

Department of Microbiology (PG)

SYLLABUS AND REGULATIONS

Under

OUTCOME-BASED EDUCATION

2020

(Effective for the Batch of Students Admitted from 2020-2021)



AUXILIUM COLLEGE (Autonomous)

(Accredited by NAAC with A⁺ Grade with a CGPA of 3.55 out of 4 in the 3rd Cycle)

Gandhi Nagar, Vellore-632 006.

AUXILIUM COLLEGE (Autonomous)(Accredited by NAAC with A⁺ Grade with a CGPA of 3.55 out of 4 in the 3rd Cycle)**Gandhi Nagar, Vellore – 632006****OUTCOME BASED EDUCATION****M.Sc. MICROBIOLOGY****(Effective for the students admitted from the academic year 2020-2021)****LIST OF COURSES****Structure of the Course and the Scheme of Examinations**

| SEM | Code | Title of the Paper | Hrs/ week | Exam hours | | Credits | Max.Marks | | |
|--------------|---------|--|--------------|---------------|----|-----------|------------|------------|-------------|
| | | | | Th | Pr | | CIA | SEM | TOT |
| I | PCMBA20 | General Microbiology | 6 | 3 | - | 5 | 40 | 60 | 100 |
| | PCMBB20 | Food, Agriculture and Environmental Microbiology | 6 | 3 | - | 5 | 40 | 60 | 100 |
| | PCMBC20 | Immunology and Immunotechnology | 5 | 3 | - | 5 | 40 | 60 | 100 |
| | PCMBG20 | Practical-I: Main practical - I | 5 | - | - | - | - | - | - |
| | PCMBH20 | Practical –II: Main practical -II | 5 | - | - | - | - | - | - |
| | PEMBA20 | Elective –I A:Petroleum Microbiology | 3 | 3 | - | 3 | 40 | 60 | 100 |
| | PEMBB20 | Elective –I B:Economic Microbiology | | | | | | | |
| | PIMBA20 | IEC-I: Public Health Microbiology | - | - | - | 2 Addn | 40 Addn | 60 Addn | 100 Addn |
| | PIMBB20 | IEC-II: Animal Tissue culture | | | | | | | |
| TOTAL | | | | | | 18 | 160 | 240 | 400 |

| SEM | Code | Title of the Paper | Hrs/ week | Exam hours | | Credits | Max.Marks | | |
|-----------|---------|--|--------------|---------------|----|---------|-----------|-----|-----|
| | | | | Th | Pr | | CIA | SEM | TOT |
| II | PCMBF20 | Medical Microbiology | 5 | 3 | - | 5 | 40 | 60 | 100 |
| | PCMBG20 | Microbial Physiology and Biomolecules | 5 | 3 | - | 4 | 40 | 60 | 100 |
| | PCMBH20 | Industrial and Pharmaceutical Microbiology | 5 | 3 | - | 4 | 40 | 60 | 100 |

| | | | | | | | | | |
|--------------|---------|--|---|---|----------------------|-----------|------------|------------|-------------|
| | PCMBG20 | Main practical –I: Applied Microbiology and Immunology | 5 | - | 6 hr/day 2days | 5 | 40 | 60 | 100 |
| | PCMBH20 | Main practical –II : Medical Microbiology | 5 | - | 6 hr/day 2days | 5 | 40 | 60 | 100 |
| | PEMBC20 | Elective-II A: Biological Techniques | 3 | 3 | - | 3 | 40 | 60 | 100 |
| | PEMBD20 | Elective II- B: Human Anatomy and Physiology | | | | | | | |
| | PNHRA20 | Human Rights (compulsory) | 2 | 3 | - | 2 | 40 | 60 | 100 |
| | PIMBC20 | IEC-III: Haematology and Blood banking | - | - | - | 2 Addn | 40 Addn | 60 Addn | 100 Addn |
| | PIMBD20 | IEC-IV: Forensic Science | | | | | | | |
| TOTAL | | | | | | 28 | 280 | 420 | 700 |
| III | PCMBI20 | Molecular Biology and Microbial Genetics | 6 | 3 | - | 4 | 40 | 60 | 100 |
| | PCMBJ20 | Advanced Microbiology | 6 | 3 | - | 4 | 40 | 60 | 100 |
| | PCMBK20 | Research Methodology | 5 | 3 | - | 4 | 40 | 60 | 100 |
| | PCMBN20 | Practical III:Main practical –III | 5 | - | - | - | - | - | - |
| | PCMBO20 | Practical IV: Main practical -IV | 5 | - | - | - | - | - | - |
| | PEMBE20 | Elective III A: Bioinoculant Technology | 3 | 3 | - | 3 | 40 | 60 | 100 |
| | PEMBF20 | Elective III B:Fungal biotechnology and Bioprospecting | | | | | | | |
| | PGTRA20 | Teaching And Research Aptitude | - | 3 | - | 3 | 40 | 60 | 100 |
| | PIMBE20 | IEC-V: Entrepreneurship and Management in Microbial Technology | - | - | - | 2 Addn | 40 Addn | 60 Addn | 100 Addn |
| | PIMBF20 | IEP-VI: Cyanobacteriology | | | | | | | |
| TOTAL | | | | | | 18 | 160 | 240 | 400 |
| IV | PCMBL20 | Microbial Gene Technology | 6 | 3 | - | 4 | 40 | 60 | 100 |
| | PCMBM20 | Bioethics and Biosafety | 6 | 3 | - | 4 | 40 | 60 | 100 |
| | PCMBN20 | Main practical –III: Genetic Engineering | 5 | - | 6 hr/day 2days | 5 | 40 | 60 | 100 |
| | PCMBO20 | Main practical –IV : Textile and Cosmetic Microbiology | 5 | - | 6 hr/day 2days | 5 | 40 | 60 | 100 |
| | PEMBG20 | Elective IV-A: Taxonomy | 3 | 3 | | 3 | 40 | 60 | 100 |

| | | | | | | | | | |
|--------------------|---------|---|---|---|---|-----------|------------|------------|-------------|
| | | and Microbial Biodiversity | | | | | | | |
| | PEMBH20 | Elective IV-B: Microbial Nanotechnology | | | | | | | |
| | PCMBP20 | Project Dissertation with Viva- voce | 5 | - | - | 5 | 50 | 150 | 200 |
| TOTAL | | | | | | 26 | 250 | 450 | 700 |
| GRAND TOTAL | | | | | | 90 | | | 2200 |

PROGRAMME OUTCOMES (PO)

On completion of the PG Programme, students will be able to:

PO1: Attain an in-depth knowledge in the respective domains augmented through self-learning.

PO2: Assimilate and apply principles and concepts towards skill development and employability.

PO3: Apply critical and scientific approaches to address problems and find solutions.

PO4: Develop research skills through multi/inter/trans-disciplinary perspectives.

PO5: Integrate issues of social relevance in the field of study.

PO6: Persist in life-long learning for personal and societal progress.

PROGRAMME SPECIFIC OUTCOMES (PSO):

On completion of the PG Programme in Microbiology, students will be able to;

PSO1: Attain an in-depth knowledge in the anatomy and physiology of a repertoire of microorganisms with its beneficial and harmful associations.

PSO2: Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.

PSO3: Develop ability to independently carry out a complete scientific work process with research ethics, including the understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.

PSO4: Acquaint a broader knowledge in the concepts of Taxonomy, molecular biology, immunology, food, environment and agricultural microbiology, nanotechnology, forensic science and genetic engineering.

PSO5: Incorporate effective career with marketing, project management, business development or venture capital within the biotech, pharmaceutical, medical technology or related fields.

PSO6: Compete in state/national level competitive exams to pursue higher study with an understanding that education is life-long process for personal and societal progress.

| PSO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---------------|------------|------------|------------|------------|------------|------------|
| PSO1 | H | M | M | H | L | M |
| PSO2 | H | H | H | H | L | M |
| PSO3 | H | M | H | H | M | L |
| PSO4 | H | M | M | H | L | H |
| PSO5 | H | H | L | M | M | H |
| PSO6 | H | H | H | H | H | H |

H – HIGH (3)

M – MODERATE (2)

L – LOW (1)

SEMESTER – I

PCMBA20 - GENERAL MICROBIOLOGY

| | | | | | | | |
|--------------------------|-----------------------------------|---|----------------------------------|------------------------------------|-----------------|---------------------|---------------------|
| Year I SEM: I | Course Code PCMBA20 | Title Of The Course General Microbiology | Course Type Theory | Course Category Core | H/W 6 | Credits 5 | Marks 100 |
|--------------------------|-----------------------------------|---|----------------------------------|------------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide an in depth knowledge on the fundamentals of Microbiology, microscopy and anatomy cum physiology of bacteria, fungi, algae, protozoa, virus

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline history and recent developments in the field of Microbiology.

CO2: Demonstrate and utilize working of different laboratory instruments.

CO3: Acquire knowledge on the sample preparation and perform various staining techniques.

CO4: Discuss important taxonomical aspects of bacteria, fungi, algae and virus.

CO5: Compile bacterial anatomy and physiology and structural properties of algae and fungi.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | M | L | H | L | M |
| CO2 | H | H | L | M | L | H |
| CO3 | H | H | H | H | M | H |
| CO4 | H | M | L | H | L | H |
| CO5 | H | L | M | H | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | L | M | L | M |
| CO2 | H | H | H | M | M | M |
| CO3 | H | H | L | M | L | M |
| CO4 | H | M | M | H | L | M |
| CO5 | H | M | M | H | L | M |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: History and Recent Developments.

(10 hours)

- 1.1 Discovery of Microbial world. (K1,K2)
- 1.2 Controversy over spontaneous generation.(K1,K2)
- 1.3 Evolutions of Microbiology with its recent developments in Medicine.(K1,K2,K3)
- 1.4 Role of Microbes in transformation of organic matter. (K1,K2,K3,K4)
- 1.5 Role of microbes in causing diseases. (K1,K2)
- 1.6 Modern trends in microbial taxonomy. (K2,K3,K4,K5)

UNIT-II: Instrumentation and Staining Methods.**(20 hours)**

- 2.1 Microscopy - Its principles and applications. Simple - Compound, Dark field, phase contrast, Fluorescent and confocal. (K1,K2,K3)
- 2.2 Electron Microscopes - SEM, TEM. (K1,K2,K3)
- 2.3 Principles, Operation and maintenance of autoclaves, Ovens, Centrifuges - refrigerated & ultra-speed. (K1,K2,K3)
- 2.4 Calorimeters, spectrophotometers, lyophilizers, deep freezer. . (K1,K2,K3)
- 2.5 Staining methods - Gram, Acid Fast, spore, metachromatic granules, capsule and flagella.(K1,K2,K3)
- 2.6 Sterilization and disinfection methods and their quality control. . (K1,K2,K3)

UNIT-III: Classification of Bacteria and Virus.**(15 hours)**

- 3.1 Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. (K1,K2,K3,K4)
- 3.2 Microbial diversity in different ecosystems. (K1,K2)
- 3.3 Halophiles, mesophiles, thermophiles.(K1,K2)
- 3.4 Acidophiles Alkalophiles, barophiles and other extremophiles. .(K1,K2)
- 3.5 Structure and function of viruses. .(K1,K2)
- 3.6 Classification of viruses - replication of viruses – bacteriophages. (K1,K2)

UNIT-IV: Bacterial Anatomy and Physiology.**(15 hours)**

- 4.1 Bacterial morphology, structure and characterization - cellular components of bacteria. (K1,K2)
- 4.2 Sporulation and its mechanics. (K1,K2)
- 4.3 Growth and nutrition - Nutritional requirements - Autotrophs, heterotrophs - enrichment culture. (K1,K2, K3,K4)
- 4.4 Growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase. (K1,K2, K3,K4)
- 4.5 Measurement of growth and growth yields - Batch Culture - Synchronous growth. (K1,K2, K3,K4)
- 4.6 Techniques of pure culture. (K2, K3,K4)

UNIT-V: Structure and Reproduction of Algae and Fungi.**(15)**

- 5.1 Classification of fungi according to Alexopoulos and Mims. (K1,K2)
- 5.2 Cell structure, specialized somatic structure. (K1,K2)
- 5.3 Life cycles and reproduction of fungi - Asexual, sexual and parasexual cycle. (K1,K2)
- 5.4 Mechanisms of growth in Fungi, Measurement and kinetics of growth, nutritional and environmental requirements; Prevention of fungal growth. (K1, K2, K3)
- 5.5 Structure and reproduction of *Spirogyra*, *Euglena*, *Exuviaella*, (K1,K2)
- 5.6 Structure and reproduction of *Diatoms*, *Sargassam* and *Porphyra*. (K1,K2)

TEXT BOOKS:

1. Pelczar Jr .M.J., Chan E.C.S and Kreig, N.R (2006). Microbiology. 6th Edition, Mc Graw Hill Inc., Newyork.
2. Lansing M. Prescott, John P. Harley, Donald Klein. (2011) .Microbiology. 8th Edition, McGraw Hill Inc., New York.

REFERENCE BOOKS:

1. Dubey R.C and Maheswari D.K (2012). A Text of Microbiology. Revised edition, S.Chand & