymes, Mechanism of action of chymotrypsin, carbonic anhydrase. | 10 | 15 |
| 3 | **ENZYME KINETICS**<br>First, second, zero and pseudo-order kinetics; Pre-steady and steady-state kinetics; Derivation of Michaelis-menten equation, Km, V max, turnover number, catalyte efficiency, specificity constant, linear transformations to M.M equation-Lineweaver-Burk, Eadie Hofstee, Hanes, Dixon plots; kinetics of bi-substrate reactions, Random and sequential order, Pingpong mechanism, Differentiation of different mechanism of bi substrate reactions. Enzyme Inhibition; Reversible and irreversible inhibition and kinetic properties, , substrate inhibition, product inhibition, measurement of reversible inhibitor potency-percent inhibition and degree of inhibition,IC50 parametres for various reversible inhibitors | 20 | 30 |
| 4 | **REGULATORY ENZYMES:**<br>Allosteric enzymes-properties, Measurement of ligand binding, Hill equation, Scatchard equation, Monod-Wyman-Changeux model and Koshland-Nemethy-Filmer model, V type allosteric systems; Hysteresis, Enzyme amplification cascade, covalent modification, Substrate channeling, Isoenzymes, Multienzyme complexes and multifunctional enzymes. | 10 | 20 |
| 5 | **INDUSTRIAL APPLICATIONS OF ENZYMES** | 10 | 20 |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Immobilization of enzymes, methods and their applications. A brief account of non-protein enzymes - ribozymes and DNA enzymes. | | |
| | **Total** | **60** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Understanding | Application | Analyze |
|---|---|---|---|
| **Weightage** | 20 | 40 | 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 | Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms. |
| CO2 | Apply kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process. |
| CO3 | Compare methods for production, purification, characterization and immobilization of enzymes. |
| CO4 | Apply the regulatory enzyme works. |
| CO5 | Discover the current and future trends of applying enzyme technology for the commercial purpose ofbiotechnological products. |

**Reference Books**

| | |
|---|---|
| 1. | **Immobilized Enzymes**<br>By Zaborsky \| CRC Press, Degraland, Ohio. |
| 2. | **Advances in Enzymology**<br>By Alton Meister \| Interscience Publishers |
| 3. | **Methods in Enzymology: Enzyme purification and related techniques**<br>By William B. Jakoby \| Academic Press, New York |
| 4. | **Allosteric Enzymes - Kinetic Behaviour**<br>By B.I. Kurganov. John Wiley and Sons \| Inc., New York. |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 2** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | 06010102-T - MICROBIOLOGICAL TECHNIQUES | |
| **Course Objective** | • To enable the students to understand the immunity and immune system.<br>• To teach our students to have a concrete knowledge about immunology human system to study about the basis of the interaction as well as the genes involved in it.<br>• To recapitulate the previous knowledge of immunology and to establish thorough understanding of various structure & function at cellular and molecular level.<br>• To study about the immunodeficiencyTo provide the use of techniques | |

| **Teaching Scheme (Contact Hours)** | | | | **Examination Scheme** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **Theory Marks** | | **Practical Marks** | | **Total Marks** |
| **Lecture** | **Tutorial** | **Lab** | **Credit** | **External Mark (T)** | **Internal Marks (T)** | **External Mark (P)** | **Internal Marks (P)** | |
| 3 | - | 2 | 4 | 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 | **Immune System**<br>• Organs and cells involved in immune system and immune response. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors of lymph cells, helper T cells, T cells suppression, lymphocyte trafficking. Types of immunity - Adaptive immunity, innate immunity. Lymphoid organs, Thymus, bone marrow, spleen, lymph nodes. | 7 | 15 |
| 2 | **Antigens and Immunoglobulin**<br>• Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenicity, super antigen.<br>• Immunoglobulin: Structure and properties of immunoglobulin classes. Theories of antibody formation, hybridism technology for monoclonal antibodies and designer monoclonal antibodies.<br>• Multiple myelomas and structural basis of antibody diversity. Freund's adjuvants and its significance.<br>• The complement system - components of classical and alternative complement pathways, complement receptors, biological, consequences of complement activation. | 8 | 20 |
| 3 | **Antigen – Antibody reactions**<br>• Antigen-Antibody reaction by precipitation, agglutination and complement fixation.<br>• Non-specific immune mechanism: - Surface defenses, tissue defenses, opsonization, inflammatory reaction, and hormone balance.<br>• Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone, protamine, basic<br>• Peptides of tissues – leukins, phagocytins, lecterins, haemocompounds). | 10 | 20 |
| 4 | **Expressions and Regulation of Immune Response** | 10 | 20 |

| | | | |
|---|---|---|---|
| | • Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in immune regulation, T cell regulation, MHC restriction, immunological tolerance.<br>• Cell mediated cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity.<br>• Complement system: Classical, alternate, lectin pathway of complement activation. Regulation of complement activation.<br>• Transplantation immunology: MHC, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection. | | |
| **5** | **Immunity and Immunoassays** | 10 | 25 |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | • Defense against bacteria, viruses, fungi and parasites. Immunodiagnostics and immunotherapy in virology – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others.<br>• Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluroscens and their application. Immune deficiencies and autoimmunity. | | |
| | **Total** | 45 | 100 |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Remembrance | Application | Analyze | Evaluate |
|---|---|---|---|---|
| **Weightage** | 15 | 35 | 15 | 35 |

*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 | Acquire knowledge on types and structure of immune systems and diversity of antibody |
| CO2 | Elucidate cytokine and compliment based activation and regulation of immune mechanisms |
| CO3 | Depict principles in diagnosis, HLA typing and Tumor immunology |
| CO4 | Perceive knowledge on Immunodeficiency's |
| CO5 | To use the techniques, skills, and modern tools necessary for imbalances in various life processes, collect andanalyze data, and interpret results |

**Reference Books**

| | |
|---|---|
| 1. | **Kuby Immunology**<br>By Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Immunology Kuby |

