**ANNAMALAI UNIVERSITY**

**(Affiliated Colleges)**

**212 – B. Sc. Microbiology**

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

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| Part | Course Code | Study Components & Course Title | Credit | Hours/Week | Maximum Marks |
| CIA | ESE | Total |
|  |  | SEMESTER – I |  |  |  |  |  |
| I | 23UTAML11/23UHINL11/23UFREL11 | Language– I:nghJ jkpo; - IHindi-I/French-I | 3 | 6 | 25 | 75 | 100 |
| II | 23UENGL12 | General English - I | 3 | 6 | 25 | 75 | 100 |
| III | 23UMICC13 | Core – I: Fundamentals of Microbiology and Microbial Diversity | 5 | 5 | 25 | 75 | 100 |
| 23UMICP14 | Core – II: Practical – I: Fundamentals of Microbiology and Microbial Diversity | 5 | 5 | 25 | 75 | 100 |
| 23UBCBE15 | Elective – I (General /Discipline Specific)Basic and Clinical Biochemistry | 3 | 4 | 25 | 75 | 100 |
| IV | 23UTAMB1623UTAMA16 | Skill Enhancement Course – I (NME-I) /\*Basic Tamil – I /Advanced Tamil - I | 2 | 2 | 25 | 75 | 100 |
| 23UMICF17 | Foundation Course:Basics of Microbiology | 2 | 2 | 25 | 75 | 100 |
|  |  | Total | 23 | 30 |  |  | 700 |
|  |  | SEMESTER – II |  |  |  |  |  |
| I | 23UTAML2123UHINL21/23UFREL21 | Language– II:nghJ jkpo; - IIHindi-IIFrench-II | 3 | 6 | 25 | 75 | 100 |
| II | 23UENCL22 | General English – II | 3 | 6 | 25 | 75 | 100 |
| III | 23UMICC23 | Core – III: Microbial Physiology and Metabolism | 5 | 5 | 25 | 75 | 100 |
| 23UMICP24 | Core – IV: Practical – II: Microbial Physiology and Metabolism Practical | 5 | 5 | 25 | 75 | 100 |
| 23UBINE25 | Elective – II (General /Discipline Specific)Bioinstrumentation | 3 | 4 | 25 | 75 | 100 |
| IV | 23UTAMB2623UTAMA26 | Skill Enhancement Course – II (NME-II) /\*Basic Tamil – II /Advanced Tamil - II  | 2 | 2 | 25 | 75 | 100 |
| 23USECG27 | Skill Enhancement Course – IIIInternet and its Applications(Common Paper) | 2 | 2 | 25 | 75 | 100 |
|  |  | Total | 23 | 30 |  |  | 700 |

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|  | NME offered to other Departments |  |  |  |
| IV | 23 UMICN16 | Social and Preventive medicine  | 2 | 2 | 25 | 75 | 100 |
| IV | 23UMICN26 | Nutrition & Health Hygiene | 2 | 2 | 25 | 75 | 100 |

\* PART-IV: NME / Basic Tamil / Advanced Tamil (Any one)

Students who have not studied Tamil upto 12th Standard and have taken any Language other than Tamil in Part-I, must choose Basic Tamil-I in First Semester & Basic Tamil-II in Second Semester.

Students who have studied Tamil upto 10th & 12th Standard and have taken any Language other than Tamil in Part-I, must choose Advanced Tamil-I in First Semester and Advanced Tamil-II in Second Semester.

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| SEMESTER: ICORE - IPART - III | **CORE – I : Fundamentals of Microbiology and Microbial Diversity (23UMICC13)** | CREDIT: 5HOURS: 5/W |

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| **Course Objectives** |
| CO1 | Learn the fundamental principles about different aspects of Microbiology including recent developments in the area.  |
| CO2 | Describe the structural organization, morphology and reproduction of microbes. |
| CO3 | Explain the methods of cultivation of microbes and measurement of growth. |
| CO4 | Understand the microscopy and other basic laboratory techniques – culturing, disinfection and sterilization in Microbiology. |
| CO5 | Compare and contrast the different methods of sterilization. |
| **UNIT** | **Details** | **No.of Hours** | **Course Objectives** |
| I | History and Evolution of Microbiology, Classification – Three kingdom, five kingdom, six kingdom and eight kingdom. Microbial biodiversity: Introduction to microbial biodiversity- ecological niche. Basic concepts of Eubacteria, Archaebacteria and Eucarya. Conservation of Biodiversity.  | 12 | CO1 |
| II | General characteristics of cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses, Viroids, Prions), Differences between prokaryotic and eukaryotic microorganisms. Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores, and gas vesicles. Structure of fungi (Mold and Yeast), Structure of microalgae.  | 12 | CO2 |
| III | Bacterial culture media and pure culture techniques. Mode of cell division, Quantitative measurement of growth. Anaerobic culture techniques.  | 12 | CO3 |
| IV | Microscopy – Simple, bright field, dark field, phase contrast, fluorescent, electron microscope – TEM & SEM, Confocal microscopy, and Atomic Force Microscopy. Stains and staining methods.  | 12 | CO4 |
| V | Sterilization–moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – membrane filter and disinfection, antiseptic; Antimicrobial agents. | 12 | CO5 |
|  | **Total** | 60 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Study the historical events that led to the discoveries and inventions and understand the Classification of Microorganisms. | PO5, PO6, PO10 |
| CO2 | Gain Knowledge of detailed structure and functions of prokaryotic cell organelles. | PO10 |
| CO3 | Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.  | PO11 |
| CO4 | Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application. | PO4, PO11 |
| CO5 | Understand the concept of asepsis and modes of sterilization and disinfectants**.** | PO4, PO11 |
| **Text Books** |
| 1 | Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7thEdition.,McGraw –Hill, New York. |
| 2 | Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott’s Microbiology. 10thEdition., McGraw-Hill International edition. |
| 3 | Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11thEdition., A La Carte Pearson. |
| 4 | Salle. A.J (1992). Fundamental Principles of Bacteriology. 7thEdition., McGraw Hill Inc.New York. |
| 5 | Boyd, R.F. (1998). General Microbiology,2ndEdition., Times Mirror, Mosby CollegePublishing, St Louis. |
| **References Books** |
| 1 | Jeffrey C. Pommerville., Alcamo’s Fundamentals of Microbiology (9thEdition). Jones &Bartlett learning 2010. |
| 2 | Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5thEdition., MacMillan Press Ltd |
| 3 | Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction,11thEdition., Benjamin Cummings. |
| 4 | Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5thEdition., McGraw Hill Publications. |
| 5 | Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology ofMicroorganisms, 13th Edition Benjamin-Cummings Pub Co. |
| **Web Resources** |
| 1 | https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology |
| 2 | <https://www.keyence.com/ss/products/microscope/bz-x/study/principle/structure.jsp> |
| 3 | https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/# |
| 4 | [https://bio.libretexts.org/@go/page/9188](https://bio.libretexts.org/%40go/page/9188) |
| 5 | https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/ |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| Create (K6) | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  |  | M | M |  |  |  | M |  |
| CO2 |  |  |  |  |  |  |  |  |  | M | M |
| CO3 |  |  |  |  |  |  |  |  |  |  | S |
| CO4  |  |  |  | M |  |  |  |  |  |  | S |
| CO5 |  |  |  | M |  |  |  |  |  |  | S |

