**ANNAMALAI UNIVERSITY**

**B.Sc. Microbiology**

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted in Affiliated Colleges from the academic year 2022 -2023 onwards)

| Course Code | Part | Study Components & Course Title | | Hours/ Week | Credit | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | CIA | ESE | Total |
| | | **SEMESTER – I** | | | | | | |
| **22UTAML11** | I | **Language Course - I : Tamil/Other Languages** | | 5 | 3 | 25 | 75 | 100 |
| **22UENGL12** | II | **English Course - I : Communicative English I** | | 5 | 3 | 25 | 75 | 100 |
| 22UMICC13 | III | Core Course - I : Fundamentals of Microbiology | | 4 | 4 | 25 | 75 | 100 |
| 22UMICC14 | | Core Course - II : Microbial Diversity and Taxonomy | | 4 | 4 | 25 | 75 | 100 |
| 22UMICP15 | | Core Practical – I : Basic Microbiology Practical | | 3 | - | - | - | - |
| | | Allied - I : Paper – 1 : Biochemistry – I | | 4 | 4 | 25 | 75 | 100 |
| | | Allied Practical – I : Allied Biochemistry Practical | | 3 | - | - | - | - |
| **22UENVS18** | IV | **Environmental Studies** | | 2 | 2 | 25 | 75 | 100 |
| | | **Total** | | **30** | **20** | | | **600** |
| | | **SEMESTER – II** | | | | | | |
| **22UTAML21** | I | **Language Course - II : Tamil/Other Languages** | | 5 | 3 | 25 | 75 | 100 |
| **22UENGL22** | II | **English Course - II : Communicative English II** | | 5 | 3 | 25 | 75 | 100 |
| 22UMICC23 | III | Core Course – III : Microbial Physiology | | 4 | 4 | 25 | 75 | 100 |
| 22UMICP24 | | Core Practical – I : Basic Microbiology Practical | | 3 | 4 | 40 | 60 | 100 |
| | | Allied – I : Paper -2 : Biochemistry – II | | 4 | 4 | 25 | 75 | 100 |
| | | Allied Practical – I : Allied Biochemistry Practical | | 2 | 3 | 40 | 60 | 100 |
| 22UMICE27 | | Internal Elective – I | Cell Biology and Molecular Biology | 3 | 3 | 25 | 75 | 100 |
| | | | Biostatistics | | | | | |
| | | | Bioinstrumentation | | | | | |
| **22UVALE27** | IV | **Value Education** | | 2 | 1 | 25 | 75 | 100 |
| **22USOFS28** | | **Soft Skill** | | 2 | 1 | 25 | 75 | 100 |
| | | **Total** | | **30** | **26** | | | **900** |

**Internal Elective Courses**

| | | |
|---|---|---|
| 22UMICE27-1 | Internal Elective - I | Cell Biology and Molecular Biology |
| 22UMICE27-2 | | Biostatistics |
| 22UMICE27-3 | | Bioinstrumentation |

**Allied Courses offered by the Department of Microbiology**

| | | |
|---|---|---|
| 22UMICA01 | Theory | Allied Microbiology - I |
| 22UMICA02 | Theory | Allied Microbiology - II |
| 22UMICAP1 | Practical | Allied Microbiology Practical |

| SEMESTER: I<br>PART: III | 22UMICC13: FUNDAMENTALS OF MICROBIOLOGY | CREDITS: 4<br>HOURS: 4 |
|---|---|---|

**COURSE OBJECTIVES**

1) To enhance the student's knowledge and impress upon the important aspects of Microbiology
2) To have a basic idea of microscopic techniques
3) To describe the morphological features of bacteria
4) To understand the concept of sterilization and disinfection
5) To learn the practical aspects of maintaining pure culture

**Unit I : History and Scope** **Hours: 12**

History and scope of Microbiology, Spontaneous generation - Contribution of Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Paul Ehrlich and Fleming. General characteristics of prokaryote and Eukaryote and their difference.

**Unit II : Microscopy and Staining** **Hours: 12**

Microscopy and Staining Methods –principles and applications of simple, Bright field, Dark-field, Phase-contract, Fluorescent, Electron Microscopes-Transmission Electron Microscope (TEM)- Scanning Electron Microscope(SEM) – Staining methods-Simple – Different staining – Gram's staining - Endospore staining, Acid fast staining, Negative-staining - Motility by hanging drop method.

**Unit III : Morphology** **Hours: 12**

Morphology - Shape, size, arrangement of Bacteria - Structure of bacterial cell - Structure and functions of cell organelles (Cell wall, structures found outside the cell wall and within the cell wall) - Structure of Endospore.

**Unit IV : Sterilization** **Hours: 12**

Sterilization and disinfection - Physical and Chemical methods - Physical agents moist: dry heat, filtration, (membrane and HEPA), Radiation, Chemical agents: Phenols and Phenols compounds, Alcohols, Heavy Metals and their compounds, Aldehydes, Gaseous agents.

**Unit V : Pure culture** **Hours: 12**

Pure culture techniques - serial dilution-Pour plate, spread plate- streak plate. Anaerobic Culture Method-Types and Preparation of media-simple medium, differential medium, solid, semi-solid and liquid medium-Media preparation-Preservation and storage of microbial culture.

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) Get basic knowledge in the scope and discovery of microorganisms.
2) Study about the principles applications of microscopy.
3) Understand the classification of microorganisms.

4) Discuss about the various sterilization methods.
5) Know the pure culture techniques.

**Text Books**

1) Michael J. Pelczar, Jr. E.C.S. Chan & Noel R. Krieg. (1993). *Microbiology*. (5th ed.). Tata McCraw Hill, New Delhi.
2) Prescott, L.M., Harley, J.P. & Klain, D.A. (2003).*Microbiology*. (5th ed.). McGraw Hill, New York.
3) Dubey, R.C. & Maheswari, D.K. (2010). *A Text Book of Microbiology*. S. Chand and Company, New Delhi.

**Supplementary Readings**

1) Talaro, K.P. & Talaro, A. (1999). *Foundation in Microbiology*. (3rd ed.). WCB McGraw Hill
2) Adas, R.A. *Principles of Microbiology*. (2nd ed.). Wm. C. Brown Publishers.
3) Salle A. J. (1984). *Fundamental Principles of Bacteriology*. (TMT Edition). Tata McGraw Hill Publishing Company, New Delhi.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | **2** | **3** | **2** | **3** | **3** |
| **CO2** | **2** | **3** | **3** | **3** | **3** |
| **CO3** | **3** | **3** | **2** | **3** | **2** |
| **CO4** | **3** | **2** | **3** | **2** | **3** |
| **CO5** | **2** | **3** | **3** | **2** | **2** |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**

| SEMESTER: I<br>PART: III | 22UMICC14: MICROBIAL DIVERSITY AND TAXONOMY | CREDITS: 4<br>HOURS: 4 |
|---|---|---|

**COURSE OBJECTIVES**

1) To analyse the microbial diversity and evolution
2) To obtain knowledge about the taxonomical classification of Microorganisms
3) To understand the classification and important groups of bacteria
4) To understand the classification and important groups of algae and fungi
5) To understand the classification and important groups of protozoa and viruses

**Unit I : Biodiversity** **Hours: 12**

Introduction to microbial diversity - Distribution, Abundance, Ecological niche. Extremophiles. Types of Microorganisms. Microbial culture collections.

**Unit II : Microbial Taxonomy** **Hours: 12**

Introduction to microbial classification and taxonomy, Various systems of Classification; Taxonomic ranks, Binomial nomenclature. Techniques and characteristics used for determination of Microbial taxonomy, Prokaryotic and eukaryotic phylogeny.

**Unit III : Classification of Bacteria** **Hours: 12**

Classification systems in prokaryotes - Bergey's manual of systemic Bacteriology, prokaryotic groups with unusual characteristics. Cyanobacteria, Green and Purple sulphur bacteria, gliding bacteria, Ricketsia and chlamydia, Actinomycetes, Archea - Classification and significance.

**Unit IV : Algae and Fungi** **Hours: 12**

Distribution of algae – Classification (Fritsch's system of classification), Structure of algae - thallus, mode of nutrition, reproduction. Characteristics features of Chlorophyta, Xanthophyta, Bacillariophyta, Pheophyta, Rhodophyta. Economic importance of algae. Fungi - Distribution , Classification, Structure, Nutrition and Reproduction . Identification and cultivation of fungi. Economical importance of fungi.

**Unit V : Protozoa and Virus** **Hours: 12**

Protozoa- General characteristics- Classification, Morphology, Nutrition, Locomotion, Reproduction. History and development of Virology – Classification (ICTV), General properties and structure of viruses, Viral replication, Cultivation of Plant and Animal Virus. Bacteriophages,

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) List the general characteristics and classification of bacteria, fungi, algae, protozoa and viruses.
2) Get knowledge to assess the microbial evolution and classification.

3) Obtain knowledge about the various types of bacterial structures.
4) Students able to identify biodiversity of microorganisms.
5) Emphasize the principles of classification, rules and its application in microbial taxonomy

**Text Books**

1) Michael J. Pelczar, Jr. E.C.S. Chan & Noel R. Krieg. (1993). *Microbiology*. (5th ed.). Tata McCraw Hill, New Delhi.
2) Prescott, L.M., Harley, J.P. & Klain, D.A. (2003). *Microbiology*. (5th ed.). McGraw Hill, New York.
3) Dubey, R.C. & Maheswari, D.K. (2010). *A Text Book of Microbiology*. S. Chand and Company, New Delhi.

**Supplementary Readings**

1) Talaro, K.P. & Talaro, A. (1999). *Foundation in Microbiology*. (3rd ed.). WCB McGraw Hill
2) Adas, R.A. *Principles of Microbiology*. (2nd ed.). Wm. C. Brown Publishers.
3) Vashista, R. (2010). *Algae*. (8th ed). S. Chand and Company, New Delhi.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 |
| CO5 | 2 | 2 | 3 | 2 | 2 |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**

| SEMESTER: II<br>PART: III | 22UMICC23: MICROBIAL PHYSIOLOGY | CREDITS: 4<br>HOURS: 4 |
|---|---|---|

**COURSE OBJECTIVES:**

1) To distinguish different nutritional types of microorganisms
2) To provide the basic knowledge of microbial growth
3) To make the students understand carbohydrate metabolism
4) To learn about anaerobic respiration
5) To study the process of microbial photosynthesis

**Unit I : Nutrition** **Hours: 12**

Nutritional requirements of microorganisms - micro and macro elements - Nutritional classification (Autotrophs, Heterotrophs, Photoautotrophs, Chemoautotrophs, Copiotrophs, Oligotrophs) - Transport of nutrients by active and passive transport mechanism.

**Unit II : Growth** **Hours: 12**

Definition-Different phases of growth- growth curve-generation time-factors influencing microbial growth-temperature, pH, pressure, salt concentration-synchronous growth and continuous culture, Diauxic growth.

**Unit III : Carbohydrate metabolism** **Hours: 12**

Embden Mayerhoff Parnas pathway - Hexose mono phosphate pathway - Entner Doudoroff pathway - Tricarboxylic acid cycle - Glyoxalate cycle. Electron transport chain - Oxidative and substrate level phosphorylation.

**Unit IV : Anaerobic Respiration** **Hours: 12**

Anaerobic Respiration - Sulphur nitrate and $CO_2$ as final electron acceptor-Fermentation-Alcoholic, lactic acid, propionic and mixed acid fermentation.

**Unit V : Photosynthesis** **Hours: 12**

Photosynthesis - photosynthetic pigments - Oxygenic and anoxygenic photosynthesis - $CO_2$ fixation. Biosynthesis of bacterial cell wall, Biosynthesis of amino acid (Glutamic acid family)-Bioluminescence – definition and application of Bioluminescence.

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) Gain knowledge about the nutritional needs of microorganisms.
2) Learn about the microbial growth factors and its importance.
3) Explain about the metabolic activities of microbes.
4) Appreciate the anaerobic metabolisms and fermentation
5) Discuss the various synthesis mechanisms of microorganisms.

**Text Books**

1) Prescott, L.M., J.P. Harley & C.A. Klein (1995). *Microbiology*. (2nd ed.). WMC Brown Publishers.
2) Moat, A.G. & Foster, J.W. (1988). *Microbial Physiology*. (2nd ed.). Springer-Verlage.
3) Dubey, R.C. & Maheswari, D.K. (2010). *A Text Book of Microbiology*. S. Chand and Company, New Delhi.

**Supplementary Readings**

1) Caldwell, D.R. (1995). *Microbial Physiology and Metabolism*. Wm.C. Brown Communications, Inc. USA.
2) Schlegal, H.G. (1993). *General Microbiology*. (7th ed.), Press Syndicate of the University of Cambridge.
3) Dawes, I. W. & Sutherland L.W. (I992). *Microbial Physiology*. (2nd Edition), Oxford Blackwell Scientific Publications.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | **2** | **3** | **2** | **3** | **3** |
| **CO2** | **3** | **3** | **3** | **3** | **3** |
| **CO3** | **3** | **3** | **2** | **3** | **2** |
| **CO4** | **3** | **2** | **3** | **3** | **3** |
| **CO5** | **2** | **2** | **3** | **2** | **2** |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**

| SEMESTER: I & II<br>PART: III | 22UMICP24: BASIC MICROBIOLOGY<br>PRACTICAL | CREDITS: 4<br>HOURS: 3 |
|---|---|---|

**COURSE OBJECTIVES**

1) To impart hands on training on the observation and culture of Microbes
2) To isolate microorganisms from samples
3) To identify bacteria using biochemical tests
4) To study the factors affecting bacterial growth
5) To preserve bacterial cultures

**List of Experiments**

1. Rules and regulations in Microbiology Laboratory
2. Cleaning and sterilization of glass wares.
3. Principles and operations – Autoclave, Hot air oven, Laminar air flow chamber, Incubator, centrifuge.
4. Media preparation- Liquid, solid and semi-solid media.
5. Pure Culture techniques:

i) Spread Plate

ii) Pour Plate

iii) Streak Plate

6. Microscope and its operation
7. Staining - Simple Staining-Differential Staining-Gram's staining and Negative staining- Endospore staining.
8. Measurement of size of microbes-Micrometry
9. Motility determination by hanging drop technique
10. Effect of pH on the growth of microbes.
11. Effect of temperature on the growth of microbes
12. Effect of salt on the growth of microbes.
13. Determination of growth curve.
14. Measurement of Microbial cell by i) Direct plate count and ii) micrometry
15. Biochemical tests:

Indole test

MR-VP test

Citrate utilization test

Carbohydrate fermentation test

Triple sugar Iron test

Catalase test

Oxidase test

Urease test

16. Starch hydrolysis
17. Culture preservation-

i) Saline suspension, low temperature

ii) Agar slant culture covered with oil (Paraffin Method)

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) Acquire basic experimentation skills of growing microorganisms
2) Design and perform experiments in Microbiology
3) Stain and observe microorganisms
4) Isolate microorganisms from different samples
5) Carry out preservation of culture

**Text Books**

1) Rajan, S and Christy, S. (2015). *Experimental procedure in Life sciences*. Anjanaa Book House Publishers, Chennai.
2) Cappuccino and Sherman. (2004). *Microbiology: A Laboratory Manual*. (7th ed.). Benjamin Cummings Publications.
3) Kannan, N. (2002). *Laboratory Manual in General Microbiology*. Panima.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **2** | **3** | **3** |
| **CO2** | **3** | **3** | **3** | **3** | **3** |
| **CO3** | **3** | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** |
| **CO5** | **2** | **3** | **3** | **2** | **3** |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**

| SEMESTER: II<br>PART: III | 22UMICE27: CELL BIOLOGY AND MOLECULAR BIOLOGY | CREDITS: 3<br>HOURS: 3 |
|---|---|---|

**COURSE OBJECTIVES**

1) To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells
2) To acquire knowledge of genome organization and cell division
3) To know about cell signalling molecules
4) To learn the basic concept of molecular biology
5) To provide basic information of gene expression and regulation

**Unit I : INTRODUCTION TO CELL BIOLOGY** **Hours: 9**

History of cell biology, cell as basic unit of life, cell theory, Classification of cell types. Structure and organization of Prokaryotic and Eukaryotic cells. Comparison between plant and animal cells. General structure of cytoskeleton.

**Unit II : CELL DIVISION** **Hours: 9**

Organization of Prokaryotic and eukaryotic genome and chromosome, types, Structure and function. Cell cycle – phases of cell cycle. Cell division – mitosis, meiosis their significance. Comparison of mitosis and meiosis cell growth, kinetic of cell growth.

**Unit III : CELL SIGNALING** **Hours: 9**

Cell communication – overview- types of cell signaling – signal molecules – signal amplification receptor types - Development and causes of cancer, Oncogenes, Tumor suppressor genes, Regulation of cell death.

**Unit IV : MOLECULAR BIOLOGY** **Hours: 9**

Introduction to molecular Biology, DNA and RNA as genetic materials. Primary and secondary structure of DNA and RNA. Alternative forma so DNA double helices – Types of RNA. DNA replication.

**Unit V : GENE EXPRESSION AND REGULATION** **Hours: 9**

Central dogma of molecular biology - gene expression - transcription, translation. Post transcriptional processing. Regulation of gene expression – operon - lac and trp operon.

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) Understand the history of cell biology and broad classification of cell types.
2) Understand cell division and the significance of cell cycle and its check points.
3) Have gained insight on types of cell signaling, signal amplification and oncogenes
4) Comprehend the history behind the development of molecular biology
5) Understand the steps involved in transcription, translation and gene regulation.

**Text books**

1) Verma, P.S. & Agarwal, V. K. (2016). *Cell Biology, Biomolecules, Molecular Biology*. Paperback, S. Chand and Company Ltd.
2) Bruce Alberts and Dennis Bray. (2013). *Essential Cell Biology*. 4th Edn. Garland Science.
3) Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. 6th Edn. John Wiley & Sons. Inc.

**Supplementary Readings**

1) Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R & Harrison, S. H. (2014). *Molecular Biology of Gene*. 7th Edn. Pearson Benjamin-Cummings.
2) De Robertis, E.D.P & De Robertis, E. M.F. (2010). *Cell and Molecular Biology*. 8th Edn. Lippincott Williams and Wilkins, Philadelphia.
3) Cooper, G. M & Hausman, R. E.(2016). *The Cell- A molecular Approach*, 7th Edn. Sinauer Associates Inc.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **3** | **3** |
| **CO2** | **2** | **3** | **3** | **3** | **3** |
| **CO3** | **3** | **3** | **2** | **3** | **2** |
| **CO4** | **3** | **2** | **3** | **2** | **3** |
| **CO5** | **2** | **3** | **3** | **2** | **2** |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**

| SEMESTER: II<br>PART: III | 22UMICE27: BIOSTATISTICS | CREDITS: 3<br>HOURS: 3 |
|---|---|---|

**COURSE OBJECTIVES**

1) To understand the basic principle of statistics
2) To acquire knowledge about statistical tools
3) To know about statistical calculations
4) To learn the applications of statistics in biology
5) To make use of statistics in basic studies

**Unit I : INTRODUCTION** **Hours: 9**

Introduction to biostatistics - Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics.

**Unit II : DATA COLLECTION** **Hours: 9**

Collection of data, sampling and sampling design, classification and tabulation, types of representations- graphic–bar diagrams, pie diagrams and curves.

**Unit III : CENTRAL TENDENCY** **Hours: 9**

Measures of central tendency (Averages) Direct, indirect and Shortcut methods; mean, median, mode, geometric mean, harmonic mean.

**Unit IV : VARIATION** **Hours: 9**

Measures of dispersion and variability - changes. Deviations – Mean Deviation, Standard Deviation, Coefficient of variation, Loren Zen's curve- Skewness and Kurtosis.

**Unit V : DISTRIBUTIONS AND ANOVA** **Hours: 9**

Inferential statistics - probability and distributions - Poisson, Binomial and Normal distribution-Testing of hypothesis - Chi square test-Students t-test-Correlation-simple and multiple-Regression - ANOVA-one way classification and two way classification.

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) Understand the basics of the biostatistics.
2) Collect data for analysis.
3) Appreciate statistical representation in a scientific data.
4) Gain knowledge about the dispersion and variability.
5) Correlate the significant scientific methodologies and results of the scientific analysis.

**Text books**

1) Arora, P.N. & Malhan, P.K. (2008). *Bio statistics*. Himalaya Publishing house.
2) Sundar Rao and Richard. (2012). Introduction to Biostatistics and Research Methods, 5th edition, PHI Learning Pvt. Ltd.
3) Bernard Rosner. (2010). *Fundamentals of Biostatistics*. (7th Edn.) Cengage Learning.

**Supplementary Readings**

1) Roland Ennos. Statistical and Data Handling Skills in Biology. Pearson. 2011.
2) Maicello Pagano and Kimberlee Gauvreau, 2nd edition Principles of Biostatistics, Duxbury Press.2000.
3) Jerrold H Zar. Bio statistical Analysis, 5th Ed, Prentice Hall. 2010.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 |
| CO2 | 2 | 3 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 3 |
| CO5 | 2 | 2 | 3 | 2 | 2 |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**

| SEMESTER: II<br>PART: III | 22UMICE27: BIOINSTRUMENTATION | CREDITS: 3<br>HOURS: 3 |
|---|---|---|

**COURSE OBJECTIVES**

1) To learn the fundamentals of centrifuge and the applications.
2) To aquire knowledge on colorimetry and types of spectroscopy
3) To study about chromatography
4) To understand the Electrophoresis techniques and the applications
5) To provide knowledge on Radioisotopic techniques

**Unit I : Centrifugation** **Hours: 9**

Centrifuge - Basic principles of sedimentation (concept of g and rpm) - relative centrifugal force -Types of centrifuges. Centrifugation – Principles and various types (preparative and analytical) – applications.

**Unit II : Colorimetry and Spectrophotometry** **Hours: 9**

Colorimetry - Principle, Beer-Lambert's Law, Applications. Spectroscopy - visible, IR, NMR, UV and atomic absorption spectrophotometry.

**Unit III : Chromatography techniques** **Hours: 9**

Chromatography techniques: Principle, instrumentation and applications of Chromatography – Column, Paper, Thin layer, Gas, liquid chromatography, HPLC.

**Unit IV : Electrophoresis techniques** **Hours: 9**

Electrophoresis techniques: - Principle and types of electrophoresis - paper, gel, proteins and nucleic acids. Immunoelectrophoresis; Applications.

**Unit V : Radioisotopic techniques** **Hours: 9**

Radioisotopic techniques - Principle, detection and measurement of Radioactivity; GM counter & Scintillation counter, Autoradiography; Biosensors and their types.

**COURSE OUTCOMES**

On successful completion of the course the student will be able to

1) Understand principles and applications of centrifuge and centrifugation.
2) Understand principles and applications of Colorimetry and Spectrophotometry
3) Evaluate the various types & applications of chromatography
4) know about various kinds of Electrophoresis techniques
5) understand the working principle and applications of Radioisotopic techniques

**Text Books**

1) Arumugam,N and Kumaresan,V. 2015. *Biophysics and Bioinstrumentation.* Saras Publication.
2) Veerakumari, L. 2019. *Bioinstrumentation*. Chennai: MJP Publisher.
3) John,G and Webster. (2008). *Bioinstrumentation*. University of Wisconsin: John Wiley & Sons, Inc.

**Supplementary Readings**

1) Kothari, C.R., 2013. *Research methodology Methods and Techniques*. New Delhi: New Age International Pvt. Ltd.
2) Keith Wilson & John Walker. 1994. *Practical Biochemistry – Principles and techniques*. New York: Cambridge Press.
3) Geddes, L.A., and Baker, L.E. 2008. *Principles of Applied Biomedical Instrumentation.* John Wiley & Sons.

**OUTCOME MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 |
|---|---|---|---|---|---|
| **CO1** | **2** | **3** | **2** | **3** | **3** |
| **CO2** | **3** | **3** | **3** | **3** | **3** |
| **CO3** | **3** | **3** | **2** | **3** | **2** |
| **CO4** | **3** | **2** | **3** | **3** | **3** |
| **CO5** | **2** | **2** | **3** | **2** | **2** |

**(Correlation level: 1 – Low, 2 – Moderate, 3 – High)**