**List of Practical**

| | |
|---|---|
| 1. | Diagnostic immunologic principles and methods Precipitation method - Immunodiffusion - Immunoelectrophoresis Agglutination method - Widal test - Haemagglutination - ELISA method |
| 2. | Separation of serum protein by submerged agarose gel electrophoresis |
| 3. | Purification of human immunoglobulins from serum and confirmation of its antigenicity. |
| 4. | Identification of S.typhi by serotyping. [Purification of H and O antigens from S.typhi] |
| 5. | Estimation of Alkaline phosphatase from patient's serum. |
| 6. | Demonstration of Western blotting. |
| 7. | Detection of isozymes of Lactate dehydrogenase by PAGE |
| 8. | Clinical diagnosis of viral diseases by PCR, ELISA. |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 2** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | Basic Knowledge of instrument \| 06020103-T - BIOINSTRUMENTATION | |
| **Course Objective** | 1. To introduce the concepts of bioinformatics.<br>2. To understand basic and applied aspects in genomics and pharmacogenomics and proteomics<br>3. To understand applications of genomics and pharmacogenomics in clinical settings<br>4. To provide an example of pharmacogenomics<br>5. To compare different types of tools used in the program analysis | |

| **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 | - | 2 | 4 | 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 | **Bioinformatics and its applications**<br>Databases, types, pair wise and multiple alignments. Structure-function relationship. Sequence assembling using computers. Computer applications in molecular biology, Protein domains and human genome analysis program (BLAST, FASTA, GCC etc.) Search and retrieval of biological information and databases sequence, databank. (PDB and gene bank), accessing information (Network expasy, EMB Net, ICGEB Net). | **12** | **20** |
| 2 | **Genomics**<br>What are Genomics, Bioinformatics and Genomics, Data generation and data flow (DNA sequencing, Generation of Scaffolds and contigs, mapping, data storage), Large-scale genome sequencing, Recognizable patterns in DNA sequences, promoter regions, Exons, Introns, ORF regions, Gene Identification, Prediction and accuracy, Gene Prediction (ab initio and similarity based). Genomic Variations: Variation in the human genome, known examples of SNPs that causediseases, Pharmacogenomics, Ethical Consequences of Genomic Variations | **12** | **20** |
| 3 | **Gene Expression Analysis**<br>Methods for analysing gene expression and microarray data, Techniques: Clustering and SVMs, Basics of designing a microarray, image analysis, normalization, variability and replication, Interpretation of large-scale data and clustering algorithms. | **12** | **20** |
| 4 | **Proteomics**<br>Introduction, Protein 3D Structures, Protein identifications (2-hybrid system, 2- D gel electrophoresis, mass spectrometry , Methods of ionization ,Mass analyser ,MALDI- TOF, application of NMR , Mining of protein databases, applications to human disease studies. | **12** | **20** |
| 5 | **Computer application in Biotechnology**<br>Protein domains – PRODOM, CATH, Analysis programs (BLAST, FASTA, GCG, CLUSTAL W), Accessing information (networks: Expasy, EMBnet), understandng records, Internet resources (Entrez, Pubmed) | **12** | **20** |
| | **Total** | **60** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Understand | 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 the basic knowledge of Bioinformatics. |
| CO2 | Apply the basic knowledge of genome analysis and sequencing. |
| CO3 | Apply the basic knowledge of sequencing analysis. |
| CO4 | Understand the concept of DNA Microarray. |
| CO5 | Understand the concept of Proteome analysis. |

**Reference Books**


| | |
|---|---|
| 1. | **Principles of Gene Manipulation and Genomics**<br>By Primrose SB and Twyman RM. (2006). \| Blackwell Publishing, Oxford, U.K. \| 7th edition. |
| 2. | **Recombinant DNAgenes and genomes- A short course**<br>by Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007).. III Edition. Freeman and Co., N.Y., USA. |
| 3. | **Bioinformatics Methods and Applications\Genomics, Proteomics and Drug Discovery**<br>By Rastogi S.C, \| PHI Learning Pvt.Ltd \| 4th., Pub. Year 2019 |
| 4. | **Basic Bioinformatics**<br>By Ignacimuthu S \| Narosa Publishing House, New Delhi 2005, Pub. Year 2005 |
| 5. | **Bioinformatics**<br>By Baxevanis Andreas D \| John Wiley and Sons, New York 2002 \| 2nd |


**List of Practical**

| | |
|---|---|
| 1. | Use of Internet/software for sequence analysis of nucleotides and proteins. |
| 2. | Studies of public domain databases for nucleic acid and protein sequences |
| 3. | Determination of protein structure (PDB) |
| 4. | Genome sequence analysis |
| 5. | Two-Dimensional Gel Electrophoresis (2D-PAGE) |
| 6. | Mass Spectrometry-Based Protein Identification |
| 7. | Gene Expression Profiling using DNA Microarrays |
| 8. | Sanger Sequencing (Chain Termination Method) |
| 9. | Study of Sequence alignment |
| 10. | Study of Gene Prediction |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Skill Enhancement Courses | |
| **Prerequisite** | 06010101 - GENERAL MICROBIOLOGY | |
| **Course Objective** | 1. To understand the fundamental concepts and significance of various types of intellectual property rights, including patents, copyrights, trademarks, and industrial designs.<br>2. To explore the historical development and key international agreements related to intellectual property rights, such as the GATT & TRIPS Agreement, WIPO Treaties, and the Indian Patent Act.<br>3. To identify the requirements, rights, and protection mechanisms for copyrights, trademarks, industrial designs, and new plant varieties.<br>4. To learn the elements of patentability, the patent filing process, patent databases, and issues related to patent infringement and licensing. | |

| **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 | 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 | **Overview and Introduction of Intellectual Property**<br>• Introduction to Intellectual Property Rights (IPR)<br>• Definition and significance of IPR<br>• The need for intellectual property protection in scientific and technological fields<br>• Overview of different types of IPR: Patent, Copyright, Trademark, Design, Geographical Indication, Plant Varieties, Layout Design, Genetic Resources and Traditional Knowledge, Trade Secret | 11 | 25 |
| 2 | **History of IPR**<br>• Overview of key international agreements and conventions: Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; Budapest Treaty<br>• Patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO); Patent Co-operation Treaty (PCT).<br>• Indian Patent Act 1970 & recent amendments. | 11 | 25 |
| 3 | **Copyrights, Trademarks, Industrial design and plant varieties**<br>• Copyrights: Definition, need, coverage and duration. Related rights. Distinction between related rights and copyright. Rights covered by copyright.<br>• Trademarks: Definition. Rights of trademark, signs that can be used as trademarks, types of trademark. Protection and registration a trademark. Duration of protection. Well-known trademarks.<br>• Industrial design: Overview, kind, duration and need for protection provided by industrial designs.<br>• New Plant Varieties: Requirements, Rights of breeder, Extent and Duration, Examples and Biotechnology Research | 11 | 25 |
| 4 | **Patents and Drafting** | 12 | 25 |

| | | | |
|---|---|---|---|
| | • Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps),<br>• Industrial Application, National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure;<br>• Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies and Patent Agents' Role,<br>• Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENT Scope(WIPO), IPO, etc.) | | |
| | | **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 | Explain the various types of intellectual property rights and their significance in scientific and technological fields. |
| CO2 | Summarize key international agreements and conventions related to IPR, including their historical development and impact on biotechnological inventions. |
| CO3 | Describe the definitions, protections, and durations of copyrights, trademarks, industrial designs, and new plant varieties. |
| CO4 | Explain the elements of patentability, including novelty, non-obviousness, and industrial application. |
| CO5 | Discover the patent filing process, including national and PCT procedures, and the role of patent databases in conducting searches. |

**Reference Books**


| | |
|---|---|
| 1. | **Intellectual Property: Patents, Trademarks, and Copyright in a Nutshell**<br>By Arthur R. Miller, Michael H. Davis \| West Academic Publishing |
| 2. | **Patent Law and Policy: Cases and Materials**<br>By Robert Patrick Merges, John Fitzgerald Duffy \| Carolina Academic Press |
| 3. | **Law relating to Intellectual Property Rights**<br>By V. K. Ahuja \| Lexis Nexis |
| 4. | **Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets**<br>By Deborah E. Bouchoux \| Cengage Learning |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | Basic knowledge regarding different microorganisms and their morphological, metabolical features \| 06010101-T - GENERAL MICROBIOLOGY | |
| **Course Objective** | 1 To provide difference of Normal flora and pathogens.<br>2 Acquisition of knowledge of bio-security and medical microbiology with particular reference to the pathogenic activities of various microorganisms.<br>3 To deliver conceptual basis of understanding pathogenic microorganisms and particularly address fundamental mechanism of their pathogenicity.<br>4 To improve the student's critical analysis skills, providing the basis for an experimental design in the field of medical microbiology.<br>5 To introduce Epidemiological study. | |

| **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 | **Introduction to medical microbiology**<br>Normal microbial flora of human body, host microbe interactions. Infection and infection process? Routes of transmission of microbes in the body. Description and pathology of diseases caused by<br>Bacteria; *Streptococcus, Pneumococcus, Gonococcus, Enterobacteriaceae, E. coli, Salmonella, Shigella, Pseudomonas, Klebsiella, Proteus, Vibrio cholera. Brucella, Haemophilus, influenzae*; pathogenic anaerobes, *Tetanus, Clostridia, Conynebacteria, Mycobacteria, Spirochaetes*. | **24** | **25** |
| 2 | **Diseases caused by fungi**<br>Description and pathology of diseases caused by *Aspergillus, Penicillium, Mucomycosis, Blastomycosis, Microsporosis, Rhinosporidium, Epidermophyscosis*. Description and pathology of diseases caused by *hemoflagellates; Leishmania donavani, L.tropica, Trypanosoma gambiense; intestinal flagellates;*<br>*Trichomonas, Giardia, Entamoeba histolytica, malarial parasites, Helminthes; Ascaris lumbricoides,* Hook worm, pinworm, Filarial parasites | **15** | **25** |
| 3 | **Laboratory diagnosis of Common infective syndromes and parasitic manifestations**<br>Laboratory diagnosis of Common infective syndromes and parasitic manifestations; Methods of transmission and role of vectors- biology of vectors. (1) House fly (2) Mosquitoes (3) sand fly. Need and significance of epidemiological studies. Epidemiological investigations to identify a disease, Principles<br>Of chemotherapy, Mode of antibiotics. - *Penicillin, streptomycin, sulfonamides* and *Polymyxins*.Antifungal drugs (Nystatin), Antiviral agents. (Robovirin) Problems of drug resistance and drug sensitivity. Drug resistance in bacteria. | **12** | **25** |
| 4 | **Viral diseases** | **9** | **25** |

| | | | |
|---|---|---|---|
| | Description, pathology and lab diagnosis of diseases caused by pox viruses; herpes virus (chicken pox- zoster); orthomyxo and paramyxo viruses; adenovirus, other respiratory viruses, (Influenza, Rhyno) viruses affecting nervous system (ex: Polio virus, Rabies virus), enterovirus, reovirus, Viral hepatitis, HIV.Interferon – Nomenclature, types & classification, Induction of interferon, types ofinducers. | | |
| | **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 | Describe the common microbial flora found in various parts of the human body, |
| CO2 | Understand medical microbiology and the importance of microorganisms in diagnosis, monitoring and treatment ofinfectious diseases. |
| CO3 | Study epidemiological analysis and its application. |
| CO4 | Conduct experiments for growing common bacteria in different microbiological media, antibiotic sensitivitydetermination and antigen antibody reaction (precipitation test in the agarose). |
| CO5 | Understand the life cycles, modes of transmission, and pathogenesis of major viruses affecting humans. |

**Reference Books**

| | |
|---|---|
| 1. | **Medical Virology**<br>By D.O. White & F.J. Fenner, \| Academic press. \| 4th Edition, |
| 2. | **Textbook of Microbiology**<br>By Ananthanarayan, C.K.J.Panikar, \| Oreint Longman Ltd., 2000. \| 6th Edition, |
| 3. | **Practical Medical Microbiology**<br>By J.G.Gollee, Churchill Livingstone. \| Mackie & Mc. Cauetrey: \| 14th Edition |
| 4. | **Textbook of Medical Parasitology,**<br>By Subish.C.Panija, \| All India Publishers and distributors |
| 5. | **Textbook of Medical Parasitology, ,**<br>By C.K.Jaya Ram Paniker \| Jaypee Brothers |
| 6. | **Advances in microbial physiology.**<br>By Poole, R. K. (1998). \| Academic Press. |

**List of Practical**

| | |
|---|---|
| 1. | Detection of pathogens from sputum sample. |
| 2. | Laboratory examination of blood and identification |
| 3. | Detection of pathogens from stool samples. |
| 4. | Antigen and antibody reactions to identify the serotypes of pathogenic bacteria |
| 5. | Staining techniques for identification Mycobacterium in sputum |
| 6. | Biochemical tests for identification of enteric bacteria |
| 7. | Morphological studies of pathogenic fungi |
| 8. | Identification of pathogenic bacteria by urine culture |
| 9. | Drug sensitivity tests |
| 10. | RPT test for screening of syphilis. |

| **Useful Links** |
| --- |
| 1.https://www.cancer.gov/publications/dictionaries/cancer<br>2.https://medlineplus.gov/ency/article/003439.htm<br>3.https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Bruslind)/09%3A_Microbial_Growth |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | | |
| **Course Objective** | 1) To understand detail concept of soil flora diversity and their interactions<br>2) To get knowledge of biogeochemical cycle and their importance<br>3) To understand role of bio-fertilizer in crop production.<br>4) To study various plant diseases and their 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 | - | 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 and development of agricultural microbiology**<br>History and development of agricultural microbiology. Distribution of soil microorganisms in soil. Factors influencing the soil microflora - Role of microorganisms in soil fertility. Interactions among microorganisms, mutualisms, comensalism, competition, amensalism, parasitism, predation Interactions between microbes and plants - rhizosphere, phyllosphere, mycorrhizae. Microbial interactions in animals-Rument microbiology. Microbial contribution to food digestion. | **15** | **20** |
| 2 | **Biogeochemical cycle**<br>Biogeochemical - carbon cycle - role of microbes in carbon cycle - trophic relationships - mobilization and immobiilisation of carbon with rhizosphere. Nitrogen cycle - mechanism of biological nitrogen fixation - ammonification - nitrification - denitrificatioin and microorganisms involved in such processes. Phosphorous cycle - Sulphur cycle. | **15** | **20** |
| 3 | **Biofertilizers**<br>Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes – phosphate solubilization- Rhizobium, Azatobacter, Azospirillum, Azolla; Anabaena Symbiosis, blue green algae, Mycorrihiza, Biopesticides – toxins from Bacillus thuringiensis, Psuedomonas syringae, Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control. | **20** | **40** |
| 4 | **Microbiological control of plant pathogens**<br>Microbiological control of plant pathogens. Environmental factors affecting disease development.Classification and symptoms of plant diseases.Important diseases of crop plants and their management. | **10** | **20** |
| | **Total** | **60** | **100** |

| **Suggested Distribution Of Theory Marks Using Bloom's Taxonomy** | | | |
|---|---|---|---|
| **Level** | Remembrance | Understanding | Application |
| **Weightage** | 20 | 40 | 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 microbial flora & their interaction in soil for study |
| CO2 | Understand the role of soil micro flora in biogeochemical cycle. |
| CO3 | Apply knowledge of bio fertilizer to improve soil diversity. |
| CO4 | Understand knowledge of bio pesticides and its effect. |
| CO5 | Identify plant diseases caused by microorganisms and their management |

| Reference Books | |
|---|---|
| 1. | **Agricultural Microbiology**<br>By Rangaswamy, G. "Bagyaraj \| 2nd, Pub. Year 1993 |
| 2. | **Soil Microorganisms and Plant Growth**<br>By Ettema, C. H. \| Science Publishers, Pub. Year 1995 |
| 3. | **Introduction to soil microbiology. Alexander M.**<br>By Kaufman, D., and P. C. Kearwey, Pub. Year 1977 |

| List of Practical | |
|---|---|
| 1. | Isolation of microbes from soil |
| 2. | Demonstration of different steps in nitrogen cycle |
| 3. | Isolation of nitrogen fixing bacteria |
| 4. | Isolation and identification of field and storage fungi from cereal grains and oil seeds |
| 5. | Isolation of plant pathogenic bacteria and fungi from diseased plants |
| 6. | Study on important bio-control agents |
| 7. | Study of fungi for degradation |
| 8. | Isolation of Actinomycetes |
| 9. | Isolation and identification of Moulds |
| 10. | Study of interaction of microorganisms |

**Useful Links**

https://www.coursera.org/learn/agriculture-economics-nature
http://www.digimat.in/nptel/courses/video/102105087/L63.html
https://onlinecourses.nptel.ac.in/noc21_ce07/preview

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | | |
| **Course Objective** | • To provide students with a comprehensive knowledge of OMICS and genetic engineering techniques for isolation, selection and improvement of strains with desired traits.<br>• To provide students with an overview of various industrial products being produced by microbes and their production processes.<br>• To provide students with a knowledge of various alternative bio based microbial products and microbial applications in treating various environmental problems and waste treatment processes.<br>• To provide the overview of microbes involved in agriculture, alternate energy generation, and vaccine development and their importance.<br>• To provide the knowledge of metagenomics to study the microbes in natural habitats, understand various techniques involved in their role in human health, waste treatment process and industrial production processes. | |

| **Teaching Scheme (Contact Hours)** | | | | **Examination Scheme** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **Theory Marks** | | **Practical Marks** | | **Total Marks** |
| **Lecture** | **Tutorial** | **Lab** | **Credit** | **External Mark (T)** | **Internal Marks (T)** | **External Mark (P)** | **Internal Marks (P)** | |
| 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 | **Unit-1**<br>History and scope of Biotechnology. Industrially important microorganisms: Screening techniques - Detection and assay of fermentation products - Strain improvements - Mutations, protoplast fusion and rDNA techniques for strain development. | **12** | **20** |
| 2 | **Unit-2**<br>Industrial fermentation: Primary and secondary metabolites; Microbial Growth kinetics. Basic functions of fermenter - body construction, aeration, agitation, theories of aeration, oxygen transfer kinetics. Concepts of Newtonian and non - newtonian fluids - antifoam - Submerged and solid state fermentation - Scale up. Fermentation Biosensors. Downstream Processing | **12** | **20** |
| 3 | **Unit-3**<br>Industrial Production: Typical Fermentation processes for the industrial production of Wine, Beer, Bacitracin, Streptomycin, Riboflavin, B-carotene, Gibberellins, glutamic acid and surfactants. Commercially useful non-microbial products produced through microbes - insulin, interferons, B-cell growth factors, tissue plasmonogen activator. Microbial Enzymes - Enzyme immobilization, Microbial Insecticides. Production of SCP - Spirulina and yeast, substrates used in producing SCP, their nutritional value. Biotransformation | **12** | **20** |
| 4 | **Unit-4**<br>Algal biotechnology: Biotechnological potential of microalgae, food, feed and fuel production - pharmaceutically valuable of microalgae, pigments and H2 gas from BGA. Nanobiotechnology: Introduction - history and recent developments - sources of nanoparticles - microbial producers of nanoparticles -advantages of microbial nanoparticles - applications - social and ethical implications - ethical concerns about patenting of living organisms and genetic materials. | **24** | **40** |
| | **Total** | **60** | **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 Screening techniques for Industrially important microorganisms and their stain improvement |
| CO2 | Understand design and construction of fermenter and their processing. |
| CO3 | Apply knowledge of production method for various industrial product |
| CO4 | Understand concept of algal biotechnology and their application |
| CO5 | Understand concept of Nano biotechnology and their application. |

**Reference Books**


| | |
|---|---|
| 1. | **Microalgal Biotechnology**<br>By Borowitzka MA, Borowitzka LJ \| Cambridge University Press |
| 2. | **Basic Industrial Biotechnology**<br>By Reddy SM, Reddy RS, Babu GN \| New Age International Publication |
| 3. | **Industrial microbiology**<br>By Casida, Lester Earl., Pub. Year 1968 |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | 06010101-T - GENERAL MICROBIOLOGY | |
| **Course Objective** | 1. To develop understanding of ideal and non-ideal bioreactors<br>2. to understand the basics of microbial growth, reproduction, methods of genetic exchange<br>3. focus on the media design, modes of operation of fermenter for large scale biomass and product formation and industrial applications of microbes and develop understanding of strategies for scale-up of bioreactor<br>4. Built concepts of control and monitoring in bioreactors.<br>5. To impart to the students the knowledge of various separation and purification techniques and enable them to design these processes | |

| **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 | - | 2 | 4 | 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** | **Bioreactors**<br>• Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process.<br>• Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases. | **10** | **20** |
| **2** | **Mass transfer in reactors**<br>• Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfercritical oxygen concentration, determination of Kla, heat transfer, aeration/agitation, its importance.<br>• Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors. | **8** | **15** |
| **3** | **Fermentation process**<br>• Growth of cultures in the fermenter Importance of media in fermentation, media formulation and modification.<br>• Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics.<br>• Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flask to industrial fermentation. | **8** | **15** |
| **4** | **Downstream processing** | **10** | **25** |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | • Biomass separation by centrifugation, filtration, flocculation and other recent developments.<br>• Cell disintegration: Physical, chemical and enzymatic methods.<br>• Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction.<br>• Purification by different methods.<br>• Concentration by precipitation, ultra-filtration, reverse osmosis.<br>• Drying and crystallization.<br>• Biomass separation by centrifugation, filtration, flocculation and other recent developments.<br>• Cell disintegration: Physical, chemical and enzymatic methods.<br>• Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction.<br>• Purification by different methods.<br>• Concentration by precipitation, ultra-filtration, reverse osmosis.<br>• Drying and crystallization. | | |
| **5** | **Microbial strain improvement**<br>• Isolation, selection and improvement of microbial cultures: Screening and isolation of microorganisms, primary and secondary metabolites, enrichment, specific screening for the desired product.<br>• Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods, strategies of strain improvement for primary, secondary metabolites with relevant examples. Use of recombinant DNA technology, protoplast fusion techniques for strain improvement of primary and secondary metabolites.<br>• Production of recombinant molecules in heterologus system, problems associated with strain improvement programme, improvement of characters other than products and its application in the industry.<br>• Preservation of cultures after strain improvement programme. | **9** | **25** |
| | **Total** | **45** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Understanding | Application | Analyze | Evaluate |
|---|---|---|---|---|
| **Weightage** | 40 | 20 | 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 basic design and specialized applications of bioreactor. |
| CO2 | Describe transport phenomena and sterilization methods for bioreactor |
| CO3 | Apply knowledge in media formulation, growth kinetics and fermentation process. |
| CO4 | Analyze various downstream procedures of fermentation |
| CO5 | Evaluate process of microbial strain improvement for fermentation |

**Reference Books**

1. **Advances in Biochemical Engineering/Biotechnology**
By T. Scheper | Springer Berlin Heidelberg New York, Pub. Year 2007

| | |
|---|---|
| 2. | **Principles of Fermentation Technology**<br>By Stanbury, P.F., Whitekar A. and Hall \| Oxford \| 2nd |
| 3. | **Principles of fermentation technology**<br>By Stanbury F., P., Whitakar A., and Hall J., S., \| Aditya books Ltd., New Delhi \| 2nd edition |
| 4. | **Principles of fermentation technology**<br>By Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall \| Elsevier, Pub. Year 2013 |

| List of Practical | |
|---|---|
| 1. | Isolation of industrially important microorganisms for microbial processes (citric/lactic/ alpha amylase) and improvement of strain for increased yield by mutation. |
| 2. | Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer. |
| 3. | [A] Determination of the growth curve of a supplied microorganism and also determines substrate degradation profile. [B] Compute specific growth rate (m), and growth yield (Y x/s) from the above. |
| 4. | Extraction of Citric acid/Lactic acid by salt precipitation. |
| 5. | Monitoring of dissolved oxygen during aerobic fermentation. |
| 6. | Preservation of industrially important bacteria by lyophilization. |
| 7. | Quantitative estimation of bioethanol produced from Lignocellulosic biomass |
| 8. | Disruption of microbial cells by ultrasonic to release intracellular products |
| 9. | Quantitative estimation of reducing sugar produced during yeast fermentation by DNS method |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Training Course/Internship | |
| **Prerequisite** | | |
| **Course Objective** | • To train student to conduct independent study a topic of relevance and deliver a seminar The student is expected choose a topic of relevance and conduct independent study<br>• The student is also expected to submit a report and present the same. | |

| **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 | - | - | 100 | - | 100 |

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

| **Suggested Distribution Of Theory Marks Using Bloom's Taxonomy** | | | | | |
|---|---|---|---|---|---|
| **Level** | Remembrance | Understanding | Application | Analyze | Evaluate |
| **Weightage** | 20 | 30 | 10 | 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 | The students will be able to summarize the recent research in the form of review |
| CO2 | Write a report on experiences during training |
| CO3 | Make a presentation to panel of examiners |

**Reference Books**


1. **Training for Development**
   By Sahu, R.K | Excel Books, New Delhi
2. **Introduction to biostatistics and research methods**
   By PSS Sundar Rao and J Richard

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | 06020202-T - ENZYME TECHNOLOGY | |
| **Course Objective** | • To describe different types of bio-fuels energy sources<br>• To explain the positive and negative aspects of the various bio-fuels energy technologies<br>• To illustrate the effects of Biofuels on the current world energy situation<br>• TO predict the applications of various commercially available bio-fuels energy technologies | |

| **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 | - | - | 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** | **Introduction**<br><br>Brief history an introduction: types of energy sources, status in India, Biorenewable energy resources, Types of biofuels, Potential yield from biomass: C3 plants, C4 plants and CAM plants, microalgae, Environmental aspects of biofuels. | **15** | **25** |
| **2** | **Biomass Feedstocks**<br><br>Definition, Biomass components, Categories of biomass and biomass characterization, Biomass fuel analyses, Biomass processing for biofuel production. | **15** | **25** |
| **3** | **Types of Biofuels and their Production**<br>Bioethanol, Biodiesel, Biooils, Biohydrogen, Biomethane | **15** | **25** |
| **4** | **Future Prospects**<br><br>Designer cells: metabolically engineered cells for ethanol production, Biofuel from supercritical fluid, Future of syngas fermentation, Integrated refining concepts, Biodiesel from Algae | **15** | **25** |
| | **Total** | **60** | **100** |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| **Level** | Remembrance | Understanding | Application | Analyze | Create |
|---|---|---|---|---|---|
| **Weightage** | 20 | 30 | 10 | 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 | Describe the theory of operation of the different types of bio-fuels energy sources and how they produce energy |
| CO2 | Analyze the positive and negative aspects of the various bio-fuels energy technologies |
| CO3 | Explain the effects of Biofuels on the current world energy situation |
| CO4 | Acquire specific bio-fuels energy information and conduct original research |
| CO5 | Demonstrate recommended applications of various commercially available bio-fuels energy technologies |

**Reference Books**

| | |
|---|---|
| 1. | **Encyclopedia of Bioprocess Technology**<br>By Flickinger, M. C. and Drew, S. W. \| Wiley- Interscience, New Jersey. (1999). |
| 2. | **Microbial Biotechnology - Fundamentals of Applied Microbiology**<br>By Glazer AN, Nikaido H. |
| 3. | **Microbial Technology**<br>By Pepple |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | | |
| **Course Objective** | 1. To Understand the Classification and Production of Antibiotics.<br>2. To Explore the Mechanisms of Action of Antibiotics.<br>3. To Examine the Industrial Production of Enzymes and Bioethanol.<br>4. To Investigate Analytical Microbiology Techniques.<br>5. To Address Microbial Ecology in Pharmaceuticals. | |

| **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 | - | - | 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** | **Introduction**<br>• Chemical disinfectants, antiseptics and preservatives.<br>• Types of Antibiotics- β lactam antibiotics, tetracycline group Rifamycin, aminoglycoside antibiotics, macrolides, polypeptide antibiotics, glycopeptide antibiotics, miscellaneous antibacterial antibiotics and antifungal antibiotics.<br>• Production of antibiotics – Penicillin, Streptomycin,<br>• Erythromycin, bacitracin and tetracycline. | **15** | **25** |
| **2** | **Mechanism of action of antibiotics**<br>• Mechanism of action of antibiotics – the bacterial cell wall, protein synthesis, chromosome function & replication, folate antagonists, the cytoplasmic membrane.<br>• Bacterial resistance to antibiotics - Intrinsic & acquired resistance, biochemical mechanism of resistance. Assay of antibiotics – Penicillin, Streptomycin. | **15** | **25** |
| **3** | **Industrial Production of Enzymes Bioethanol.**<br>• Industrial Production of Enzymes – amylases, Proteases, organic acids- lactic acid, citric acid, vinegar, amino acids – L-lysine, L-glutamic acid; Food supplements and hormones.<br>• Production of Vitamin B12; Microbial transformation of steroids and non-steroids. Analytical Microbiology – microbiological assays of Vitamins (Riboflavin, B12), amino acids (lysine, tryptophan). | **15** | **25** |
| **4** | **Ecology of Microorganisms as it effects the pharmaceutical industry**<br>• Microbial spoilage & preservation of medicines using antimicrobial agents; quality assurance and the control of microbial risk in medicines.<br>• Contamination of non-sterile pharmaceuticals in hospital & community environments. | **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 | Demonstrate knowledge of various antibiotics, their mechanisms of action, and their application in pharmaceutical microbiology. |
| CO2 | Acquire practical skills in the industrial production of enzymes, bioethanol, and antibiotics, and in conducting assays to assess pharmaceutical potency and quality. |
| CO3 | Understand microbial spoilage mechanisms, preservation methods using antimicrobial agents, and strategies for quality assurance in pharmaceutical manufacturing. |
| CO4 | Develop skills in microbiological assays for vitamins, amino acids, and other pharmaceutical components to ensure product efficacy and safety. |
| CO5 | Comprehend regulatory frameworks and quality control standards relevant to pharmaceutical manufacturing, including contamination risks and compliance with industry guidelines. |

| **Reference Books** | |
|---|---|
| 1. | **Prescott's Microbiology**<br>by Joanne Willey, Linda Sherwood, and Christopher J. Woolverton (McGraw-Hill Education, 10th Edition) |
| 2. | **Antibiotics: Actions, Origins, Resistance**<br>by Christopher Walsh and Timothy Wencewicz (ASM Press, 1st Edition) |
| 3. | **Industrial Microbiology: An Introduction**<br>by Michael J. Waites, Neil L. Morgan, John S. Rockey, and Gary Higton (Wiley-Blackwell, 3rd Edition) |
| 4. | Pharmaceutical Microbiology<br>by W.B. Hugo and A.D. Russell (Wiley-Blackwell, 8th Edition) |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | | |
| **Course Objective** | 1. To understand the fundamental principles of stem cell biology.<br>2. To analyze the molecular mechanisms regulating stem cell fate.<br>3. To evaluate the ethical and regulatory frameworks governing stem cell research.<br>4. To explore current trends and advancements in stem cell technology.<br>5. To apply knowledge to propose innovative solutions. | |

| **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 | - | - | 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 | **Foundations of Stem Cell Biology**<br>• Introduction: Understanding stem cells and their classifications.<br>• Historical Perspective: Evolution of stem cell research and major milestones.<br>• Sources and Characteristics: Exploring different types of stem cells and methods to study them.<br>• Ethical and Regulatory Considerations: Addressing ethical dilemmas and regulatory frameworks in stem cell research. | **15** | **25** |
| 2 | **Molecular Mechanisms Governing Stem Cells**<br>• Cellular Signals: How signals influence stem cell behavior.<br>• Transcriptional Control: The role of genes and factors in determining stem cell fate.<br>• Microenvironment: Understanding the environment affecting stem cell activity.<br>• Technological Advancements: Recent innovations in manipulating stem cells for research and therapy. | **15** | **25** |
| 3 | **Clinical Applications of Stem Cells**<br>• Regenerative Medicine: How stem cells are used to repair damaged tissues.<br>• Challenges in Translation: Overcoming obstacles in applying stem cells to clinical settings.<br>• Future Directions: Emerging trends and potential breakthroughs in stem cell therapy. | **15** | **25** |
| 4 | **Stem Cells in Biotechnology and Drug Discovery**<br>• Industrial Applications: Using stem cells in biotechnology and pharmaceutical production.<br>• Modeling Diseases: Creating models of diseases for drug testing using stem cells.<br>• Societal Impact: Considerations around ethical, legal, and social implications of stem cell research and applications. | **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 | To classify different types of stem cells, explain their properties, and discuss their potential applications in research and therapy. |
| CO2 | Evaluate scientific literature, case studies, and experimental data related to stem cell biology and its applications. |
| CO3 | Develop a nuanced understanding of ethical issues surrounding stem cell research and therapy, and apply ethical principles to decision-making in professional contexts. |
| CO4 | Demonstrate proficiency in experimental design, execution, and data interpretation related to stem cell research and biotechnological applications. |
| CO5 | Communicate scientific concepts, research findings, and ethical considerations related to stem cells through oral presentations, written reports, and discussions. |

| **Reference Books** | |
|---|---|
| 1. | **Stem Cells: A Very Short Introduction**<br>by Jonathan Slack (Oxford University Press, 1st edition, 2012) |
| 2. | **Essentials of Stem Cell Biology**<br>edited by Robert Lanza, John Gearhart, et al. (Academic Press, 3rd edition, 2014) |
| 3. | **Stem Cell Biology and Regenerative Medicine**<br>edited by Anthony Atala, Robert Lanza, et al. (Wiley-Blackwell, 1st edition, 2011) |
| 4. | **The Stem Cell Revolution**<br>by Mark Berman and Elliot Lander (BenBella Books, 1st edition, 2016) |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 3** |
| **Type of Course** | Discipline-Specific Elective Courses | |
| **Prerequisite** | | |
| **Course Objective** | 1. To enable the students to understand about the theoretical and practical use and application of Nano biotechnology.<br>2. To foundational knowledge of the Nano science and related fields.<br>3. To make the students acquire an understanding the Nano science and Applications.<br>4. To help them understand in broad outline of Nano science and Nanotechnology<br>5. 5 To predict the structure of protein through bioinformatics tools. | |

| **Teaching Scheme (Contact Hours)** | | | | **Examination Scheme** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **Theory Marks** | | **Practical Marks** | | **Total Marks** |
| **Lecture** | **Tutorial** | **Lab** | **Credit** | **External Mark (T)** | **Internal Marks (T)** | **External Mark (P)** | **Internal Marks (P)** | |
| 3 | - | - | 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 | **BIONANOMACHINES AND THEIR BASICS**<br>Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bionanomachines. The role of proteins- amino acids- nucleic acids- lipids and polysaccharides in modern biomaterials. Overview of natural Bionano machines: Thymidylate Sythetase , ATP syntheses, Actin and myosin, Opine, Antibodies and Collagen. | **9** | **20** |
| 2 | **SYNTHESIS OF BIOMOLECULES & INTERPHASE SYSTEMS**<br>Recombinant Technology, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures and their integration with biological structures. Interphase systems of devices for medical implants – Microfluidic systems – Microelectronic silicon substrates – Nano-biometrics – Introduction – Lipids as Nano bricks and mortar: self-assembled Monolayers. | **9** | **20** |
| 3 | **FUNCTIONAL PRINCIPLES OF NANOBIOTECHNOLOGY**<br>Information driven Nano assembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, Structure and functional properties of Biomaterials, Bimolecular motors: ATP synthetize and flagella motors, Traffic across membranes: Potassium channels, ABC Transporters and Bacteriorhodapsin, | **9** | **20** |
| 4 | **PROTEIN AND DNA BASED NANOSTRUCTURES**<br>Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of bimolecular recognition events – Nanobioelectronic devices and polymer Nano containers – Microbial production of inorganic nanoparticles – Magnetosomes. | **9** | **20** |
| 5 | **APPLICATIONS OF NANOBIOTECHNOLOGY**<br>Semiconductor (metal) nanoparticles, nucleic acid and protein based recognition groups —- Nanotechnology in agriculture – Fertilizer and pesticides. Designer proteins, Peptide nucleic acids, nano- medicine, Drug delivery, DNA computing, Biosensors, Future of bio-nanotechnology. | **9** | **20** |
| | **Total** | **45** | **100** |

| Suggested Distribution Of Theory Marks Using Bloom's Taxonomy | | | | |
|---|---|---|---|---|
| **Level** | Application | Analyze | Evaluate | Create |
| **Weightage** | 30 | 25 | 25 | 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 | Learn about the background on Nano science. |
| CO2 | Implement the synthesis of nanomaterial and their application and the impact of nanomaterial on environment. |
| CO3 | Analyze the role of different biomolecules and natural bionanomaterials |
| CO4 | Apply their learned knowledge to develop Nanomaterial. |
| CO5 | Apply these recognition groups in the development of advanced biosensors and diagnostic tools. |