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| SEMESTER: ICORE Practical- IPART - III | **CORE –II :Practical – 1** **Fundamentals of Microbiology and Microbial Diversity (23UMICP14)** | CREDIT: 5HOURS: 5/W |

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| **Course Objectives** |
| CO1 | Acquire knowledge on Cleaning of glass wares, GLP and sterilization.  |
| CO2 | Gain knowledge on media preparation and cultural characteristics. |
| CO3 | Learn the pure culture technique |
| CO4 | Learn the microscopic techniques and staining methods. |
| CO5 | Acquire knowledge on stain and staining methods  |
| **UNIT** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Cleaning of glass wares, Microbiological good laboratory practice and safety. Sterilization and assessment of sterility– Autoclave, hot air oven, and membrane filtration. | 12 | CO1 |
| II | Media preparation: liquid media, solid media, semi-solid media, agar slants, agar deeps, agar plates. | 12 | CO2 |
| III | Preparation of basal, differential, enriched, enrichment, transport, and selective media preparation- quality control of media, growth supporting properties, sterility check of media.Pure culture techniques: streak plate, pour plate, decimal dilution.  | 12 | CO3 |
| IV | Culture characteristics of microorganisms: growth on different media, growth characteristics, and description. Demonstration of pigment production.Microscopy: light microscopy and bright field microscopy. | 12 | CO4 |
| V | Staining techniques: smear preparation, simple staining, Gram’s staining and endospore staining.Study on Microbial Diversity using Hay Infusion Broth-Wet mount to show different types of microbes, hanging drop.  | 12 | CO5 |
|  | **Total** | 60 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Practice sterilization methods; learn to prepare media and their quality control.  | PO4, PO7, PO8, PO9, PO11 |
| CO2 | Learn streak plate, pour plate and serial dilution and pigment production of microbes. | PO4, PO7, PO8, PO9 |
| CO3 | Understand Microscopy methods, different Staining techniques and motility test. | PO4, PO7, PO8, PO9, PO11 |
| CO4 | Observe culture characteristics of microorganisms. | PO4, PO7, PO8, PO9 |
| CO5 | Study on Microbial Diversity using Hay Infusion Broth-Wet mount | PO4, PO7, PO8, PO9 |
| **Text Books** |
| 1 | James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996. |
| 2 | Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications. |
| 3 | Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications. |
| 4 | Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi. |
| 5 | R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing. |
| **References Books** |
| 1 | Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.  |
| 2 | Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India |
| 3 | Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS |
| 4 | Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.  |
| 5 | Lim D. (1998). Microbiology, 2ndEdition, WCB McGraw Hill Publications. |
| **Web Resources** |
| 1 | http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403. |
| 2 | <https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635> |
| 3 | https://www.grsmu.by/files/file/university/cafedry//files/essential\_microbiology.pdf |
| 4 | https://microbiologyinfo.com/top-and-best-microbiology-books/ |
| 5 | <https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology> |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  | M |  |  | L | M | L |  | M |
| CO2 |  |  |  | S |  |  | L | L | L |  |  |
| CO3 |  |  |  | S |  |  | M | M | L |  | M |
| CO4 |  |  |  | S |  |  | M | L | L |  |  |
| CO5 |  |  |  | S |  |  | M | L | L |  |  |

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| SEMESTER: IElecvtive-1PART - III | **Elective – 1** **BASIC AND CLINICAL BIOCHEMISTRY** **(23UBCBE15)** | CREDIT: 3HOURS: 4/W |

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| **Course Objectives** |
| CO1 | Attain thorough knowledge on carbohydrates and lipids, their characteristic properties and organization in carrying out all the living functions which constitute the life. |
| CO2 | Explain the biological activity of amino acids and proteins. |
| CO3 | Identify the metabolic errors in enzymes of carbohydrates and lipids. |
| CO4 | Describe the disorders in amino acid metabolism. |
| CO5 | Interpret the consequences, biochemical, clinical features, diagnosis and treatment of metabolic diseases of day today life. |
| **UNIT** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Biomolecules -Carbohydrate – General properties, function, structure, classification– monosaccharides (Glucose, Fructose, Galactose), Oligoaccharides (Sucrose, Maltose, Lactose) and polysaccharides (Starch, Glycogen,) and biological significance. Lipids – General properties, functions, structure, classification (Simple, Derived and Complex), Cholesterol, LDL, HDL – biological significance. | 12 | CO1 |
| II | Biomolecules - Amino acids – General properties, functions, structure, classification and biological significance. Proteins– General structure, Properties, functions, classification and biological significance. | 12 | CO2 |
| III | Disorders of Metabolism: Disorders of carbohydrate metabolism: diabetes mellitus,ketoacidosis, hypoglycemia, glycogen storage diseases, galactosemia and lactose intolerance. Disorders of lipid metabolism: hyperlipidemia, hyperlipoproteinemia, hypercholesterolemia, hypertriglyceridemia,sphingolipidosis. | 12 | CO3 |
| IV | Disorders of Metabolism: Disorders of amino acid metabolism:alkaptonuria, phenylketonuria, phenylalaninemia, homocystineuria, tyrosinemia, aminoacidurias. | 12 | CO4 |
| V | Evaluation of organ function tests: Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. | 12 | CO5 |
|  | Total | 60 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Explain the structure, classification , biochemical functions and significance of carbohydrates and lipids | PO1 |
| CO2 | Differentiate essential and non-essential amino acids, biologically important modified amino acids and their functions, Illustrate the role, classification of Proteins and recognize the structural level organization of proteins, its functions and denaturation. | PO1 |
| CO3 | Assess defective enzymes and Inborn errors. Recognize diseases related to carbohydrate and lipid metabolism. | PO4, PO5, PO6 |
| CO4 | Discuss and evaluate the pathology of aminoacid metabolic disorders. | PO4, PO5, PO6 |
| CO5 | Appraise the imbalances of enzymes in organ function and relate the role of Clinical Biochemistry in screening and diagnosis. | PO5, PO6, PO9 |
| **Text Books** |
| 1 | Satyanarayana, U. and Chakrapani, U(2014).Biochemistry,4th Edition, Made Simple Publisher. |
| 2 | Jain J L, Sunjay Jain and Nitin Jain (2016).Fundamentals of Biochemistry, 7th Edition, S Chand Company. |
| 3 | AmbikaShanmugam’s (2016). Fundamentals of Biochemistry for Medical Students, 8th Edition. Wolters Kluwer India Pvt Ltd. |
| 4 | Vasudevan. D.M.Sreekumari.S, Kannan Vaidyanathan (2019). Textbook Of Biochemistry For Medical Students. Kindle edition, Jaypee Brothers Medical Publishers |
| 5 | Jeremy M. Berg,LubertStryer, John L. Tymoczko, Gregory J. Gatto (2015). Biochemistry, 8th edition. WH Freeman publisher. |
| **References Books** |
| 1 | AmitKessel&Nir Ben-Tal (2018). Introduction to Proteins: structure, function and motion. 2ndEdition, Chapman and Hall. |
| 2 | David L. Nelson and Michael M. Cox (2017).Lehninger Principles of Biochemistry, 7thEdition W.H. Freeman and Co., NY. |
| 3 | LupertStyrer, Jeremy M. Berg, John L. Tymaczko, Gatto Jr., Gregory J (2019). Biochemistry. 9thEdition ,W.H.Freeman& Co. New York. |
| 4. | Donald Voet, Judith Voet, Charlotte Pratt (2016). Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, Wiley. |
| 5.  | Joy PP, Surya S. and AswathyC (2015). Laboratory Manual of Biochemistry, Edition 1.,Publisher:Kerala agricultural university.  |
| **Web Resources** |
| 1 | https://www.abebooks.com › plp |
| 2 | <https://kau.in/document/laboratory-manual-biochemistry> |
| 3 | https://metacyc.org |
| 4 | https://www.medicalnewstoday.com |
| 5 | https://journals.indexcopernicus.com |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | M |  |  |  |  |  |  |  |  |  |  |
| CO2 | M |  |  |  |  |  |  |  |  |  |  |
| CO3 |  |  |  | S | S | S |  |  |  |  |  |
| CO4 |  |  |  | S | S | S |  |  |  |  |  |
| CO5 |  |  |  |  | S | S |  |  | S |  |  |

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| SEMESTER: IFoundation CoursePART - IV | **Foundation Course : Basics of Microbiology****(23UMICF17)** | CREDIT: 2HOURS: 2/W |

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| **Learning Objectives** |
| CO1 | To become familiar with the concepts of microorganisms in soil |
| CO2 | To understand the microbial populations in water |
| CO3 | To gain the knowledge of microorganisms in air |
| CO4 | To understand the relationship between microorganisms and food  |
| CO5 | To know the applications of microorganisms |
| **UNIT** | **Details** | **No. of Hours** | **Course Objectives** |
| I | **Microbiology of Soil**Soil as an environment as a culture medium-Micro biota of soil-Rhizosphere- Definition: Rhizosphere and non rhizosphere microflora-R:S ratio, interactions between plant and rhizophere flora- microbes used as biofertilizers. | 12 | CO1 |
| II | **Microbiology of Water**Microbial communities in natural water-Ponds, lakes, streams-Marine habits-estuaries, mangroves, deep sea-zonation-Eutrophication. Indicator bacteria. | 12 | CO2 |
| III | **Microbiology of Air**Composition of air-Number and kinds of microorganisms in air (indoor, outdoor)-Distribution and sources of air borne microorganisms-Air as a carrier of microorganisms-Droplet, droplet nuclei, dispersal of microorganisms in air. Air sanitation- dust control, UV radiation, bacter/icidal vapors, filtration, laminar air flow system (HEPA filters). | 12 | CO3 |
| IV | **Microbiology of Food**Food as a substrate for microorganisms-sources of contamination of food-importance of *Lactobacillus* in food fermentation- spoilage of foods-Food preservation-pasteurization-canning. | 12 | CO4 |
| V | **Economic importance of microorganisms**Applications of bacteria- Bio fertilizer-Eg. Rhizobium, fungi-Eg. Penicillin production, algae-Eg.SCP- Spirulina and virus- Bio pesticides-CPV, NPV | 12 | CO5 |
|  | **Total** | **60** |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| **CO1** | To understand relevance of microorganismsin agriculture | PO1 |
| **CO2** | To understand the marine habitat and microbial community in water | PO1, PO2 |
| **CO3** | To gain knowledge of distributions and sources of microorganisms in air | PO4, PO6 |
| **CO4** | To understand the spoilage and contamination of food and food products | PO4, PO5, PO6 |
| **CO5** | To learn about the biofertilizer, biopesticide and its applications | PO3, PO8 |
| **Text Books** **(Latest Editions)** |
| 1. | Atlas R.M., Microbiology – fundamentals and applications, Macmillan Publishing Company, New York.  |
| 2 | Pelczar .J. Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Book Company, New York.  |
| 3. | Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi. |
| 4 | Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited. |
| 5 | RavindraNath, Fundamentals of Biology Courses for Biotechnology, - Vol.1, Special Bangalore University edition, Kalayani Publishers. |
| **References Books** **(Latest editions, and the style as given below must be strictly adhered to)** |
| 1. | Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi. |
| 2. | Thomas M. Bell, 1965. An Introduction to General Virology, William Heinemann Medical books, London. |
| 3. | Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi. |
| 4. | Salle A.J., Fundamental Principles of Bacteriology, Tata McGraw – Hill Publishing Company Limited, New Delhi. |
| 5 | Benson Harold J, Microbiological Applications, WCB McGraw – Hill, New York. |
| 6 | Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford. |
| 7 | Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California. |
| 8 | Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill. |
| 9 | Madigan MT, Martinko JM and Parker J (2012). Brock Biology of Microorganism, 11th edition Prentice Hall International Inc. London. |
| **Web Resources** |
| 1. | <https://vlab.amrita.edu/?sub=3&brch=73> |
| 2. | <https://learn.chm.msu.edu/vibl/> |
| 3. | <https://mvi-au.vlabs.ac.in/> |
| 4. | <https://virtuallab.tlc.ontariotechu.ca/intro.php> |
| 5. | <https://www.merlot.org/merlot/viewMaterial.htm?id=79694> |
| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | S |  |  |  | S | S |  |  |  |  |  |
| CO2 | S | S |  | M | S | S |  |  | M |  |  |
| CO3 |  |  |  | M | S | S |  |  |  |  |  |
| CO4 | S |  |  | S | S | M |  |  |  |  |  |
| CO5 | S |  |  |  | S | S |  |  |  |  |  |

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| SEMESTER: ICore-IIIPART - III | **MICROBIAL PHYSIOLOGY AND METABOLISM (23UMICC23)** | CREDIT: 5HOURS: 5/W |

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| **Course Objectives** |
| CO1 | Study the basic principles of microbial growth. |
| CO2 | Understand the basic concepts of aerobic and anaerobic metabolic pathways. |
| CO3 | Analyze the role of individual components in overall cell function. |
| CO4 | Provide information on sources of energy and its utilization by microorganisms. |
| CO5 | Study the different types of metabolic strategies. |
| **Unit** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Physiology of microbial growth: Batch – continuous - synchronous cultures; Growth Curve and measurement method (turbidity, biomass, and cell count). Control of microbial growth. | 12 | CO1 |
| II | Nutrition requirements - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria), Chemoorganotrophs. Nutrition transport mechanisms – Passive diffusion and Active transport. Factors affecting microbial growth. | 12 | CO2 |
| III | An overview of Metabolism - Embden Meyerhof Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. ATP synthesis. Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation. | 12 | CO3 |
| IV | Photosynthesis - An Overview of chloroplast structure. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle. | 12 | CO4 |
| V | Bacterial reproduction - Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa. | 12 | CO5 |
|  | Total | 60 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Describe microorganisms based on nutrition. | PO6, PO9 |
| CO2 | Know the concept of microbial growth and identify the factors affecting bacterial growth. | PO6, PO7, PO9 |
| CO3 | Explain the methods of nutrient uptake.  | PO6, PO9 |
| CO4 | Describe anaerobic and aerobic energy production. | PO6, PO9 |
| CO5 | Elaborate on the process of bacterial photosynthesis and reproduction. | PO6, PO9 |
| **Text Books** |
| 1 | Schlegal, H.G. (1993). General Microbiology.,7th Edition, Press syndicate of the University of Cambridge. |
| 2 | RajapandianK.(2010). Microbial Physiology, Chennai: PBS Book Enterprises India. |
| 3 | MeenaKumari. S. Microbial Physiology, Chennai 1st Edition MJP Publishers 2006. |
| 4 | Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. |
| 5 | S. Ram Reddy, S.M. Reddy (2008). Microbial Physiology. Anmol Publications Pvt Ltd. |
| **References Books** |
| 1 | Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49. |
| 2 | Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge. |
| 3 | Daniel R. Caldwell. (1995). Microbial Physiology & Metabolism Wm.C. Brown Communications, Inc. USA. |
| 4 | Moat, A.G and J.W Foaster (1995). Microbial Physiology, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications. |
| 5 | BhanuShrivastava. (2011). Microbial Physiology and Metabolism: Study of Microbial Physiology and Metabolism. Lambert academic Publication. |
| **Web Resources** |
| 1 | https://sites.google.com/site/microbial physiologyoddsem/teaching-contents |
| 2 | https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition |
| 3 | <https://onlinecourses.swayam2.ac.in/cec20_bt14/preview> |
| 4 | http://web.iitd.ac.in/~amittal/2007\_Addy\_Enzymes\_Chapter.pdf |
| 5 | <https://www..frontiersin.org.microbial-physiology-and-metabolism> |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  |  |  | M |  |  | M |  |  |
| CO2 |  |  |  |  |  | M | L |  | M |  |  |
| CO3 |  |  |  |  |  | M |  |  | M |  |  |
| CO4 |  |  |  |  |  | M |  |  | M |  |  |
| CO5 |  |  |  |  |  | M |  |  | M |  |  |

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| SEMESTER: ICore-IVPART - III | **PRACTICAL-II:****MICROBIAL PHYSIOLOGY AND METABOLISM (23UMICP24)** | CREDIT: 5HOURS: 5/W |

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| **Course Objectives** |
| CO1 | Understand the principles of motility test.  |
| CO2 | Understand the basic concepts of staining methods. |
| CO3 | Learn the bacterial count using different methods and anaerobic culture. |
| CO4 | Study the morphological demonstration of microorganisms and identification. |
| CO5 | Study the biochemical identification of the bacteria. |
| **UNIT** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Motility demonstration: hanging drop, wet mount preparation, semi-solid agar, Craigie’s tube method. Staining techniques: Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining | 12 | CO1 |
| II | Direct counts – Direct cell count (Petroff-Hausser counting chamber), Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve.  | 12 | CO2 |
| III | Anaerobic culture methods. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains. | 12 | CO3 |
| IV | Morphological variations in algae, fungi and protozoa. Micrometry: Demonstration of the size of yeast, fungal filaments and protozoa. | 12 | CO4 |
| V | Methods of bacterial identification- morphological, physiological, and biochemical methods - IMViC test, H2S, TSI, Oxidase, catalase, urease test, and Carbohydrate fermentation test.Maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture. | 12 | CO5 |
|  | **Total** | 60 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Describe hanging drop, wet mount preparation, semi-solid agar, Craigie’s tube method.  | PO6, PO7, PO8, PO9, PO11 |
| CO2 | Demonstrate Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining. | PO6, PO7, PO8, PO9, PO11 |
| CO3 | Explain antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains. | PO6, PO7, PO8, PO9, PO11 |
| CO4 | Describe demonstration of the size of yeast, fungal filaments and protozoa. | PO6, PO7, PO8, PO9, PO11 |
| CO5 | Elaborate on the bacterial identification- morphological, physiological, and biochemical methods. | PO6, PO7, PO8, PO9, PO11 |
| **Text Books** |
| 1 | James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York . |
| 2 | Kannan. N (1996).Laboratory manual in General Microbiology. Palani Publications. |
| 3 | Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications. |
| 4 | Gunasekaran. P (2007). Laboratory manual in Microbiology. New age international publisher. |
| 5 | Elsa Cooper (2018). Microbial Physiology: A Practical Approach. Callisto Reference publisher. |
| **References Books** |
| 1 | DavidWhite., James Drummond., Clay Fuqua (2012) Physiology and Biochemistry of Prokaryotes. 4th Ed. Oxford University Press, New York. |
| 2 | Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49. |
| 3 | Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge. |
| 4 | Dawes, I.W and Sutherland L.W (1992). Microbial Physiology (2nd edition), Oxford Blackwell Scientific Publications. |
| 5 | Moat, A.G and J.W Foaster, (1995). Microbial Physiology, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications. |
| **Web Resources** |
| 1 | https://sites.google.com/site/microbial physiologyoddsem/teaching-contents |
| 2 | <https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition> |
| 3 | <https://onlinecourses.swayam2.ac.in/cec20_bt14/preview> |
| 4 | https://www.studocu.com/microbial-physiology-practicals |
| 5 | https://www.agr.hokudai.ac.jp/microbial-physiology |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 40 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 60 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations. |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  |  |  | M | L | M | L |  | M |
| CO2 |  |  |  |  |  | M | M | L | M |  | L |
| CO3 |  |  |  |  |  | L | M | M | L |  | M |
| CO4 |  |  |  |  |  | L | M | M | M |  | M |
| CO5 |  |  |  |  |  | M | M | M | M |  | M |

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| SEMESTER: IElective-IIPART - III | **Elective-II: BIOINSTRUMENTATION** **(23UBINE25)** | CREDIT: 3HOURS: 4/W |

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| **Course Objectives** |
| CO1 | Understand the analytical instruments and study the basic principles in the field of sciences. |
| CO2 | To gain knowledge about principles of spectroscopy |
| CO3 | Understand the analytical techniques of Chromatography and electrophoresis |
| CO4 | To understand the principle of different types of scans used in medical diagnosis |
| CO5 | To gain information about the principles of radioactivity and its measurements |
| **Unit** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Basic instruments: pH meter, Buffer of biological importance, Centrifuge- Preparative, Analytical and Ultra, Laminar Air Flow, Autoclave**,** Hot Air Oven and Incubator. Biochemical calculations-preparations of Molar solutions - Buffers- Phosphate, Acetate, TE, TAE- calculation of Normality ,PPM- Ammonium sulphate precipitation. | 12 | CO1 |
| II | Spectroscopic Techniques: Spectroscopic Techniques: Colorimeter, Ultraviolet and visible, Infra red and Mass Spectroscopy. | 12 | CO2 |
| III | Chromatographic and Electrophoresis Techniques: Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch Gel, AGE, PAGE.  | 12 | CO3 |
| IV | Imaging techniques: Principle, Instrumentation and application of ECG, EEG, EMG, MRI, CT and PET scan radioisotopes.  | 12 | CO4 |
| V | Fluorescence and radiation based techniques: Spectr of luorimeter, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography. | 12 | CO5 |
|  | Total | 60 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Gain knowledge about the basics of instrumentation. | PO1,PO4,PO11 |
| CO2 | Exemplify the structure of atoms and molecules by using the principles of spectroscopy. | PO4,PO10,PO11 |
| CO3 | Evaluate by separating and purifying the components. | PO4,PO7,PO11 |
| CO4 | Understand the need and applications of imaging techniques. | PO7,PO8,PO11 |
| CO5 | Categorize the working principle and applications of fluorescence and radiation. | PO10,PO11 |
| **Text Books** |
| 1. | Jayaraman J (2011). Laboratory Manual in Biochemistry, 2nd Edition. Wiley Eastern Ltd., New Delhi . |
| 2. | Ponmurugan. P and Gangathara PB (2012). Biotechniques.1stEdition. MJP publishers. |
| 3 | Veerakumari, L (2009).Bioinstrumentation- 5 thEdition -.MJP publishers. |
| 4 | Upadhyay, Upadhyay and Nath (2002). Biophysical chemistry – Principles and techniques 3rd Edition. Himalaya publishing home. |
| 5 | Chatwal G and Anand (1989). Instrumental Methods of Chemical Analysis. S.Himalaya Publishing House, Mumbai. |
| **References Books** |
| 1 | Rodney.F.Boyer (2000). Modern Experimental Biochemistry, 3rd Edition. Pearson Publication. |
| 2 | SkoogA.,WestM (2014). Principles of Instrumental Analysis – 14th Edition W.B.SaundersCo.,Philadephia. |
| 3 | N.Gurumani. (2006). Research Methodology for biological sciences- 1st Edition – MJPPublishers . |
| 4 | Wilson K, and Walker J (2010). Principles and Techniques of Biochemistry and Molecular Biology.7thEdition. Cambridge University Press . |
| 5 | Webster, J.G. (2004). Bioinstrumentation- 4th Edition - John Wiley & Sons (Asia) Pvt.Ltd,Singapore.  |
| **Web Resources** |
| 1 | http://www.biologydiscussion.com/biochemistry/centrifugation/centrifugeintroduction- types- uses-and-other-details-with-diagram/12489  |
| 2 | https://www.watelectrical.com/biosensors-types-its-working-andapplications/ |
| 3 | http://www.wikiscales.com/articles/electronic-analytical-balance/ Page 24 of 75 |
| 4 | https://study.com/academy/lesson/what-is-chromatography-definition-typesuses.html |
| 5 | http://www.rsc.org/learn-chemistry/collections/spectroscopy/introduction |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes**:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | L |  |  | M |  |  |  |  |  |  | S |
| CO2 |  |  |  | L |  |  |  |  |  | M | S |
| CO3 |  |  |  | L |  |  | M |  |  |  | S |
| CO4 |  |  |  |  |  |  | S | S |  |  | S |
| CO5 |  |  |  |  |  |  |  |  |  | M | S |

**Elective papers Offered by Department of Microbiology to other programmes**

**Elective Paper I FUNDAMENTALS OF MICROBIOLOGY**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **L** | **T** | **P** | **S** | **Credits** | **Instructional Hours** | **Marks** |
| **CIA** | **External** | **Total** |
|  | **3** | **1** |  |  | **3** | **4** | **25** | **75** | **100** |
| **Course Outcomes** |
| CO1 | Understand the classification of Microorganisms and structure of bacteria |
| CO2 | Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms. |
| CO3 | Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes. |
| CO4 |  Understand the skills in working procedures of Microscopes. |
| CO5 | Understand about the nutritional requirements of Microorganisms. |
| **UNIT** | **Contents** | **No.of Hours** |
| I | History and scope of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology. |  15 |
| II | Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram’s, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae. | 15 |
| III | Sterilization methods - physical and chemical methods- Mode of action – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL. | 15 |
| IV | Microscopy: Principle and applications of Bright field, Dark field, Phase contrast, Fluorescent Microscope, Electron microscope-TEM and SEM. | 15 |
| V | Microbial metabolism: Nutritional requirements - macro and micro nutrients - Nutritional groups-Nutrient Transport: Active, passive and facilitated-Microbial Growth-Growth curve - Factors affecting growth (temperature, acidity, alkalinity, water availability and oxygen requirement) -measurement of growth,-Bacterial growth kinetics-Batch, continuous culture and synchronous growth. | 15 |
| **Total** | **75** |
| **Text Books** |
| 1 | Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw –Hill, New York. |
| 2 | Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. |
| 3 | Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016. |
| 4 | Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC |
| **Reference Books** |
| 1 | Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017. |
| 2 | Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby CollegePublishing, St Louis. |
| 3 | [Dr. C.B.Powar](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Dr.+C.B.Powar&search-alias=stripbooks) (Author), [Dr.H.F. Daginawala](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&field-author=Dr.H.F.+Daginawala&search-alias=stripbooks). January 2010.General Microbiology Vol. I Vol.II. Himalalya Publishing home. |
| 4 | Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson. |

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| **Web Resources** |
| 1 | Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB) |
| 2 | <http://www> ejb.org/content. |
| 3 | www. Biotech.kth.se Electronic Journal of biotechnology |
| 4 | https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to- microbiology/a-brief-history-of-microbiology |
| 5 | [https://bio.libretexts.org/@go/page/9188](https://bio.libretexts.org/%40go/page/9188) |

**MAPPING WITH PROGRAMME OUTCOMES**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  | M |  |  | L | M | L |  | M |
| CO2 |  |  |  | S |  |  | L | L | L |  |  |
| CO3 |  |  |  | S |  |  | M | M | L |  | M |
| CO4 |  |  |  | S |  |  | M | L | L |  |  |
| CO5 |  |  |  | S |  |  | M | L | L |  |  |

**ELECTIVE PRACTICAL I -FUNDAMENTALS OF MICROBIOLOGY**

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| **Subject Code** | **L** | **T** | **P** | **S** | **Credits** | **Hours/W** | **Marks** |
| **CIA** | **External** | **Total** |
|  |  |  | **4** |  | **2** | **4** | **25** | **75** | **100** |
| **Course Outcomes** |
| CO1 | Describe the general Laboratory safety & Sterilization Techniques  |
| CO2 | Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques  |
| CO3 | Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques. |
| CO4 | Perform the Motility of organisms. |
| CO5 | Able to characterize and identify bacteria using Biochemical tests.  |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Sterilization techniques – Preparation of Media | 9 |
| II | Inoculation techniques- Pour plate, spread plateIsolation of bacteria from various sources and dilution techniques. | 9 |
| III | Staining techniques: Simple, Gram’s, Capsule (Negative), Spores,Preparation of temporary mounts- Lacto phenol cotton blue staining. | 9 |
| IV | Motility tests: Hanging drop technique.  | 9 |
| V | Biochemical characterization - catalase, oxidase, IMVIC test and TSI.Antibiotic sensitivity test (demonstration). | 9 |
| **Total** | **45** |
| **Text Books** |
| 1 | James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996. |
| 2 | Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications. |
| 3 | Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications. |
| 4 | Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi. |
| 5 |  R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing. |
| **Reference Books** |
| 1 | Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers. |
| 2 | Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India. |
| 3 | Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS. |
| 4 | Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication. |
| 5 | Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications. |
| **Web Resources** |
| 1 | <http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403>. |
| 2 | <https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635> |
| 3 | [https://www.grsmu.by/files/file/university/cafedry//files/essential\_microbiology.pdf](https://www.grsmu.by/files/file/university/cafedry/files/essential_microbiology.pdf) |
| 4 | <https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology> |

**MAPPING WITH PROGRAMME OUTCOMES**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | M |  |  |  |  |  |  |  |  |  |  |
| CO2 | M |  |  |  |  |  |  |  |  |  |  |
| CO3 |  |  |  | S | S | S |  |  |  |  |  |
| CO4 |  |  |  | S | S | S |  |  |  |  |  |
| CO5 |  |  |  |  | S | S |  |  | S |  |  |

**Elective Paper II APPLIED MICROBIOLOGY**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **L** | **T** | **P** | **S** | **Credits** | **Hours/W** | **Marks** |
| **CIA** | **External** | **Total** |
|  | **3** | **1** |  |  | **3** | **4** | **25** | **75** | **100** |
| **Course Outcomes** |
| CO1 | Understand beneficial role of microorganisms in dairy and food products. |
| CO2 | Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms. |
| CO3 | Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes. |
| CO4 |  Exhibit knowledge in analyzing the importance ofBio insecticides, Bio fertilizersprebiotics and probiotics. |
| CO5 | Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications. |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Microorganisms as food and feed: SCP, Mushroom-Oyster (Pleurotus) and Button (Agaricus) mushroom. Dairy products-cheese, yoghurt; Beverages-Beer and Wine. Probiotics. |  15 |
| II | Microorganisms in Agriculture: Bacterial Biofertilizers, Phosphate solubilizers, Vasicular Arbusucular Mycorrhizae, Algal Biofertilizers. | 15 |
| III | Biocontrol of microbial pathogens-Bio pesticide-Bactericide-*Bacillus thuringiensis*; Fungicide-*Trichoderma viridae-*Viral Biopesticides-CPV and NPV | 15 |
| IV | Microorganisms and Environment: liquid waste and solid waste-liquid waste management-water recycling- Industrial effluent treatment (sugar mill effluent, tannery effluent)- Solid waste management -Composting and vermicomposting. | 15 |
| V | Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector borne disease (Dengue, Malaria). | 15 |
| **Total** | **75** |
| **Text Books** |
| 1 | Rangaswami G and Bagyaraj DJ (2002). Agricultural Microbiology. Second edition, PHI Learning (P) Ltd., New Delhi |
| 2 | Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. |
| 3 | Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016. |
| **Reference Books** |
| 1 | . Adams, M.R and M.O. Moss (2005). Food Microbiology. 1st edition. Reprinted, Published byNew Age International (P) Ltd, Publishers-New Delhi. |
| 2 | Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012. |
| 3 | Maier, R.M., Pepper, I.L. & Gerba, C.P. (2009). Environmental Microbiology. 2nd Ed. Academic Press. |
| 4 | Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013. |

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| **Web Resources** |
| 1 | <http://www> ejb.org/content. |
| 2 | www. Biotech.kth.se Electronic Journal of biotechnology |
| 3 | [https://bio.libretexts.org/@go/page/9188](https://bio.libretexts.org/%40go/page/9188) |

**MAPPING WITH PROGRAMME OUTCOMES**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  | M |  |  | L | M | L |  | M |
| CO2 |  |  |  | S |  |  | L | L | L |  |  |
| CO3 |  |  |  | S |  |  | M | M | L |  | M |
| CO4 |  |  |  | S |  |  | M | L | L |  |  |
| CO5 |  |  |  | S |  |  | M | L | L |  |  |

**ELECTIVE PRACTICAL II –APPLIED MICROBIOLOGY**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Subject Code** | **L** | **T** | **P** | **S** | **Credits** | **Instructional Hours** | **Marks** |
| **CIA** | **External** | **Total** |
|  |  |  | **4** |  | **2** | **4** | **25** | **75** | **100** |
| **Course Outcomes** |
| CO1 | Describe the techniques to estimate the quality of dairy products  |
| CO2 | Develop Skills in enzyme production  |
| CO3 | Microscopically analyze the morphological features of algae and root nodules bacteria |
| CO4 | Learn the methods available to check the water quality |
| CO5 | Understand the pathogenic bacteria in various sample  |
| **UNIT** | **Contents** | **No.of Hours** |
| I | Detection of bacteria in milk by SPC, Methylene Blue reduction test, Microscopic observation of curd  | 9 |
| II | Demonstration of enzymes producing bacteria (lipase, amylase, protease) | 9 |
| III | Azolla- morphological study, Isolation of Rhizobium from root nodules,  | 9 |
| IV | Enumeration of bacteria from water sample, test for coliforms by MPN method | 9 |
| V | Isolation of pathogenic bacteria from air, water, and food specimens | 9 |
| **Total** | **45** |

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| **Text Books** |
| 1 | James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996. |
| 2 | Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications. |
| 3 | Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications. |
| 4 | Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi. |
| 5. | Rajan. S and Selvi Christy (2015). Experiments Procedure in Life Science, Anjanaa book House Publisers, Chennai |
| 6 |  R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing. |
| **Reference Books** |
| 1 | Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers. |
| 2 | Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India. |
| 3 | Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS. |
| 4 | Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication. |
| 5 | Lim D. (1998). Microbiology, 2nd Edition, WCB McGraw Hill Publications. |
| **Web Resources** |
| 1 | <http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403>. |
| 2 | <https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635> |
| 3 | [https://www.grsmu.by/files/file/university/cafedry//files/essential\_microbiology.pdf](https://www.grsmu.by/files/file/university/cafedry/files/essential_microbiology.pdf) |
| 4 | <https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology> |

**MAPPING WITH PROGRAMME OUTCOMES**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | M |  |  |  |  |  |  |  |  |  |  |
| CO2 | M |  |  |  |  |  |  |  |  |  |  |
| CO3 |  |  |  | S | S | S |  |  |  |  |  |
| CO4 |  |  |  | S | S | S |  |  |  |  |  |
| CO5 |  |  |  |  | S | S |  |  | S |  |  |

**NME offered to other Departments**

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| --- | --- | --- |
| **SEMESTER: I****Skill Enhancement Course-1(NME-1)****PART-IV** | **Social and Preventive medicine (23 UMICS16)** | **CREDIT:2****HOURS:2/W** |

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| **Course Objectives** |
| CO1 | Describe the concepts of health and disease and their social determinants |
| CO2 | Summarize the health management system |
| CO3 | Know about the various health care services |
| CO4 | Outline the goals of preventive medicine |
| CO5 | Gain knowledge about alternate medicine |
| **UNIT** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Introduction to social medicine:History of social medicine-concepts of health and disease-social determinants of health and disease-Health and quality of life-Health information system- measures of population health-health policies. | 6 | CO1 |
| II | Health management:Applications of behavioral sciences and psychology in health management- nutritional programs for health management-water and sanitation in human health-national programs for communicable and non-communicable diseases- environmental and occupational hazards and their control.  | 6 | CO2 |
| III | Health care and services:Health care of the community-information, education, communication and training in health-maternal & child health-school health services- Geriatrics-care and welfare of the aged-mental health-health services through general practitioners. | 6 | CO3 |
| IV | Preventive medicine: Introduction- role of preventive medicine- levels of prevention-Risk assessment in communities and vulnerable population –surveillance, monitoring and reporting of disease outbreaks - forecasting and control measures in community setting – early detection methods. | 6 | CO4 |
| V | Prevention through alternate medicine:Unani, Ayurveda, Homeopathy, Naturopathy systems in epidemic and pandemic outbreaks. International health regulations. Infectious disease outbreak case studies and precautionary response during SARS and MERS coronavirus, Ebola and novel SARS-COV2 outbreaks.  | 6 | CO5 |
|  | Total | 30 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Identify the health information system | PO1,PO5, PO6 |
| CO2 | Associate various factors with health management system | PO1,PO2, PO3,PO5, PO6, PO9 |
| CO3 | Choose the appropriate health care services | PO1,PO5, PO6 |
| CO4 | Appraise the role of preventive medicine in community setting | PO4,PO5, PO6 |
| CO5 | Recommend the usage of alternate medicine during outbreaks  | PO1,PO5, PO6 |
| **Text Books** |
| 1. | Park.K (2021). Textbook of preventive and social medicine, 26th  edition. BanarsidasBhanot publishers. |
| 2. | Mahajan& Gupta (2013). Text book of preventive and social medicine, 4thedition. Jaypeebrothers medical publishers.  |
| 3.  | Chun-Su Yuan, Eric J. Bieber, Brent Bauer (2006). Textbook of Complementary and Alternative Medicine. Second Edition. Routledge publishers. |
| 4. | Vivek Jain (2020). Review of Preventive and Social Medicine: Including Biostatics. 12th edition, Jaypee Brothers Medical Publishers. |
| 5. | Lal Adarsh Pankaj Sunder (2011). Textbook of Community Medicine: Preventive and Social Medicine, CBS publisher. |
| **References Books** |
| 1 | Howard Waitzkin, Alina Pérez, Matt Anderson (2021). Social Medicine and the coming Transformation. First Edition. Routledge publishers. |
| 2 | GN Prabhakara (2010). Short Textbook of Preventive and Social Medicine. Second Edition. Jaypee publishers. |
| 3 | Jerry M. Suls, Karina W. Davidson, Robert M. Kaplan (2010).Handbook of Health Psychology and BehavioralMedicine.Guilford Press. |
| 4 | Marie Eloïse Muller, Marie Muller, MarthieBezuidenhout, KarienJooste (2006).Health Care Service Management. Juta and Company Ltd. |
| 5 | Geoffrey Rose (2008).Rose's Strategy of Preventive Medicine: The Complete.OUP Oxford. |
| **Web Resources** |
| 1 | <https://www.omicsonline.org/scholarly/social--preventive-medicine-journals-articles-ppts-list.php> |
| 2 | https://www.teacheron.com/online-md\_preventive\_and\_social\_medicine-tutors |
| 3 | <https://www.futurelearn.com> |
| 4 | <https://www.healthcare-management-degree.net> |
| 5 | https://www.conestogac.on.health-care-administration-and-service-management |

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| **Methods of Evaluation** |
| **Internal Evaluation** | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| **External Evaluation** | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (K1)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand/ Comprehend (K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyze (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 | S |  |  |  | S | S |  |  |  |  |  |
| CO2 | S | S |  | M | S | S |  |  | M |  |  |
| CO3 |  |  |  | M | S | S |  |  |  |  |  |
| CO4 | S |  |  | S | S | M |  |  |  |  |  |
| CO5 | S |  |  |  | S | S |  |  |  |  |  |

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| **SEMESTER: II****Skill Enhancement Course-2(NME-2)****PART-IV** | **Nutrition & Health Hygiene (23UMICN26)** | **CREDIT:2****HOURS:2/W** |

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| **Course Objectives** |
| CO1 | Learn about nutrition and their importance  |
| CO2 | Make student understand thenutritional facts fora better life. |
| CO3 | Learn information to optimize our diet |
| CO4 | Impart knowledge on different health care programs taken up by India |
| CO5 | Learn knowledge on different health indicators and types of hygiene methods |
| **Unit** | **Details** | **No.of Hours** | **Course Objectives** |
| I | Nutrition – definition, importance, Good nutrition, and mal nutrition; Balanced Diet: Basics of Meal Planning. Carbohydrates, Lipids, Proteins and Vitamins –functions, dietary sources, effects of deficiency. Macro and micro minerals –functions, effects of deficiency; food sources of Calcium, Potassium, and Sodium; food sources of Iron, Iodine, and Zinc. Importance of water– functions, sources, requirements and effects of deficiency | 5 | CO1 |
| II | Nutrition for Life Cycle: Balanced diet - Normal, Pregnant, lactating women, Infancy, young children Adolescents, Adults, and the Elderly; Diet Chart; Nutritive value of Indian foods. | 5 | CO2 |
| III | Improper diets: Definition, Identification, Signs and Symptoms - malnutrition, under-nutrition, over-nutrition, Protein Energy Malnutrition, obesity; Nutritional Disease and Disorder - hypertension, diabetes, anemia, osteomalacia, cardiovascular disease.  | 5 | CO3 |
| IV | Health - Determinants of health, Key Health Indicators, Environment health & Public health; Health-Education: Principles and Strategies. Health Policy & Health Organizations: Health Indicators and National Health Policy of Govt. of India; Functioning of various nutrition and health organizations in India. | 5 | CO4 |
| V | Hygiene – Definition; Personal, Community, Medical and Culinary hygiene; WASH (Water, Sanitation and Hygiene) programme. Rural Community Health: Village health sanitation & Nutritional committee. Community & Personal Hygiene: Environmental Sanitation and Sanitation in Public places. | 5 | CO5 |
|  | **Total** | 25 |  |
| **Course Outcomes** |
| **Course Outcomes** | On completion of this course, students will; |
| CO1 | Learn the importance of nutrition for a healthy life | PO5, PO6, PO7, PO8, PO10 |
| CO2 | Study the nutrition for life cycle | PO5, PO6, PO7, PO8, PO10 |
| CO3 | Know the health care programmes of India | PO5, PO6, PO7, PO8, PO10 |
| CO4 | Learn the importance of community and personal health & hygiene measures | PO5, PO6, PO7, PO10 |
| CO5 | Create awareness on community health and hygiene | PO5, PO6, PO7, PO10 |

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| **Text Books** |
| 1. | Bamji, M.S., K. Krishnaswamy& G.N.V. Brahmam (2009) Textbook of HumanNutrition(3rd edition) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi |
| 2. | Swaminathan (1995)Food &Nutrition(Vol I, Second Edition) The Bangalore Printing&Publishing Co Ltd., , Bangalore |
| 3 | SK. Haldar(2022). Occupational Health and Hygiene in Industry. CBS Publishers. |
| 4 | Acharya, Sankar Kr, Rama Das, Minati Sen (2021). Health Hygiene and Nutrition Perception and Practices.Satish Serial Publishing House |
| 5 | Dass (2021).Public Health and Hygiene, Notion Press |
| **References Books** |
| 1 | VijayaKhader (2000)Food, nutrition & health, Kalyan Publishers, New Delhi |
| 2 | Srilakshmi, B., (2010)Food Science, (5th Edition) New Age International Ltd., New Delhi |
| 3 | Arvind Kumar Goel (2005). A College Textbook of Health & Hygiene,ABD Publishers |
| 4 | Sharma D. (2015).Textbook on Food Science and Human Nutrition. Daya Publishing House. |
| 5 | Revilla M. K. F., Titchenal A. and Draper J. (2020). Human Nutrition. University of Hawaii, Mānoa. |
| **Web Resources** |
| 1 | National Rural Health Scheme:https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=969&lid=49 |
| 2 | National Urban Health Scheme:https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=970&lid=137 |
| 3 | Village health sanitation & Nutritional committeehttps://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=149&lid=225 |
| 4 | Health Impact Assessment - https://www.who.int/hia/about/faq/en/ |
| 5 | Healthy Living https://www.nhp.gov.in/healthylivingViewall |
| **Methods of Evaluation** |
| Internal Evaluation | Continuous Internal Assessment Test | 25 Marks |
| Assignments |
| Seminars |
| Attendance and Class Participation |
| External Evaluation | End Semester Examination | 75 Marks |
|  | Total | 100 Marks |
| **Methods of Assessment** |
| **Recall (KI)** | Simple definitions, MCQ, Recall steps, Concept definitions |
| **Understand /Comprehend****(K2)** | MCQ, True/False, Short essays, Concept explanations, Short summary or overview |
| **Application (K3)** | Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain |
| **Analyse (K4)** | Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge |
| **Evaluate (K5)** | Longer essay/ Evaluation essay, Critique or justify with pros and cons |
| **Create (K6)** | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations |

**Mapping with Programme Outcomes**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
| CO1 |  |  |  |  | S | M | M | M |  | S |  |
| CO2 |  |  |  |  | S | M | M | M |  | S |  |
| CO3 |  |  |  |  | S | M | M | M |  | S |  |
| CO4 |  |  |  |  | S | S | L |  |  | S |  |
| CO5 |  |  |  |  | S | S | M |  |  | S |  |