Rev: 04

# SYLLABUS

*For*

## 3 YEARS BSC MICROBIOLOGY PROGRAMME

***(Revised Syllabus Approved by Academic Council)***

Dept. of

Applied Biology

**JUNE, 2018**


**UNIVERSITY OF SCIENCE &TECHNOLOGY, MEGHALAYA**

Techno City, 9th Mile, Baridua, Ri-Bhoi, Meghalaya, 793101

## Programme Specific Outcomes of B. Sc. Microbiology

**Programme Name: B. Sc. Microbiology** **Programme Code: BMB**

**PSO1.**The objective of the Bachelor's Programme in Microbiology is to increase the understanding regarding the fascinating world of microorganism; the various cytological and biochemical aspects associated with microbes.

**PSO2.** It develops the concept of diverse microbial and allied groups of organisms present in different spheres of the environment; the life processes as well as their role (both beneficial and harmful) in day to day life.

**PSO3.** It helps in understanding the different technical aspects (cultural, microscopic and molecular methods) for the study of microbes.

**PSO4.** It increases the understanding of the association of microbes with other cellular organism and how such host-microbe interaction affecting each other.
It clears the concept of microbial association with human diseases; the different phases of disease development and the laboratory techniques for the detection and treatment of such abnormalities.

**PSO5.** It helps in learning the potential of microbes in obtaining product of human interest and how some of the microbes are industrially exploited for obtaining such products.

After successful completion of the B. Sc. Microbiology programme, students can opt for higher studies in areas like Medical and Pharmaceutical Microbiology, Food and Industrial Microbiology, Environmental and Agricultural Microbiology and Marine Microbiology and Oceanography. Moreover, the concept in the subject concerned will give the students to establish themselves as professionals in Quality Control (Pharmaceutical and Food sector), Diagnosis (Medical and Health sector) and Research Personals (R & D sector). The knowledge attained during the period of the programme will help the students in qualifying different competitive exams. related to Academics, Research and Professional courses.

## SEMESTER WISE DISTRIBUTION OF COURSE

### SEMESTER-I

| Course Code | Title | Credit | Nature of the Course | Marks Allotted | | |
|---|---|---|---|---|---|---|
| | | | | Internal | End Semester | Total |
| BMB 101 | Fundamentals of Microbiology **(CC-1)** | **4** | **T** | **30** | **70** | **100** |
| BMB 102 | Biochemistry **(CC-2)** | **4** | **T** | **30** | **70** | **100** |
| BEN-711 | Communicative English **(AECC-1)** | **2** | **T** | **30** | **70** | **100** |
| BMB 104 | Phycology and Mycology **(GE-1)** | **4** | **T** | **30** | **70** | **100** |
| BMB 105 | Practical on CC-1, CC-2 and GE-1**(CC-3)** | **2+2+2** | **P** | **30** | **70** | **100** |
| | **Total** | **20** | **-** | **150** | **350** | **500** |

### SEMESTER-II

| Course Code | Title | Credit | Nature | Marks Allotted | | |
|---|---|---|---|---|---|---|
| | | | | Internal | End Semester | Total |
| BMB 201 | Bacteriology **(CC-4)** | **4** | **T** | **30** | **70** | **100** |
| BMB 202 | Virology **(CC-5)** | **4** | **T** | **30** | **70** | **100** |
| BMB 203 | Microbes in Environment **(GE-1)** | **4** | **T** | **30** | **70** | **100** |
| BMB 204 | Environmental Studies **(AECC-1)** | **2** | **T** | **30** | **70** | **100** |
| BMB 205 | Practical on C-3, C-4 and GE-2 **(CC-6)** | **6** | **P** | **30** | **70** | **100** |
| | **Total** | **20** | **-** | **150** | **350** | **500** |

## SEMESTER-III

| Course Code | Title | Credit | Nature | Marks Allotted | | |
|---|---|---|---|---|---|---|
| | | | | Internal | End Semester | Total |
| BMB 301 | Microbial Physiology and Metabolism **(CC-7)** | **4** | **T** | **30** | **70** | **100** |
| BMB 302 | Cell Biology **(CC-8)** | **4** | **T** | **30** | **70** | **100** |
| BMB 303 | Molecular Biology **(CC-9)** | **4** | **T** | **30** | **70** | **100** |
| BMB 304 | Agricultural Microbiology **(GE-3)** | **4** | **T** | **30** | **70** | **100** |
| BMB 305 | Chemistry-1 **(SEC-1)** | **2** | **T** | **30** | **70** | **100** |
| BMB 306 | Practical on C-5, C-6, C-7 and GE-3 **(CC-10)** | **6** | **P** | **30** | **70** | **100** |
| **Total** | | **24** | **-** | **180** | **420** | **600** |

## SEMESTER-IV

| Course Code | Title | Credit | Nature | Marks Allotted | | |
|---|---|---|---|---|---|---|
| | | | | Internal | End Semester | Total |
| BMB 401 | Microbial Genetics **(CC-11)** | **4** | **T** | **30** | **70** | **100** |
| BMB 402 | Environmental Microbiology **(CC-12)** | **4** | **T** | **30** | **70** | **100** |
| BMB 403 | Food & Dairy Microbiology **(CC-13)** | **4** | **T** | **30** | **70** | **100** |
| BMB 404 | Genetic Engineering (**GE-4)** | **4** | **T** | **30** | **70** | **100** |
| BMB 405 | Chemistry-2 (**SEC-2)** | **4** | **T** | **30** | **70** | **100** |
| BMB 406 | Practical on C-8, C-9, C-10 and GE-4 **(CC-14)** | **4** | **P** | **30** | **70** | **100** |
| | **Total** | **24** | **-** | **180** | **420** | **600** |

## SEMESTER-V

| Course Code | Title | Credit | Nature | Marks Allotted | | |
|---|---|---|---|---|---|---|
| | | | | Internal | End Semester | Total |
| BMB 501 | Medical Microbiology **(CC-15)** | **4** | **T** | **30** | **70** | **100** |
| BMB 502 | Immunology **(CC-16)** | **4** | **T** | **30** | **70** | **100** |
| BMB 503 | Bio-informatics **(DSE-1)** | **4** | **T** | **30** | **70** | **100** |
| BMB 504 | Instrumentation & Bio-techniques (**DSE-2)** | **4** | **T** | **30** | **70** | **100** |
| BMB 505 | Practical C-11, C-12. DSE-1 and DSE-2 **(CC-17)** | **4** | **P** | **30** | **70** | **100** |
| | **Total** | **20** | **-** | **150** | **350** | **500** |

## SEMESTER-VI

| Course Code | Title | Credit | Nature | Marks Allotted | | |
|---|---|---|---|---|---|---|
| | | | | Internal | End Semester | Total |
| BMB 601 | Industrial Microbiology **(CC-18)** | **4** | **T** | **30** | **70** | **100** |
| BMB 602 | Recombinant DNA Technology **(CC-19)** | **4** | **T** | **30** | **70** | **100** |
| BMB 603 | Advances in Microbiology (**DSE-3)** | **4** | **T** | **30** | **70** | **100** |
| BMB 604 | Biosafety & IPR **(DSE-4)** | **4** | **T** | **30** | **70** | **100** |
| BMB 605 | Practical C-11, C-12. DSE-1 and DSE-2 **(CC-20)** | **4** | **P** | **30** | **70** | **100** |
| HVP-760 | Human Values and Professional Ethics | **NCM*** | **T** | **15** | **35** | **50** |
| | **Total** | **20** | **-** | **150** | **350** | **500** |

*NCM: Non Credit Mendatory

**Structure of B. Sc. Microbiology under CBCS**

**Core Course**

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

**Discipline Specific Elective (Any Four)**

DSE-1: Bioinformatics & Biostatistics
DSE-2: Microbial Biotechnology
DSE-3: Advances in Microbiology
DSE-4: Plant Pathology
DSE-5: Biomathematics and Biostatistics
DSE-6: Inheritance Biology
DSE-7: Microbes in Sustainable Agriculture and Development
DSE-8: Biosafety and Intellectual Property Rights
DSE-9: Project Work
DSE-10: Instrumentation and Biotechniques

**Generic Electives (Any Four)**

GE-1: Introduction and Scope of Microbiology
GE-2: Bacteriology and Virology
GE-3: Microbial Metabolism
GE-4: Industrial and Food Microbiology
GE-5: Agricultural Microbiology
GE-5: Microbes in Environment
GE-6: Medical Microbiology and Immunology
GE-7: Genetic Engineering and Biotechnology
GE-8: Microbial Genetics and Molecular Biology
GE-5: Phycology and Mycology

**Ability Enhancement Compulsory Courses**

AE-1: Environmental Sciences
AE-2: Communicative English

**Skill Enhancement Elective Courses (Any Two)**

SE-1: Microbial Quality Control in Food and Pharmaceutical Industries
SE-2: Microbial Diagnosis in Health Clinics
SE-3: Biofertilizers and Biopesticides
SE-4: Food Fermentation Techniques
SE-5: Management of Human Microbial Diseases
SE-6: Microbiological Analysis of Air and Water
SE-7: Chemistry-1
SE-8: Chemistry-2

**SEMESTER-I**

**BMB 101** **Fundamentals of Microbiology** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To explore the fascinating world of microorganism and their role (both beneficial and harmful) in day to day life. It imparts knowledge on the various phases and contribution of different Scientists how Microbiology established itself as a separate branch of Science.

**CO2.** To understand the different categories of microbes and sub-microbial groups with their position in the tree of life (classification), their characteristic features and importance.

**CO3.** To become familiarize with the different technical aspects [isolation, cultivation, observation (microscopy), and identification] of studying microbes.

**CO4.** To get an insight on the existence of microbes in different spheres of the environment and how the microbes are affected/induced in these environments or *vice versa*.

**CO5.** To get the basic idea about the industrial application of different microbes for the production of single cell protein, beverages, industrial enzymes and genetically modified (GM) foods.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit I: Introduction to Microbial World**<br>1. Development of microbiology as a discipline. Spontaneous generation *vs*. Biogenesis; Microbes in nature; Role of microbes in the fields of agriculture & environment, industry, medicine, astrobiology.<br>2. History of microbiological development with special reference to the works of: Anton von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming and Elie Metchnikoff. | **10** |
| **Unit II: Diversity of Microbial World**<br>1. Binomial Nomenclature. Whittaker's five kingdom and Carl Woese's three domain concept of classification and their utility. Basics of Bergeys manual of systematic bacteriology.<br>2. General characteristics of acellulars (Viruses, Viroids, Virusoid and Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on their distribution and occurrence, morphology, mode of reproduction and economic importance. | **15** |
| **Unit III: Methods of studying microorganism**<br>1. Principle and application of light (bright and dark field), phase contrast, fluorescent, electron microscope, staining and fixation in microbiology.<br>2. Sterilization: Physical and chemical methods of sterilization; mode of action of chemotherapeutic agents.<br>3. Culture media: classification and importance; pure culture methods, preservation of pure cultures. | **20** |
| **Unit IV: Microbial Ecology**<br>1. Microorganisms of Soil: Diversity of soil microflora and factors affecting their distribution. Brief account of microbial interactions in soil-symbiosis, mutualism, commensalism, competition and synergism and parasitism. Microbes in the Rhizosphere and their importance.<br>2. Microorganisms of Water, Microorganisms of Air, Source and distribution of airborne and waterborne microorganisms. Microbes in the phyllosphere and their importance. | **20** |
| **Unit V: Microbial Application in Industry:**<br>1. Food preservation (chemical and physical) methods, Microbial deterioration of food products. Fermented food products.<br>2. Application of bacteria, yeast and molds in food industry. | **15** |

**Textbooks:**


1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology*. 4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.

**References:**


1. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.
2. Atlas RM. (2005). *Principles of Microbiology*. 4th edition. WMT. Brown Publishers.
3. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
4. Frazier WC and Westhoff DC. (2005). *Food Microbiology*. 5th edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
5. Martin A. (1977). *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London.
6. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2009). *General Microbiology*. 7th edition. McMillan.
8. Tortora GJ, Funke BR, and Case CL. (2013). *Microbiology: An Introduction*. 11th edition. Pearson Education.


**BMB 102 Biochemistry Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight into the various biochemical principles governing the physiology of cellular life. It also deals with the concept of buffer system acting as the mobile phase for various biochemical pathways.

**CO2.** To familiarize with the characteristic, types and structural features of important bio-molecules (carbohydrate, protein, lipid, amino acids) that form the building block of cellular organisms.

**CO3.** To develop the concept on the type, nature and other features of enzyme molecules that controls the different physiological processes of microbes and other cellular organisms.

**CO4.** To get an insight into the principles of various metabolic/biochemical processes (sugar degradation, electron transport, fermentation etc.) occurring in or carried out by different microbial/ cellular systems.

**CO5.** To develop the concept of the principles and mechanism of photosynthetic pathway occurring in $C_3$, $C_4$ plants and also carried out by various groups of bacteria and Cyanobacteria.

| Course Content | No. of Classes |
|---|---|
| **Unit I:** | **10** |
| 1. Cell dimension, turbidity measurements, Henderson-Hasselbach equation.<br>2. Modern concepts of acids and bases. Ionisation of acids; Dissociation of water, ionic product of water; Hydrogen in concentration-pH, determination of pH, dissociation of weak acids. | |
| **Unit II:** | **10** |
| 1. Classification and structure of Amino acids.<br>2. Amino acids as zwitterions in aqueous solutions, titration of amino acids, separation of amino acids, amino acid sequencing. | |
| **Unit III:** | **10** |
| 1. Introduction, Classification and functions of proteins; Primary, Secondary, Tertiary and Quaternary structural organization of proteins, protein synthesis, charactieristics of a dipeptide, Ramachandran plot. | |
| **Unit IV:** | **20** |
| 1. Carbohydrate metabolism- Glycolysis, Kreb's Cycle, Oxidative phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glyoxylate cycle.<br>2. Structure of mitochondria, sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain. | |
| **Unit V:** | **15** |
| 1. Photosynthesis, Structure of photosynthetic apparatus, light and dark reactions, $C_3$, $C_4$ and CAM pathways. | |

**Unit VI:** **15**

1. Structure, properties, classification and function of Lipids.
2. Fatty acid oxidation, biosynthesis of saturated and unsaturated fatty acids. Ketone bodies, oxidation of unsaturated and odd chain fatty acids.

**Suggested Readings:**


1. Albert L. Lehninger. *Principles of Biochemistry*-CBS Publishers & Distributors
2. Lubert Stryer. *Biochemistry*-Freeman International Edition.
3. Keshav Trehan. *Biochemistry*-Wiley Eastern Publications
4. Dr. A.C. Deb. *Fundamental of Biochemistry*.
5. U. Satyanarayana. *Biochemistry*-Books and Allied Pvt. Ltd.
6. Conn and Stump. *Outlines of Biochemistry*-Wiley Eastern Ltd., New Delhi.
7. Voet and Voet. *Biochemistry*-John Wiley and Sons.
8. S. Sadasivam and A. Manickam. *Biochemical Methods*-New Age International Publishers, New-Delhi.


**BMB 103** **Communicative English** **Theory** **Credit: 2**

**After successful completion, this course enables students**

**CO1.** To enhance reading and writing abilities mainly focusing academic and day to day uses.

**CO2.** To develop the idea of grammar usage (determiners, tenses, voice, direct and indirect speech, punctuation, word formation idioms and phrases) in developing communicating skills.

**CO3.** To get an insight into the format of official correspondence, Letter (formal and informal), Circular and Notice.

**CO4.** To develop the skill in writing Cvs/Resume, Essay, e-mail, Blog, Story and Paragraph which act as a source of communication at different platform.

**CO5.** To develop the skill in writing comprehension and precis that enables the students to understand a particular passage and express opinions in their own language.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit 1:Literary Texts (Poetry)**<br>This particular unit will help the students to enjoy, understand and interpret poems and develop a taste for fine poetry. The texts that have been chosen to be included are as follows:<br>•"The Poison Tree" by William Blake<br>•"The Daffodils" by William Wordsworth<br>•"If" by Rudyard Kipling. | **20** |
| **Unit 2: Literary Texts (Prose)**<br>This particular unit will help the students to foster a taste for literary prose pieces. The texts that have been chosen to be included are as follows:<br>•"The Stolen Bacillus" by H.G. Wells.<br>•"The Verger" by Somerset Maugham.<br>•"Shooting an Elephant" by George Orwell. | **20** |
| **Unit 3: Grammar and Usage:**<br>•Determiners, Tenses, Voice, Direct and Indirect Speech, Punctuation, Word Formation, Antonyms and Synonyms, Homophones, One-word substitution.<br>•Idioms and Phrases | **20** |
| **Unit 4: Writing Skills:**<br>This part would include areas like official correspondence, Letter (Formal and Informal), Circular, Notice, Writing Cvs/ Resume, Essay writing, e-mail writing, Blog writing, Story Writing, Paragraph writing.<br>The second section of this part will include **Comprehension** and **Precis Writing**that will enable the students to understand a particular passage and then express their opinions in their own language. This will enhance the student's reading and writing abilities. | **20** |

**Suggested Readings:**

- Nilanjana Gupta, *Communicate With Confidence,* Anthem Press.
- V. Shyamala, *Effective English Communication for You,* Emerald Publisher.
- Krishnamohan and Meera Bannerji, *Developing Communication Skills.*
- R.K. Madhukar, *Business Communication,* Vikash Publishing house Pvt. Ltd.
- Shalin Sharma, *Concepts of Professional Communication,* Acme Learning
- Daniel Jones, *English Phonetics.*
- R.K. Bansal and Harrison, *Spoken English for India,* Sec. Ed. Madras Orient Longman.
- Donald Treadwell and Jill B. Treadwell, *Public Relations Writing,* Sec. Ed. Sage Publications, Inc.
- P.D. Chaturvedi and Mukesh Chaturvedi, *Business Communication Concepts, Cases and Applications,* Sec. Ed. Manipal Press Limited.
- Sarah Trenholm and Arthur Jensen, *Interpersonal Communication,* Sixth Ed. Oxford University Press.
- Pulak Bhattacharyya (ed), *Musings- II: A Collection of English Prose*, Book Land Publishers.
- David V. Erdman(ed), *The Complete Poetry and Prose of William Blake*, Anchor Publishers.
- Maugham,Somerset, 65 Short Stories,Heinemann: London,1988[rpt] *Henry Reed(ed), The Complete Poetical Works of William Wordsworth, Troutman and Hayes Publishers.*


**BMB 104** **Phycology and Mycology** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight into the taxonomic position, habitat, morphology, cellular, nutritional and reproductive features of different groups of algae.
It also familiarizes students with the beneficial aspects of different algal groups.

**CO2.** To get an insight into the kingdom of Fungi; their taxonomic position, habitat, morphology, cellular, nutritional and reproductive features and how these features vary among different groups of fungi.

**CO3.** To familiarize with the important beneficial symbiotic association (lichen and mycorrhiza) of fungi and their specific role in different sectors.

**CO4.** To familiarize with beneficial aspects of different fungal groups and their industrial and environmental applications.

**CO5.** To familiarize with specific mechanism adopted by fungi for disease development (mycotoxins) and at the same it also gives an insight to the various means/approaches (antifungal agents) to combat such diseases.

| **Course Content** | **No. of Classes** |
|---|---|
| **Section: Phycology** | |
| **Unit I:** | **05** |
| 1. Characteristic features and classification of Algae | |
| **Unit II:** | **25** |
| 1. Study of the following classes with reference to genera listed below (occurrence, thallus organization and life cycles):<br>a) Chlorophyceae: *Volvox, Coleochaete*<br>b) Charophyceae: *Chara*<br>c) Diatoms: General features with reference to pinnate and centric diatoms<br>d) Xanthophyceae: *Vaucheria*<br>e) Phaeophyceae: *Ectocarpus*<br>f) Rhodophyceae: *Polysiphonia*<br>g) Cyanobacteria: *Nostoc* | |
| **Unit III:** | **05** |
| 1. Applications of algae in agriculture, environment, industry and food | |
| **Section: Mycology** | |
| **Unit IV:** | **05** |
| 1. Characteristic features and classification of fungi | |

**Unit V:** **30**

1. Study of the following classes with reference to the genera listed below (occurrence, somatic structure and life cycles):

a) Cellular slime molds - *Dictyostelium*
b) True slime molds (Myxomycetes) - *Physarum*
c) Oomycetes - *Saprolegnia, Phytophthora*
d) Chytridiomycetes - *Neocallimastix*
e) Zygomycetes – *Mucor*
f) Ascomycetes - *Saccharomyces, Penicillium, Neurospora*
g) Basidiomycetes - *Agaricus*
h) Deuteromycetes - *Candida, Alternaria*

**05**

**Unit VI:**

1. Lichens: Types, thallus structure and importance.

**Unit VII:** **15**

1. Economic importance of fungi with reference to agriculture, environment (biodeterioration), industry (pharmaceutical and food); Mycotoxins.

**Suggested Readings**

**Phycology**


1. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group,New York.
2. Graham LE, Graham JM and Wilcox LW. (2009). Algae. 2nd edition. Benjamin Cumming, New York.
3. Sharma OP. (2005). Textbook of Algae. Tata McGraw Hill Publishing Co. Ltd.
4. Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Ltd., New Delhi.


**Mycology**


1. Alexopoulos CJ, Mims CW and Blackwell M. (1996). Introductory Mycology. 4th edition. John Wiley and Sons, Inc.
2. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
3. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
4. Webster J. (1980). Introduction to Fungi. 2nd edition. Cambridge University Press


**BMB 105 Practical on Microbiology, Biochemistry and Phycology & Mycology Practical Credit: 4**

**This course enhances the practical application of the concept based on the theory courses of the semester. After successful completion, this course enables students**

**CO1.** To understand the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
Students also learn the basics of preparing common microbial media used for isolation and maintenance of microbial isolates.

**CO2.** To get an insight into the laboratory techniques for the isolation and enumeration of microorganisms from fro different environmental spheres like soil, water and air.
Students also learn the basics of isolating bacteria in pure cultures by streaking method and determination of bacterial growth curve.

**CO3.** To get the idea of preparing of biochemical solution of different strength including Stock Solution, PPM, Per cent, Normal, Molar and Millimolar solutions.

**CO4.** To get an insight into the biochemical methods for the estimation of carbohydrates, proteins and amino acids- both quantitatively and qualitatively.
It also helps students to develop the idea of separation of plant pigments and amino acids using chromatographic methods of TLC/ Paper chromatography.

**CO5.** To understand vegetative and reproductive structures of different algal (*Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia* and *Nostoc*) and fungal (*Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*) genera through temporary and permanent slides preparation.

| Course Content | No. of Classes |
|---|---|
| **Microbiology:** | **45** |
| 1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory. | |
| 2. Preparation of common microbial media (PDA, CDA, NA). | |
| 3. Isolation and enumeration of microorganisms from soil, water and air. | |
| 4. Isolation of pure cultures of bacteria by streaking method and determination of bacterial growth curve. | |
| 5. Study of the protozoans (*Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium)* using permanent mounts/photographs. | |
| **Biochemistry:** | |
| 6. Preparation of Stock Solution, PPM, Per cent, Normal, Molar and Millimolar solutions. | |
| 7. Tests of carbohydrates, proteins and amino acids- both quantitative and qualitative. | |
| 8. TLC / Paper chromatographic separation of plant pigments and amino acids. | **35** |
| 9. Determination of isoelectric point of protein. | |
| **Phycology and Mycology:** | |
| 10. Study of the following genera through temporary and permanent slides: *Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia* and *Nostoc* | |
| 11. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor*, *Saccharomyces, Penicillium, Agaricus* and *Alternaria* | **10** |

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**SEMESTER II**

**BMB 201** **Bacteriology** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To familiarize with the characteristic and structural features of bacteria (eubacteria and archaea) as a representative type of prokaryotic cellular organism.

**CO2.** To get an insight into the differences between eubacteria and protobacteria (archaea) as well as the important groups of organisms studied under them.

**CO3.** To get an insight into the various required factors (nutritional/physical) for the laboratory cultivation of bacteria. It also deals with the laboratory techniques for the cultivation and control of different microorganisms.

**CO4.** To have an idea of different reproductive strategies in bacteria with special emphasis on genetic recombination processes.

**CO5.** To get an insight into the bacterial systematic *i.e.* taxonomy of different bacterial groups and the application of conventional, molecular, and rRNA oligonucleotide, signature and protein sequencing for establishing bacterial phylogeny.

| **Course Content** | **No. of Classes** |
|---|---|

**Unit I: Cell organization** **25**

1. Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.
2. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall; Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms; Effect of antibiotics and enzymes on the cell wall.
3. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.
4. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids.
5. Endospore: Structure, formation, stages of sporulation.

**Unit II: Growth and nutrition** **15**

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

**Unit III: Reproduction in Bacteria** **15**

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

**Unit IV: Bacterial Systematics** **15**

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

**Unit V: Important archaeal and eubacterial groups** **20**

1. **Archaebacteria:** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota and Euryarchaeota [Methanogens, thermophiles and Halophiles]
2. **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups:

(a) Gram Negative:

Non proteobacteria: General characteristics with suitable examples.

Alpha-,Beta-, Gamma- Delta- and Zeta proteobacteria: General characteristics with suitable examples.

(b) Gram Positive: Low (Firmicutes) and High (Actinobacteria) G+C: General characteristics with

suitable examples.

(c) Cyanobacteria: An Introduction

**TEXTBOOKS:**


1. Pelczar MJ, Chan ECS and Krieg NR. (2010). *Microbiology*. 8th edition. McGraw Hill Book Company.
2. Sharma PD. (2005). *Microbiology*.4th edition (reprint). Rastogi Publication, Meerut.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 8th edition. McGraw Hill Higher Education.


**REFERENCES:**


1. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited by Paniker CKJ). University Press Publication.
2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). *Jawetz, Melnick and Adelberg's Medical Microbiology*. 24th edition. McGraw Hill Publication.
3. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
4. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th ed. Pearson/Benjamin Cummings.
5. Tortora GJ, Funke BR and Case CL (2013). *Microbiology: An Introduction*. 11th edition. Pearson Education.
6. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
7. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
8. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.


**BMB 202 VIROLOGY Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight into one of the most important acellular entity lying at the borderline of living and dead called virus and its allied groups including viroids, virusoids and prions.
It also deals with the nomenclature, classification of viruses and other aspects related to virus and its allied groups.

**CO2.** To have an idea about the general features, morphology, ultra-structure, composition and arrangements of structural components in virus.
To familiarize with the concept and important aspects (types, structural organization, multiplication cycle and therapeutic application) of bacteriophages *i.e.* the virus of bacteria.

**CO3.** To get an insight into the cultivational, diagnostic and serological (haemagglutination, immuno-fluorescence ELISA) methods concerned with the characterization and identification of virus.

**CO4.** To have the basics of salient features, multiplication and replication strategies among important types of plant and animal viruses with special reference to the nature of their nucleic acid.

**CO5.** To get an insight into the concept of oncogenic viruses i.e. viruses responsible for cancer.
It also deals with the concept of antiviral compounds, interferon and viral vaccines with special reference to their mode of action.
It also gives an idea about the application of virus specifically viral vectors in cloning and expression and gene therapy.

**Course Content** **No. of Classes**

**Unit I: Nature and Properties of Viruses**

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

**Unit II: Bacteriophages** **20**

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

**Unit III: Viral Transmission, Salient features of viral nucleic acids and Replication**

1. Modes of viral transmission: Persistent, non-persistent, vertical and horizontal
2. Salient features of viral Nucleic acid: Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) **10**
3. Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna), Assembly, maturation and release of virions **30**

**Unit IV:**

**Viruses and Cancer**

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

**Prevention & control of viral diseases**

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

**Unit V: Applications of Virology** **20**

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

**SUGGESTED READINGS:**

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition BlackwellPublishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC. **10**
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

**BMB 203 MICROBES IN ENVIRONMENT Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight into the different sphere of the environment (soil, water and air) as microbial habitat and how the microbes are affected/induced in these environments or *vice versa*.

**CO2.** To familiarize with the different types of microbial association developed in soil and how these associations affecting other cellular life in/on soil.

It also help in developing the concept on the application of microbes or their processes/products for developing beneficial and eco-friendly byproducts like biofertilizers, biopesticides, biopolymers, bioplastics etc.

**CO3.** To familiarize with the role of microbes in the cycling (mineralizationand immobilization) of nutrient elements like carbon, nitrogen, phosphorus, sulphur, iron required for a proper soil health.

**CO4.** To develop the idea about the important environmental roles played by microbes specifically in the light of management of municipal solid waste and sewage treatment and remediation of contaminated sites.

**CO5.** To get an insight into how microbes affecting aquatic health and what are the different approaches for monitoring and maintaining potability of water.

**Course Content** **No. of Classes**

**Unit I: Microorganisms and their Habitats**

1. Terrestrial Environment: Soil profile and soil microflora
2. Aquatic Environment: Microflora of fresh water and marine habitats
3. Atmosphere: Aeromicroflora and dispersal of microbes
4. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
5. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

**Unit II: Microbial Interactions**

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

**Unit III: Biogeochemical Cycling**

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

**Unit IV: Waste Management**

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

**Unit V: Microbial Bioremediation**

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

**Unit VI: Water Potability**

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

**Suggested Readings**


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

**BMB 204** **Environmental Studies** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight in to the multidisciplinary nature of environmental studies and its importance in other branches of sciences mainly to create public awareness regarding environment.
It highlights the natural resources and associated problems in terms of non-renewable sources describing the role of an individual in conservation of natural resources.

**CO2.** To have the concept of an ecosystem, it's structure and function with special emphasis on energy flow and ecological succession process.

**CO3.** To have an idea about the concept of biodiversity at global, national and local levels; threats to biodiversity and conservation strategies.

**CO4.** To get an insight in to the burning issue of environmental pollution describing the concept of pollutants, cause, effects and control measures of air, water, soil, noise, thermal and nuclear pollution.

**CO5.** To understand the social issues related to the environment describing human role in biodiversity destruction and its conservation as well as the ethical and legal (Environment Protection Acts) issues related to the environment.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit I: Multidisciplinary nature of environmental studies:**<br>1. Definition, scope and importance environmental studies. Relationship of environmental science with other branches of sciences. Need for public awareness regarding environment. | **5** |
| **Unit II: Natural Resources:**<br>**Renewable and non-renewable resources:**<br>1. Natural resources and associated problems. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. | **15** |
| **Unit III: Ecosystems**<br>1. Concept of an ecosystem. Structure and function of an ecosystem. Concept of producers, consumers and decomposers. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids. Ecological succession. | **15** |
| **Unit IV: Biodiversity and its conservation**<br>1. Definition of genetic, specific and ecosystem diversity.<br>2. Hot-spots of biodiversity. Biodiversity at global, National and local levels. India as a mega-diversity nation. Bio-geographical classification of India. Endangered and endemic species of India.<br>3. Threats to biodiversity. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. | **10** |
| **Unit V: Environnemental Pollution**<br>1. Definition and sources of environmental Pollution. Concept of pollutants. Cause, effects and control measures of:-Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards. Disaster management: floods, earthquake, cyclone and landslides. | **10** |
| **Unit VI: Social Issues and the Environment**<br>1. Conservation strategies: Water conservation, rain water harvesting, watershed management. Wasteland reclamation.<br>2. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.<br>3. Environmental ethics: Issues and possible solutions. Environment Protection Acts: a conceptual approach. | **10** |
| **Unit VII: Human Population and the Environment**<br>1. Population explosion and Family Welfare Programme. Environment and human health. Value Education. Women and Child Welfare. HIV/AIDS.<br>**2.** Role of Information Technology in Environment and human health. | **10** |
| **Unit VIII: Field work**<br>1. Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain. | |

2. Visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural. **15**
3. Study of common plants, insects, birds.
4. Study of simple ecosystems-pond, river, hill slopes, etc.

(Field work Equal to 5 lecture hours)

**Textbooks:**


1. Agarwal, K.C. (2001). Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Dey, A.K. Environmental Chemistry, Wiley Eastern Ltd.
3. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Saunders Co. USA.


**References:**


1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, India, (R)
2. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
3. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
4. Down to Earth, Centre for Science and Environment (R)
5. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press. 473p
6. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7. Heywood, V.H &Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
8. Jadhav, H &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub.House, Delhi 284 p.
9. Mckinney, M.L. & School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p.
10. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
11. Rao M N. &Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd.
12. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut. Survey of the Environment, The Hindu (M)
13. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell. Science (TB)
14. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
15. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
16. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p


(M) Magazine
(R) Reference
(TB) Textbook

**BMB 205 Practical on Bacteriology, Virology and Microbes in Environment Practical Credit: 4**

**This is a practical course based on various aspects related to bacteria, virus and environmental impact of different microbial groups. After successful completion, this course enables students**

**CO1.** To understand the principle and methods of different staining techniques in Bacteria (Simple staining, Negative staining, Gram's staining, Acid fast staining, Capsule staining and Endospore staining).

**CO2.** To learn the laboratory methods of pure cultures isolation of bacteria by streaking method as well as estimation of CFU count by spread plate and pour plate method.
It also describes the test of motility in bacteria by hanging drop method.

**CO3.** To understand the structural features of important animal viruses (rhabdo, influenza, paramyxo, hepatitis B and retroviruses), plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) and bacteriophages (ϕX 174, T4, λ) using electron micrographs that enables students to understand cytopathic effects of these viruses.

**CO4.** To understand the techniques of isolating microbes from specific microenvironments like rhizosphere, rhizoplane, phyllosphere and phylloplane.
It also gives an idea about the enzymatic activity (qualitatively) of microbes in soil (dehydrogenase, amylase, urease).

**CO5.** To learn the process of assessment of microbiological quality of water to determine it's potability.

| **Course Content** | **No. of Classes** |
|---|---|
| **Bacteriology:** | **45** |

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Study of staining techniques in Bacteria: Simple staining, Negative staining, Gram's staining, Acid fast staining, Capsule staining and Endospore staining.
3. Isolation of pure cultures of bacteria by streaking method.
4. Estimation of CFU count by spread plate method/pour plate method.
5. Motility by hanging drop method.

**Virology:** **20**

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

**Microbes in Environment:**

1. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane. **25**
2. Isolation of microbes (bacteria & fungi) from phyllosphere and phylloplane.
3. Assessment of microbiological quality of water.
4. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

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**SEMESTER III**

**BMB 301** **Microbial Physiology and Metabolism** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight into the concept of growth in terms of microbial cells; different cultural approaches for the measurement of microbial growth (growth curve).

**CO2.** To have the concept on the effect of environmental factors (temperature, pH, solute and water activity, oxygen requirement, nutrition and energy) on microbial growth.

**CO3.** To familiarize with the mechanism of nutrient uptake and transport in microbial cells.

**CO4.** To get an insight into the principles of various metabolic/biochemical processes (sugar degradation, electron transport, fermentation etc.) occurring in or carried out by different microbial/ cellular systems.

**CO5.** To understand the principles and mechanism of phototrophic metabolic pathway carried out by various groups of bacteria and Cyanobacteria.

| Course Content | No. of Classes |
|---|---|
| **Unit I: Microbial Growth and Environmental Effect on Microbial Growth**<br>1. Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve<br>2. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.<br>3. Microbial growth in response to nutrition and energy–Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. | **25** |
| **Unit II: Nutrient uptake and Transport**<br>1. Passive and facilitated diffusion; Primary and secondary active transport, concept of uniport, symport and antiport; Group translocation; Iron uptake | **10** |
| **Unit III: Chemoheterotrophic Metabolism - Aerobic Respiration**<br>1. Concept of aerobic respiration, anaerobic respiration and fermentation; Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway: TCA cycle<br>2. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors | **15** |
| **Unit IV: Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation**<br>1. Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)<br>2. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways | **15** |
| **Unit V: Chemolithotrophic and Phototrophic Metabolism**<br>1. Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction)<br>2. Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria | **15** |

**Suggested Readings:**


1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition,

McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**BMB: 302** **Cell Biology** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have the concept of cell theory; structural organization and functions of prokaryotic and eukaryotic cells as well as their comparative account.

**CO2.** To get an insight into the structural organization and functional roles of important cell organelles including plasma membrane, endoplasmic reticulum, golgi complex, lysosome, peroxisome and vacuoles and mitochondria.

**CO3.** To understand the structural organization and functional roles nucleus, the controlling centre of a cell.

**CO4.** To understand the structural organization and functional roles of cytoskeleton that gives specific shape and structure to a cell.

**CO5.** To get an insight into various stages of cell cycle that regulates proper organization in cellular organisms. It also deals with the abnormalities during cell division process leading to cancer like problem.

**Course Content**

**Unit I: Introduction to cell** **15**

1. Cell theory, Structural organization of prokaryotic cell, eukaryotic cells and their function.
2. Comparative characters of prokaryotes and eukaryotes.

**Unit II: Plasma membrane** **10**

1. Structural organization of cell membrane, plasma membrane and their function
2. Mechanism of transport across the plasma membrane, Sodium Potassium pump, Glucose transport, transport of ions in neuron.

**Unit III: Cell organelles; structure & function** **15**

1. Endoplasmic reticulum, golgi complex, lysosome, peroxisome and vacuoles, mitochondria; role of mitochondria in oxidative reactions and electron transport chain. Chloroplast and its role in photosynthesis.

**Unit IV: Nucleus** **15**

1. Nucleus- Structure, organization and function, Nuclear envelope, role of nuclear pore in transport across the envelope, nucleoplasm and nucleolus, Chromatin structure and organization.

**Unit V: Cytoskeleton** **10**

1. Microtubule and microfilaments:
2. Intermediate filaments and Extra cellular matrix

**Unit VI: Cell cycle & cell division** **15**

1. Cell cycle and its phases, Cell divisions and Cell death
2. Cell cycle- control and regulation and cancer.

**Suggested Readings:**

1. Bruce Alberts *et al*. *Molecular Biology of cell*. Garland Publications
2. Daniel. *Molecular Cell Biology*. Sceintific American Books.
3. Jack D. Bruke. *Cell Biology*. The William Twilkins Company.
4. Old and Primrose. *Principles of Gene Manipulations*. Black Well Scientific Publications.
5. Ambrose and Dorouthy M Hasty. *Cell Biology*. ELBS Publications.
6. Sharp. *Fundamentals of Cytology*. Mc Graw Hill Company.
7. Wilson and Marrision. *Cytology*. Reinform Publications
8. Smith. *Molecular Biology*. Faber and Faber Publications
9. EDP Roberties and EMF Roberties. *Cell and Molecular Biology*. Sauder College.

10. Gardener EJ, Simmons MJ and Snustad DP. *Principles of Genetics*. John Wiley and Sons Publications.

**BMB 303** **Molecular Biology** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight in to the molecular basis of biological activity between biomolecules in the various systems of a cell.

**CO2.** To have the basics of DNA, RNA, and proteins; their structure and interactions within the cell to promote growth, division and development.

**CO3.** To understand the different mechanism DNA replication adopted in prokaryotic and eukaryotic system.
It also highlights the factors inducing and inhibiting replication.

**CO4.** To get an insight in to the wide range of mechanisms required for the regulation of transcription, translation and expression of gene in prokaryotic and eukaryotic system.

**CO5**. To understand the responses to environmental or physiological changes or alterations of cell function brought about by mutation.
It also highlights the molecular basis for cancer and other related abnormalities and the molecular tools and techniques to study such abnormalities.

| Course Content | No. of Classes |
|---|---|
| **UnitI: Basic concepts of Genetic Information**<br>1. Nucleic acids as genetic information carriers, experimental evidences.<br>2. Primary structure of nucleic acids and their properties. Highly repetitive, moderately repetitive and unique DNA sequences, Classes of RNA, secondary and tertiary structure.<br>3. Secondary structures of nucleic acids, anti-parallel strands, base composition, base equivalence, base pairing and base stacking, types of DNA, structural characteristics, chirality and cot curve. | **25** |
| **Unit II: DNA Replication**<br>1. DNA replication in prokaryotes: Conservative, semiconservative and dispersive types, DNA polymerases, enzymes and protein factors involved in replication.<br>2. Mechanism of replication in eukaryotes, inhibitors of replication. | **15** |
| **Unit III: Transcription, Translation and Regulation of Gene Expression**<br>1. Transcription in prokaryotes and eukaryotes, RNA polymerases; promoters, differences in transcription termination, post translational modifications.<br>2. Genetic code: Basic features of genetic code, biological significance of degeneracy, Wobble hypothesis; gene within genes and overlapping genes, mechanism of translation in prokaryotes and eukaryotes, ribosome assembly.<br>3. Regulation of Gene Expression in Prokaryotes and eukaryotes, Enzyme induction and repression, operon concept, Lac operon, Trp operon, eukaryotic gene arrangements. | **20** |
| **Unit IV: Mutation and Repair**<br>1. Mutation: molecular basis of mutation, types of mutation, dominant and recessive mutations, spontaneous and induced mutations.<br>2. Mutagenicity testing: Correlation of mutagenicity and carcinogenicity: Ames testing, Random and site directed mutagenesis. DNA Repair- Types and evidences. | **30** |

**Suggested Readings:**

1. Glick, B.T and Pastermak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrooket al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA

6. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7. Karp.G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley and Sons; INC
8. Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut.

**BMB 304** **Agricultural Microbiology** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To develop the idea about the formation, stratification and physico-chemical properties of soil. It also deals with how the microorganisms are affected/ induced in a terrestrial ecosystem.

**CO2.** To get an insight in to the chemical transformation carried out by microbes during organic matter decomposition wherein mineralization and immobilization of important nutrient occurs resulting in enhancement of soil nutrient profile.

**CO3.** To familiarize with the concept of diseases of agricultural commodities caused by microbial agents, different terminology associated with such disease and at the same time some of the important measures for controlling/eradicating diseases from crop fields.

**CO4.** To get an insight into the significance of microorganisms in terms of formulation of biofertilizers, phytostimulators, bioinsecticides which are eco-friendly alternative to their chemical counterparts.

**CO5.** To have the concept of microbes as a source of bio-fuels and biogas, alternative to non-renewable fossil fuels. It also highlights the issues associated with the development of GM crops and transgenic animals.

| Course Content | No. of Classes |
|---|---|
| **Unit I: Soil Microbiology**<br>1. Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil | **10** |
| **Unit II: Microbial Activity in Soil**<br>1. Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium.<br>2. Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control | **10** |
| **Unit III: Microbesas Plant Pathogens**<br>1. Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases.<br>2. Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds | **15** |
| **Unit IV: Biofertilization, Phytostimulation, Bioinsecticides**<br>1. Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non-Symbiotic (*Azospirillum, Azotobacter, Mycorrhizae*, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs<br>2. General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications. | **10** |
| **Unit V: Secondary Agriculture Biotechnology**<br>1. Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters | **15** |
| **Unit VI: GM crops**<br>1. Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals. | **15** |

**Suggested Readings:**

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Env. Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. NewYork.
11. Reddy, S.M. *et. al.* (2002). Bioinoculants for Sustainable Agriculture and Forestry, Sci.Pubs.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

**BMB 305: Microbial Diagnosis in Health Clinics Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To understand the concept of Stereochemistry with the help of Fischer, Newmann and Sawhorse projection and Wedge formulae.

**CO2.** To acquaint with various conformations of ethane, butane, ethane-1,2-diol and cyclohexane with reference to relative stability of different conformations in terms of energy difference.

**CO3.** To understand the mechanism of addition reactions with the help of hydrogenation, hydrohalogenation, hydroxylation and ozonolysis in alkenes, alkynes, aldehydes and ketones.
It also help in understanding the mechanism of substitution and elimination reactions among organic compounds.

**CO4.** To understand the mechanism of oxidation reactions occurring in aromatic side chain compounds, alcohols, aldehydes and ketones and the rules governing such mechanisms.

**CO5.** To understand the mechanism of catalytic hydrogenation, electrolytic and other reduction reactions occurring in aldeydes, ketones, carboxylic acids and their derivatives and nitro compounds.

| Course Content | No. of Classes |
|---|---|
| **Unit I: Importance of Diagnosis of Diseases**<br>1. Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems,<br>2. Disease associated clinical samples for diagnosis. | **10** |
| **Unit II: Collection of Clinical Samples**<br>1. Method of collecting clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required.<br>2. Method of transport of clinical samples to laboratory and storage. | **15** |
| **Unit III: Direct Microscopic Examination and Culture.**<br>1. Examination of sample by staining-Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsastained thin blood film for malaria<br>2. Preparation and use of culture media-Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar,<br>3. Distinct colony properties of various bacterial pathogens. | **20** |
| **Unit IV: Serological and Molecular Methods**<br>1. Serological Methods-Agglutination, ELISA, immunofluorescence, Nucleic acid-based methods - PCR, Nucleic acid probes | **20** |
| **Unit V: Testing for Antibiotic Sensitivity in Bacteria**<br>1. Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method; Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method. | **10** |

**Suggested Reading**

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition,

Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnickand Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

**BMB 306 Practical on Microbial Physiology, Cell- and Molecular Biology and Agricultural Microbiology**
**Practical Credit: 4**

**This is a practical course based on cyto-morphological, molecular and physiological basis of microbial life. After successful completion, this course enables students.**

**CO1.** To understand the different stages of reductive cell division process of meiosis– chromosome staining in flower bud anthers.

**CO2.** To study the induction of variation in chromosome number using chemical mutagenes and karyotype analysis in in plant and animal cells.

**CO3.** To learn the molecular methods of isolation and quantification of DNA using UV-VIS spectrophotometric analysis and agarose gel electrophoresis.

**CO4.** To understand the concept of soil profile and the distribution of microflora of different types of soils with reference to cellulose degrading organisms

**CO5.** To understand the pattern of growth in *E. coli* by turbidometric and standard plate count methods and to estimate generation time and specific growth rate from the plotted graph.
It is also concerned with the effect of temperature, pH, C and N sources and salt on growth of *E. coli* that demonstrates the thermal death time and decimal reduction time of *E. coli.*

**Course Content** — **No. of Classes**

**Cell Biology:** — **45**

1. Induction of variation in chromosome number using chemical mutagenes.
2. Karyotype analysis: Man and Onion- (normal and abnormal); Down and Turner's syndromes (With the help of slides).
3. Stages of meiosis cell division – chromosome staining in flower bud anthers.

**Molecular Biology** — **15**

1. Isolation and quantification of DNA: UV-VIS spectrophotometric analysis, Optical activity of DNA.
2. Separation of DNA bands by agarose gel electrophoresis and determination of molecular weight.

**Agricultural Microbiology**

1. Study soil profile
2. Study microflora of different types of soils
3. Design and functioning of a biogas plant
4. Isolation of cellulose degrading organisms

**Microbial Physiology and Metabolism**

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

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**SEMESTER IV**

**BMB 401: MICROBIAL GENETICS** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have the concept about the genome organization in prokaryotic and eukaryotic system.

**CO2.** To have an idea of the responses to environmental or physiological changes or alterations of cell function brought about by mutation and their expression at genetic level.

**CO3.** To get an insight into the extra-chromosomal inheretary material called plasmids; their type, specificity and regulation.

**CO4.** To have an idea about the mechanisms of genetic exchange including transformation, conjugation and transduction and at the same time molecular aspects of mapping by recombinants.
It also highlights the genetic mechanisms in phage particle with reference to T4 lambda.
**CO5.** It deals with the concept of transposable elements in prokaryotes and eukaryotes with special emphasis on their role in transmission of hereditary characters.

| Course Content | No. of Classes |
|---|---|
| **Unit I: Genome Organization and Mutations**<br>1. Genome organization: *E. coli, Saccharomyces, Tetrahymena*<br>2. Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations<br>3. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes | **20** |
| **Unit II: Plasmids**<br>1. Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids | **10** |
| **Unit III: Mechanisms of Genetic Exchange**<br>1. Transformation - Discovery, mechanism of natural competence<br>2. Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping<br>3. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates,<br>4. Mapping by recombination and co-transduction of markers | **25** |
| **Unit IV: Phage Genetics**<br>1.Features of T4 genetics,<br>Genetic basis of lytic versus lysogenic switch of phage lambda | **10** |
| **Unit V: Transposable elements**<br>1. Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons,<br>2. Replicative and Non replicative transposition, Mu transposon<br>3. Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds)<br>4. Uses of transposons and transposition | **25** |

**Suggested Readings:**

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings

5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

**BMB 402: ENVIRONMENTAL MICROBIOLOGY** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get an insight into the different sphere of the environment (soil, water and air) as microbial habitat and how the microbes are affected/induced in these environments or *vice versa*.
It also deals with the microbes present in environments with extreme conditions and microbial strategies to survive in those extreme environments.

**CO2.** To familiarize with the different types of association developed between microbes, microbes with plants and microbes with animals and how these associations affecting other cellular life.

**CO3.** To have the concept about the role of microbes in the cycling (mineralization and immobilization) of nutrient elements like carbon, nitrogen, phosphorus, sulphur, iron required for a proper soil health.

**CO4.** To familiarize with the important environmental roles played by microbes specifically in the light of sewage treatment and remediation of contaminated sites.

**CO5.** To get an insight into how microbes affecting aquatic health and what are the different approaches for monitoring and maintaining potability of water.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit 1: Microorganisms and their Habitats**<br>1. Terrestrial Environment: Soil profile and soil microflora<br>2. Aquatic Environment: Microflora of fresh water and marine habitats<br>3. Atmosphere: Aeromicroflora and dispersal of microbes<br>4. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.<br>5. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter | **10**<br><br><br><br><br>**20** |
| **Unit II: Microbial Interactions**<br>1. Microbial interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation<br>2. Microbe-Plant interaction: Symbiotic and non symbiotic interactions<br>3. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria | <br><br>**30** |
| **Unit II: Biogeochemical Cycling**<br>1. Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin<br>2. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction<br>3. Phosphorus cycle: Phosphate immobilization and solubilisation<br>4. Sulphur cycle: Microbes involved in sulphur cycle<br>5. Other elemental cycles: Iron and manganese | <br>**15** |
| **Unit IV: Waste Management**<br>1. Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)<br>2. Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment | |

**Unit V: Microbial Bioremediation**

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

**Unit VI: Water Potability**

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

**Suggested Readings:**


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


**BMB 403: FOOD AND DAIRYMICROBIOLOGY** **Theory** **Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have an idea about the association of microbe with different food product and the physico-chemical alteration occurring in food items due to microbial contamination that bring about spoilage of them.

**CO2.** To get an insight into various strategies (physical and chemical) for preserving food from microbial spoilage.

**CO3.** To have the concept of microbial fermentation and different fermented food products obtained through microbial process.

**CO4.** To conceptualize the pharmaco-nutritional assessment of fermented food products.

**CO5.** To have the idea about the food-borne infections and intoxications resulting from microbial contamination of food; the laboratory diagnosis of such food-borne infections and their preventive measures.

| Course Content | No. of Classes |
|---|---|
| **Unit 1: Foods as a substrate for microorganisms**<br>1. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. | **05** |
| **Unit II: Microbial spoilage of various foods**<br>1. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods | **10** |
| **Unit III: Principles and methods of food preservation**<br>1. Principles, physical methods of food preservation: temperature (low, high, canning, drying), | **15** |

irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, $SO_2$, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

**Unit IV: Fermented foods** **25**

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

**Unit V: Food borne diseases (causative agents, foods involved, symptoms and preventive measures)** **25**

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

**Unit VI:** **10**

1. Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

**Suggested Readings:**


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


**BMB 404: Genetic Engineering Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have the basic concept of genetic engineering and r-DNA technology laying the basis of genetic modification of cellular organisms.

**CO2.** To develop the concept about the types, nature and functions of restriction enzymes that act as the mediators of DNA modification during genetic manipulation process.

**CO3.** To get an insight into the concept of different vectors (plasmids, cosmids, phagemids, artificial chromosome vectors) that act as carrier of DNA fragment between cellular organisms during genetic modification.

**CO4.** To understand the different blotting techniques (Southern, Northern and Western) hybridization process as well as the construction and screening genomic and c DNA libraries.

**CO5.** To have concept about the most versatile molecular technique of Polymerized Chain Reaction (PCR); its types, applications and different PCR based and PCR independent marker (RAPD, RFLP, AFLP) methods in Molecular Biology.

**Course Content** **No. of Classes**

**Unit I:** **05**

1. Introduction to Genetic Engineering, Recombinant DNA technology (r-DNA technology)

**Unit II:** **20**

1. Restriction enzymes- Introduction, types and its functions; Restriction modification, DNA polymerases, Ligases, and DNA modifying enzymes
2. Cohesive and blunt end ligation. Linkers, adaptors, homopolymeric tailing.

**Unit III:** **20**

1. Cloning vectors: Plasmids, types of plasmids, cosmids, phagemids, artificial chromosome vectors (BAC, YAC).
2. Phage biology Lytic and Lysogenic cycle, phage as a cloning vector, replacement and integrated vector.

**Unit IV:** **15**

1. Hybridization techniques- Southern, Northern and Western Hybridization, DNA and RNA probes; Construction of libraries and its screening (genomic and c DNA libraries)

**Unit V:** **20**

1. PCR and its applications, types of PCR- Gradient, Reverse transcriptase, Real time PCR.
2. Basics of marker methods in molecular biology: RAPD, RFLP, AFLP, microarrays, DNA fingerprinting.

**UNIT-VI** **10**

1. Introduction of DNA into mammalian cells, transfection techniques; vectorless DNA delivery.

**Suggested Readings:**


1) S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6$^{th}$Edition, S.B.University Press, 2001.
2) J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3) N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.
4) Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006. Mange E J and Mange A. P., Human genetics, 2nd Edition, Sinauer Associates publications, 1999.
5) S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.
6) J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols1-3, CSHL, 2001.
7) Campbell AM & Heyer LJ, Discovering Genomics, Proteomics & Bioinformatics, 2$^{nd}$Edition. Benjamin Cummings 2007.
8) Singh, B.D. Biotechnology, Kalyani publishers, India.


**BMB 405: Food Fermentation Techniques** **Theory** **Credit: 4**

**After completion, this course enables students**

**CO1.** To understand the structure of molecule following valence bond approach as well as the concept of resonance in various organic and inorganic compounds. It also gives an idea VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

**CO2.** To get an idea on various intermolecular forces like van der Waals forces, Hydrogen bonding and their effects on melting point, boiling point and solubility of compounds.

**CO3.** To have the concept on transition elements specifically their electronic configuration, variable valency, color, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for with special reference to Mn, Fe and Cu.

**CO4.** To understand the concept of Valence Bond Theory with reference to inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu; their structural and stereoisomerism with coordination numbers 4 and 6.

**CO5.** To understand the concept of Crystal Field Theory with reference to crystal field effect for weak and strong fields and crystal field stabilization energy.

**Course Content** **No. of Classes**

**Unit -I:** Isolation, selection, improvement and maintenance of industrial important strain.

Metabolicpathways and metabolic control mechanisms; primary metabolites (alcohols, vitamins, enzymes and organic acids) and secondary metabolites (antibiotics and toxins); substrates for industrial fermentation

**Unit-II:** Batch culture in fermentation, growth kinetics of micro-organisms.
Classification of fermentation process; growth and nutrient, growth and product formation, heat evolution, effect of environment (temperature, pH, high nutrient concentration); media formulation and sterilization, kinetics of thermal death of micro-organisms.

**Unit-III**: Continuous culture and scale up – Continuous culture system, productivity, productformation, power requirement oxygen transfer kinetics, foam and antifoam-instrument control, physical and chemical environment sensors.

**Unit-IV:** Downstream processing objectives and criteria, foam separation; Precipitation methodsfiltration devices industrial scale centrifugation and cell disruption methods. liquid -liquid extraction solvent I recovery chromatography. Two phase aqueous extraction, super critical fluid extraction, ultrafiltration drying devices crystallization and whole broth processing.
IPR and bioethics.

**Suggested Books:**


1. Industrial Microbiology by Prescott and Dunn. Agrobios (India)
2. Industrial Microbiology: An Introduction. Michael J. Waites, Neil L. Morgan, Gary Higton. Wiley-blackwell
3. Industrial Microbiology by Patel. Macmillan Publishers India
4. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd
5. Industrial Microbiology by Casida
6. Industrial Microbiology by Cruger & Cruger
7. Principles of Fermentation Technology. Stanbury Pf, Whitaker A, Hall Sj. Elsevier India P Ltd


**BMB 405 Chemistry-II: Chemical Bonding, Transition Metals and Coordination Chemistry**

**Theory Credit: 4**

**After completion, this course enables students**

**CO1.** To understand the structure of molecule following valence bond approach as well as the concept of resonance in various organic and inorganic compounds. It also gives an idea VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

**CO2.** To get an idea on various intermolecular forces like van der Waals forces, Hydrogen bonding and their effects on melting point, boiling point and solubility of compounds.

**CO3.** To have the concept on transition elements specifically their electronic configuration, variable valency, color, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for with special reference to Mn, Fe and Cu.

**CO4.** To understand the concept of Valence Bond Theory with reference to inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu; their structural and stereoisomerism with coordination numbers 4 and 6.

**CO5.** To understand the concept of Crystal Field Theory with reference to crystal field effect for weak and strong fields and crystal field stabilization energy.

**Course Content**

**Unit 1: The covalent bond and the structure of molecules**

1. Valence bond approach, Concept of resonance in various organic and inorganic compounds.
2. Hybridization and structure, equivalent and non-equivalent hybrid orbitals, Bent's rule and its applications.
3. VSEPR model for predicting shapes of molecules and ions containing lone pairs, sigma and pi bonds.

**Unit 2: Molecular Orbital Approach**

1. LCAO method, symmetry and overlap for s-s, s-p and p-p combinations.
2. MO treatment of homonuclear diatomic molecules of $2^{nd}$ period (B2, C2, N2, O2, F2) and heteronuclear di-atomic molecules (CO, NO) and their ions.

**Unit 3: Intermolecular forces:**

1. van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility.

**Unit 4: Transition Elements (3*d* series)**

1. General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.
2. Concept of Lanthanoids and actinoids.

**Unit 5: Coordination Chemistry**

1. Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.
2. Drawbacks of VBT. IUPAC system of nomenclature.

**Unit 6: Crystal Field Theory**

1. Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry.
2. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for *Oh* and *Td* complexes, Tetragonal distortion of octahedral geometry.
3. Jahn-Teller distortion, Square planar coordination.

**Suggested Readings:**


1. James E. Huheey, *"Inorg. Chemistry: Principles of structure and reactivity"*, Prentice Hall, IV Edition.
2. D. S. Shriver and P.A. Atkins, *"Inorganic Chemistry"*, Oxford University Press, IV Edition.
3. Alan G. Sharpe, "*Inorganic Chemistry"*, University of Cambridge, III Edition.
4. J. D. Lee, *"A New Concise Inorganic Chemistry"*, ELBS IV Edition
5. Grey L. Miessler and Donald A. Tarr, *"Inorganic Chemistry"*, Prentice Hall, III Edition.
6. B. Douglas, D. H. McDaniel and J. J. Alexander, *"Concepts and Models of Inorganic Chemistry", John Wiley and Sons, III Edition.*
7. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.


**BMB 406: Practical on Microbial Genetics, Environmental Microbiology, Genetic Engineering and Food & Dairy Microbiology** **Practical** **Credit: 4**

**This is a practical course concerned with microbial genetics and technical aspects of genome modification as well as importance of such genetically modified strains in the field of food and dairy industry. After successful completion, this course enables students**

**CO1.** To learn the laboratory techniques of preparing Master and Replica Plates for the study of the effect of chemical ($HNO_2$) and physical (UV) mutagens on bacterial cells.

**CO2.** To understand the process of genetic recombination in bacteria including conjugation, transformation and transduction

**CO3.** To learn the different analytical methods to determine physic-chemical properties of soil (pH, moisture content, water holding capacity, percolation, capillary action) and water (BOD, COD and microbial count).
It also helps in learning different microbial activity in soil like enzymatic activities and root nodule formation.

**CO4.** To learn different laboratory methods to determine quality of food products (MBRT and Alkaline phosphatase test to check the efficiency of pasteurization of milk).
It also deals with different microbes associated with spoilage of vegetables, fruits and other food products.
It also helps in learning the preparation process of fermented products like Yogurt and Dahi.