| Reference Books | |
|---|---|
| 1. | **Nanobiotechnology: Concepts, Applications and Perspectives**<br>By C. M. Niemeyer, C. A. Mirkin, Wiley \| Wiley – VCH, (2004). |
| 2. | **Nano: The Essentials**<br>By T. Pradeep \| McGraw – Hill education, (2007). |
| 3. | **Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact**<br>By Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer \| Wiley – VCH, (2005). |
| 4. | **Nanoparticle Assemblies and Superstructures**<br>By Nicholas A. Kotov \| Boca Raton: Dekker/CRC Press. |
| 5. | **Bionanotechnology**<br>By David S Goodsell \| John Wiley & Sons, (2004). |

| Useful Links |
|---|
| W1:- https://archive.nptel.ac.in/courses/118/107/118107015/ |
| W2:- https://onlinecourses.swayam2.ac.in/aic21_ge16/previe |
| W3:- https://www.researchgate.net/publication/343864776_Fundamentals_of_Nanotechnology_and_Nanobiotechnology |

| | | |
|---|---|---|
| **Course** | Master of Science (M.Sc.) | **Semester - 4** |
| **Type of Course** | Core Courses | |
| **Prerequisite** | 06010206 - TRAINING EVALUATION | |
| **Course Objective** | • To identify appropriate question To execute independent research<br>• To apply knowledge and skills for selected research problemTo establish link between theory and practical in research<br>• To understand and apply ethical standard for conduct in the collection and evaluation of data | |

| **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** |
| - | - | - | 18 | - | - | 500 | - | 500 |

***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** | **Guidelines**<br>Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation.<br>Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student.<br>Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage.<br>The file is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.<br>In general, the File should be comprehensive and include<br>● A short account of the activities that were undertaken as part of the project;<br>● A statement about the extent to which the project has achieved its stated goals.<br>● A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project;<br>● Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project;<br>● Any problems that have arisen that may be useful to document for future reference.<br>● The guidelines and format for dissertation is given in 2nd Module | | |
| **2** | **Dissertation Guidelines** | | |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | 1. GENERAL :<br>The manual is intended to provide broad guidelines to the M.Sc. candidates in the preparation of the dissertation report. In general, the project report shall report, in an organised and scholarly fashion an account of original research work of the candidate leading to the discovery of new facts or techniques or correlation of facts already known.<br>2. NUMBER OF COPIES TO BE SUBMITTED:<br>Students should submit three copies to the Head of the Department concerned on or before the specified date.<br>3. ARRANGEMENT OF CONTENTS OF DISSERTATION:<br>Dissertation material should be arranged as follows:<br>1. Cover Page & Title page<br>2. Declaration<br>3. Certificate<br>4. Abstract (Hindi and English)<br>5. Acknowledgements<br>6. Table of Contents<br>7. List of Tables<br>8. List of Figures<br>9. List of Symbols, Abbreviations and Nomenclature (Optional)<br>10. Chapters<br>11. References<br>12. Appendices<br>13. One page CV<br>The Tables and Figures shall be introduced in the appropriate places.<br>4. PAGE DIMENSIONS AND MARGIN:<br>The dimensions of the dissertation should be standard A4 size paper may be used for preparing the copies, standard margin with 1.5 line spacing. | | |
| **3** | **Manuscript Preparation** | | |

**Course Content**

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

| Sr. | Topics | T | W |
|---|---|---|---|
| | The general text of thesis shall be typed in font style Times New Roman and font size 12. Same quality of the paper should be used for the preparation of the entire report/thesis; except figure, photos are shown.<br>1 Cover Page & Title Page - A specimen copy of the Cover page & Title page for report/thesis 2 Certificate-The Bonafide Certificate as per the format 3 Abstract: Abstract should be an essay type (HINDI and ENGLISH) of narration not exceeding 500 words outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in 1.5line spacing.<br>4 Acknowledgements: The acknowledgements shall be brief and should not exceed onepage. The student's signature shall be made at the right bottom above his / her name typed in capitals.<br>5 Table of contents - The table of contents should list all material following it as wellas any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.<br>6 List of Table - The list should use exactly the same captions as they appear above thetables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.<br>7 List of Figures - The list should use exactly the same captions as they appear belowthe figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head<br>8 List of Symbols, Abbreviations and Nomenclature - One and a half spacing shouldbe adopted for typing the matter under this head. Standard symbols, abbreviations etc. should be used.<br>9 Chapters - The chapters may include: Chapter I – Introduction<br>Chapter II - Literature Review<br>Chapter III –Materials and Methods<br>Chapter IV- Results and Discussion 10. Research output/outcome if any published or presented in a conference/ seminar/symposium may be included. 11. List of References - Any works of other researchers, if used either directly orindirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms. APA Style.<br>APA in-text citation style uses the author's last name and the year of publication, for example:(Field, 2005).<br>Example:Derwing, T. M., Rossiter, M. J., & Munro, M. J. (2002). Teaching native speakers to listen to foreign-accented speech. Journal of Multilingual and Multicultural Development, 23(4), 245-259. | | |
| | **Total** | | |

**Suggested Distribution Of Theory Marks Using Bloom's Taxonomy**

| Level | Remembrance | Understanding | Application | Analyze | Create |
|---|---|---|---|---|---|
| **Weightage** | 10 | 20 | 30 | 20 | 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 | Identifying appropriate research question and applying suitable research designs |
| CO2 | Execution of independent research experiments |
| CO3 | Application of knowledge and skills previously gained for selected research problem |

| | |
|---|---|
| CO4 | Establishing links between theory and methods in selected area of research |
| CO5 | Understand and apply ethical standards of conduct in the collection and evaluation of data and other resources |

| Reference Books | |
|---|---|
| 1. | **BIOSTATISTICS AND RESEARCH METHODOLOGY**<br>By Dr. Ashok A. Hajare \| Nirali Prakashan, Pub. Year 2022 |
| 2. | **How to research**<br>By Blaxter Loraine \| Viva book \| 2nd, Pub. Year 2002 |
| 3. | **Research Methodology**<br>By D K Bhattacharya \| Excel Books, New Delhi. |
| 4. | **Research Methodology**<br>By C. R. Kothari \| New Age International Publishers |