**CO5.** To learn the techniques for isolation of genomic DNA (from bacteria, plant and animal tissues) and plasmid DNA (*E. coli*).
It also helps in learning the technique of restriction digestion of DNA and its separation by Gel Electrophoresis.
Protein profiling- SDS PAGE.

| **Course Content** | **No. of Classes** |
|---|---|
| **Microbial Genetics**<br>1. Preparation of Master and Replica Plates<br>2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells<br>3. Study survival curve of bacteria after exposure to ultraviolet (UV) light<br>4. Isolation of Plasmid DNA from *E.coli*<br>5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.<br>6. Demonstration of Bacterial Conjugation<br>7. Demonstration of bacterial transformation and transduction<br>8. Demonstration of AMES test | **30** |
| **Environmental Microbiology**<br>1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.<br>2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).<br>3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.<br>4. Assessment of microbiological quality of water.<br>5. Determination of BOD of waste water sample.<br>6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.<br>7. Isolation of Rhizobium from root nodules. | **20** |
| **Food and Dairy Microbiology**<br>1. MBRT of milk samples and their standard plate count.<br>2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.<br>3. Isolation of any food borne bacteria from food products.<br>4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.<br>5. Isolation of spoilage microorganisms from bread. 6. Preparation of Yogurt/Dahi. | **20** |
| **Genetic Engineering**<br>1. Isolation of genomic DNA (from bacteria, plant and animal tissues) and plasmid DNA (*E. coli*).<br>2. Restriction digestion of DNA and separation of DNA by Gel Electrophoresis.<br>3. Protein profiling- SDS PAGE. | **20** |

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**SEMESTER V**

**BMB 501: MEDICAL MICROBIOLOGY Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have an understanding about the microbial associated with human body (skin, respiratory tract, digestive tract, urino-genital system); their source, path of entry and the infection resulted from such association.

**CO2.** To get an insight into the host-pathogen relationships (disease cycle), transmission of pathogens and post-infectional changes in the host.

**CO3.** To understand the various stages of laboratory diagnosis of microbial infections including collection and processing of clinical specimen and microscopic, biochemical examination for the characterization and identification of clinical specimens.

**CO4.** To have the concept about pathogenicity, symptomology, transmission, disease cycle, laboratory diagnosis and treatment of diseases caused by bacteria, fungi, protozoa and virus.

**CO5.** To understand the different antimicrobial and chemotherapeutic agents, antibiotics and antiseptics with mechanism of action against targeted pathogens.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit 1: Normal microflora of the human body and host pathogen interaction**<br>1. Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract<br>2. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS | **10** |
| **Unit II: Sample collection, transport and diagnosis**<br>1. Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes). | **10** |
| **Unit III: Bacterial diseases**<br>1. Diseases of various organ systems and their causative agents.<br>2. Symptoms, mode of transmission, prophylaxis and control of<br>3. Respiratory Diseases: *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis*<br>4. Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori*<br>5. Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficie* | **15** |
| **Unit IV: Viral diseases**<br>1. List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control of Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis | **15** |
| **Unit V: Protozoan diseases**<br>1. List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar | **10** |
| **Unit VI: Fungal diseases**<br>1. Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention<br>2. Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis | **10** |
| **Unit VII: Antimicrobial agents: General characteristics and mode of action**<br>1. Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein | **20** |

synthesis; Inhibitor of metabolism
2. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
3. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

**Suggested Readings:**


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


**BMB 502: IMMUNOLOGY Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To familiarize with the concept of non-specific (innate) and specific (acquired) resistance mechanism developed in man against pathogens and other non-self factors which is the basis of this course.

**CO2.** To get an insight into the formation, types, organization and functional specificity of different cellular and organ level components conferring resistance in man.

**CO3.**To familiarize with the nature, types and function of antigens that induce immunological response in man and how the product of this response (antibody, B and T cells) help in neutralizing them (agglutination and precipitation reactions).
It also deals with the different diagnostic and serological approaches for the study of interaction between an antigen and its specific antibody including Widal Test, immunodiffusion, Immuno-electrophoresis, ELISA, RIA etc.

**CO4.** To have the concept of different mediators/cell signaling molecules (complement, cytokines: interferons, Interleukins, heamatopoetins and chemokines) associated with immunological responses as well as their biological consequences.

**CO5.** To understand the immune disorders (hypersensitivity, autoimmune disorders, oncogenesis etc.) and induced immunity (vaccination) to overcome such abnormalities.

**Course Content** **No. of Classes**

**Unit-I** **20**
1. History of immunology.
2. Types of immunity: Innate and Acquired immunity; Cells and Organs of the immune system.

**Unit-II**
1. Antigen – Antigenecity, Immunogenecity, Epitopes, Haptens, Adjuvants; MHC self-antigen – Class and structure. **20**
2. Antibodies- Structure, classes and function, Isotype, Allotype, and Idiotype; Genetic diversity of antibody class
3. Antigen and antibody interaction, affinity and avidity, cross reactivity, precipitation and agglutination reaction; Cytokines.

**Unit-III** **20**
1. Complement system.
2. Allergy and Hypersensitivity – type – I, II, III and IV their clinical manifestation; Autoimmune disorders; Immunity to Bacteria & Virus.

**Unit-IV** **30**
1. Transplantation – Allograft rejection, Graft vs Host rejection, Immunosuppressor drugs.
2. Single Radial Immuno-diffusion, Immuno-electrophoresis, Electro immuno-diffusion; Principle and

applications of RIA and ELISA
3. Tumor immunology.

**Suggested Readings:**


1. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman,2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
3. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
4. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4 t h Edition-, Blackwell Publishing, 2002


**BMB 503: BIOINFORMATICS Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To understand the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge.

**CO2**. To understand the major steps in pairwise and multiple sequence alignment including the principle and execution of pairwise sequence alignment by dynamic programming.

**CO3.** To have the concept of the process of predicting the secondary and tertiary structures of protein sequences.

**CO4.** To familiarize with the use of a wide variety of internet applications, biological database and will be able to apply these methods to research problems.

**CO5.** To understand the theoretical and practical development of useful tools for automation of complex computer jobs, and making these tools accessible on the network from a Web browser.

**Unit I: Introduction to Computer Fundamentals** **No. of Classes**

1. RDBMS - Definition of relational database
2. Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

**Unit II: Introduction to Bioinformatics and Biological Databases**

1. Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways,
2. Mode of data storage - File formats - FASTA, Genbank and Uniprot; Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB

**Unit III: Sequence Alignments, Phylogeny and Phylogenetic trees**

1. Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood

**Unit IV: Genome organization and analysis**

1. Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Genome, transcriptome, proteome, 2-D gel electrophoresis, Maldi Toff spectroscopy Major features of completed genomes: *E. coli, S.cerevisiae, Arabidopsis*, Human

**Unit V: Protein Structure Predictions**

1. Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design

**Biostatistics**

**UNIT V**

1. Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

**UNIT VI**

1. Probability classical & axiomatic definition of probability, Theorems on total and compound

probability), Elementary ideas of Binomial, Poisson and Normal distributions.

**UNIT VII**

1. Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA).

**UNIT VIII**

1. Correlation and Regression. Emphasis on examples from Biological Sciences.

**Suggested Readings:**


1. Bioinformatics (2002) Bishop Martin
2. Molecular databases for protein and sequence and structure studies: Sillince A. and Sillince M.
3. Sequence Analysis primers: Gribskov, M. and Devereux, J.
4. Bioinformatics: Sequence and Genome Analysis by David W. Mount, *University of Arizona, Tucson*
5. Discovering Genomics, Proteomics, & Bioinformatics, Second Edition by A. Malcolm Campbell, *Davidson College;* Laurie J. Heyer, *Davidson College;* With a Foreword by Francis S. Collins
6. Digital Computer Fundamentals, Bartee, 6th Edn.
7. Fundamentals of Computer algorithms, Horowitz, Shahni, Rajasekaran.
8. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House
9. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
10. Lesk MA(2008) Introduction to Bioinformatics. Oxford Pub., 3rd International Student Ed.
11. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
12. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell


**BMB504 Instrumentation and Biotechniques Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To familiarize with the important techniques necessary for the study and prediction of different processes occurring in microbes and other cellular organisms.

**CO2.** To get an insight into the concept of radioisotopic techniques applied in biochemical and immunological processes as well as the biohazard of using radioisotopes.

**CO3.** To understand the importance, principle and types of basic and advanced chromatography techniques and their role in the study of biological system.

**CO4.** To familiarize with the importance, principle and types of electrophoretic techniques and their role in the study of biological system.

**CO5.** To get an insight into the important immunological techniques (immunodiffusion, immunoelectrophoresis, radio-immunoassay, ELISA, immunofluorscence) used in diagnostic process.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit–I: Hydrodynamic Methods** | **15** |
| 1. Sedimentation- Sedimentation velocity, Preparative and analytical ultracentrifugation techniques, Acid, base and buffers, buffering capacity, Measurement of pH, principles of glass and reference electrodes, types of electrodes, complications of pH measurement (dependence of pH on ionic strength, electrode contamination and sodium error) and use of pH paper. | |
| **Unit- II: Radioisotopic Techniques** | **15** |
| 1. Types of radioisotopes used in Biochemistry, units of radioactivity measurements.<br>2. Techniques used to measure radioactivity (gas ionization and liquid scintillation counting), nuclear emulsions used in biological studies, $^{32}P$, $^{36}S$, $^{14}C$ and $^{3}H$), Autoradiography.<br>3. Biological hazards of radiations and safety measures in handling radioisotopes, Biological applications. | |

**Unit- III: Chromatography** **20**

1. General principles and applications of: Adsorption and absorption, Ion exchange, Thin layer chromatography, Molecular sieve, Gas liquid, HPLC, Affinity, Column and Paper chromatography

**Unit–IV: SpectroscopicTechniques**

1. Beer-Lambert's law, light absorption and its transmittance. **20**
2. Determination and application of extinction coefficient, application of visible and UV spectroscopy, Principle and applications of Mass spectroscopy

**Unit -V: Electrophoresis** **10**

1. Basic principles of agarose electrophoresis –GEL and PAGE.
2. One/Two dimensional electrophoresis, isoelectrofocussing .

**UNIT –VI: Immunological techniques** **10**

1. Immunodiffusion, immunoelectrophoresis, radioimmunoassay, ELISA, immunofluorscence.

**Suggested Readings:**


1. Principles and Techniques of Biochemistry and Molecular Biology: - Ed. K. Wilson and J.Walker,Cambridge Univerity Press.
2. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.
3. Biophysical chemistry. Principles and Techniques: Upadhayay A, Upadhayay K and Nath N,Himalaya publishing house.
4. Experimental Biochemistry. Cark Jr J. M. and Switzer R.L., W.H. Freeman and Company.
5. Instrumental Methods of Chemical Analysis: Chatwal. G and Anand.S., Himalaya Pub. House, Mumbai.
7. A Biologist's Guide to Principles and Techniques of Practical Biochemistry: Williams. B.L. and Wilson. K. (ed.) Edward Arnold Ltd. London


**BMB 505 Practical on Medical Microbiology, Immunology, Bioinformatics and Bioinstrumentation**

**Practical Credit: 4**

**This is a practical course concerned with technical aspects of study and identification of microbes associated with human or animal diseases. It is also concerned with computational methods of Bioinformatics in understanding the structural and other aspects related to biomolecules. After successful completion, this course enables students**

**CO1.** To isolate bacterial flora of skin by swab method and their identification on the basis of cultural, morphological and biochemical characteristics.

**CO2.** To understand the principle and process of antibiotic sensitivity (Kirby-Bauer method) in bacteria using minimal inhibitory concentration (MIC) of an antibiotic.
It also deals with the study of various stages of diseases (symptoms and life-cycle) like Polio, anthrax, herpes, chicken pox, HPV warts, AIDS, candidiasis, dermatomycoses (ring worms) and malaria.

**CO3.** To understand the principle and process of blood group determination following slide agglutination test, blood cell count following blood film preparation and immune-diagnostic methods like Radial immunoassay and ELISA.

**CO4.** To understand the practical aspects of Bioinformatics including
a. operating systems like UNIX, LINUX and Windows;
b. bioinformatics databases systems like NCBI/ PDB/ DDBJ, Uniprot, PDB;
c. sequence retrieval using BLAST and sequence alignment & phylogenetic analysis using clustalW & phylip;
d. protein structure prediction using psipred, homology modeling using Swissmodel, and molecular visualization using jmol.

**CO5.** To understand the working principle and application of
a) phase contrast and Electron microscopy,
b) paper, thin layer and column chromatography and
c) polyacrylamide Gel Electrophoresis (PAGE).

**Course Content** **No. of Classes**

**Medical Microbiology and Immunology** **40**

1. Identify bacteria (any three *of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms) **50**
7. Study of various stages of malarial parasite in RBCs using permanent mounts.
8. Blood coagulation test, blood group determination, Blood film preparation.
9. Radial immunoassay, ELISA tests (both using Kit).

**Bioinformatics**

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psipred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene

**Bioinstrumentation**

1. Ray diagrams of phase contrast microscopy and Electron microscopy.
2. Separation of mixtures by paper / thin layer chromatography.
3. Demonstration of column packing in any form of column chromatography.
4. Separation of protein mixtures by any form of chromatography.
5. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
6. Determination of λmax for an unknown sample and calculation of extinction coefficient.

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**SEMESTER VI**

**BMB 601: INDUSTRIAL MICROBIOLOGY Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have the concept on the sources, isolation, preservation and maintenance of industrially important microbial strains as well as their specific features.

**CO2.** To get an insight into the principle, types and components of a typical industrial fermentor; the basic requirement, process, measurement and control of fermentation parameters.

**CO3.** To develop the basic concept and different phases of operation (cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying) of down-stream processing.

**CO4.** To understand the mechanism of industrial production of alcoholic beverages, antibiotics, solvents, vitamins and industrial enzymes using microbial fermentation process with special reference to micro-organisms involved, media, fermentation conditions, downstream processing and their uses.

**CO4.** It deals with one of the important industrial process of enzyme immobilization describing the methods of immobilization and large scale applications of immobilized enzymes.

| Course Content | No. of Classes |
|---|---|
| **Unit- I:Introduction to industrial microbiology**<br>1. Brief history and developments in industrial microbiology | **10** |
| **Unit II: Isolation of industrially important microbial strains and fermentation media**<br>1. Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement,<br>2. Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates | **15** |
| **Unit III: Types of fermentation processes, bio-reactors and measurement of fermentation parameters**<br>1. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations<br>2. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters,<br>3. Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration | **25** |
| **Unit IV: Down-stream processing**<br>1. Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying | **10** |
| **Unit V:**<br>1. Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)<br>2. Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase), Wine, beer | **15** |
| **Unit VI: Enzyme immobilization**<br>1. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase) | **15** |

**Suggested Readings**:


1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
7. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company

5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition,Elsevier Science Ltd.

**BMB 602: RECOMBINANT DNA TECHNOLOGYTheory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get the basic concept of recombinant DNA technology which is the basis of genetic modification of cellular organisms.
**CO2.** To understand the types, nature and functions of restriction enzymes that act as the mediators of DNA modification during genetic manipulation process.
It also gives an insight into the concept of different vectors (plasmids, cosmids, phagemids, and artificial chromosome vectors) that act as carrier of DNA fragment between cellular organisms during genetic modification.

**CO3.** To get an insight in to the methods in molecular cloning process for transformation and delivery of gene with special emphasis on different blotting techniques (Southern, Northern and Western) in hybridization process.

**CO4.** To understand the most versatile molecular technique of Polymerized Chain Reaction (PCR); its types, applications and different PCR based and PCR independent marker (RAPD, RFLP, AFLP) methods in Molecular Biology.
It also describes the construction and screening genomic and c- DNA libraries.

**CO5.** To learn the application of recombinant DNA technology for the production of human therapeutic agents (insulin, HGH, recombinant vaccines) and transgenic crops.

| **Course Content** | **No. of Classes** |
|---|---|
| **Unit-I: Molecular Cloning- Tools and Strategies**<br>1. Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering<br>2. DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases<br>3. Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series<br>4. Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors | **10** |
| **Unit II: Methods in Molecular Cloning**<br>1. Transformation of DNA: Chemical method, Electroporation,<br>2. Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery DNA,<br>3. RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting. | **20** |
| **Unit III:DNA Amplification and DNA sequencing**<br>1. PCR: Basics of PCR, RT-PCR, Real-Time PCR<br>2. Sanger's method of DNA Sequencing: traditional and automated sequencing<br>3. Primer walking and shotgun sequencing | **20** |
| **Unit IV: Construction and Screening of Genomic and cDNA libraries**<br>1. Genomic and cDNA libraries: Preparation and uses,<br>2. Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping | **15** |
| **Unit V: Applications of Recombinant DNA Technology**<br>1. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagensis | **25** |

**Suggested Readings:**


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


**BMB 603 ADVANCES IN MICROBIOLOGY Theory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To have an advanced concept in microbial science with special emphasis on microbial genome sequencing and horizontal gene transfer technique.

**CO2.** To understand the evolution of bacterial virulence through the concept of genomic (GI) and pathogenicity islands (PAI).

**CO3.** To develop the concept of metagenomics and its utilization in understanding microbial diversity.
It also gives the idea advanced techniques of meta- transcriptomics, metaproteomics and metabolomics.

**CO4.** To get an insight in to the molecular basis of host-microbe Interactions with special emphasis on virulence and antimicrobial resistance in case of plant and animal pathogens.

**CO5.** To develop the idea on the networking in biological systems (Quorum sensing) and future implications of synthetic biology with respect to bacteria and viruses.

**Course Content** **No. of Classes**

**Unit 1:Evolution of Microbial Genomes**

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

**Unit II: Metagenomics**

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

**Unit III: Molecular Basis of Host-Microbe Interactions**

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

**Unit IV: Systems and Synthetic Biology**

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

**Suggested Readings:**


1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM

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

**BMB 604 BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTSTheory Credit: 4**

**After successful completion, this course enables students**

**CO1.** To get the idea of biosafety issues in biotechnological processes as well as the biosafety guidelines and regulations (National and International) in case of the application of GMOs/LMOs.

**CO2.** To get an insight in to the concerns and challenges associated with GMO applications in food and agriculture. It also deals with the assessment, analysis and management of risk in application of GMOs as well as International Agreements related to this.

**CO3.** To get an insight in to the guidelines for using radioisotopes in laboratories, safety measures and disposal mechanism.

**CO4.** To understand the basics of intellectual property rights including the concept, types, importance and legal issues related to patents, trademarks, copyright, industrial design and rights, traditional knowledge and geographical indicators.

**CO5.** To get the idea about the process of granting patent by patenting authorities with reference to types of patent applications, patent filing procedures, patent licensing and agreement and rights and duties of patent owner.

| Course Content | No. of Classes |
|---|---|
| **Unit- 1:** | **20** |
| 1. Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms | |
| **Unit II:** | **15** |
| 1. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. | |
| **Unit III:** | **15** |
| 1. AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions. | |
| **Unit IV:** | **20** |
| 1. Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO). | |
| **Unit V:** | **20** |
| 1. Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. | |

**Unit VI:**

1. Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

**Suggested Readings:**


1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Pub. Co. Pvt. Ltd., Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.


**BMB 605: Practical on Industrial Microbiology and Recombinant DNA Technology**

**Practical Credit: 4**

**This practical course concerned with genomic modification of important microbes through R-DNA Technology and their industrial application to get new and novel products. After successful completion, this course enables students**

**CO1.** To understand structural parts and working process of industrial fermenter (a visit to fermentation industry, included as a part of the practical, gives an exposure to the students in learning the use of a fermenter).

**CO2.** To understand the process of microbial fermentations for the production and estimation of enzyme (amylase and protease), amino acid (glutamic acid), organic acid (citric acid) and ethanol.

**CO3.** To understand the principle and process of bacterial transformation.

**CO4.** To learn the technique of digestion of DNA (using restriction enzymes), ligation of DNA fragments and analysis by agarose gel electrophoresis

**CO5.** To learn the technique of DNA amplification by PCR and designing of primers for this process.

| **Course Content** | **No. of Classes** |
|---|---|
| **Industrial Microbiology** | **40** |
| 1. Study different parts of fermenter<br>2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:<br>(a) Enzymes: Amylase and Protease<br>(b) Amino acid: Glutamic acid<br>(c) Organic acid: Citric acid<br>(d) Alcohol: Ethanol<br>3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations. | |
| **Recombinant DNA Technology** | **50** |
| 1. Preparation of competent cells for transformation<br>2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.<br>3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis<br>4. Ligation of DNA fragments<br>5. Cloning of DNA insert and Blue white screening of recombinants.<br>6. Interpretation of sequencing gel electropherograms<br>7. Designing of primers for DNA amplification<br>8. Amplification of DNA by PCR<br>9. Demonstration of Southern blotting | |

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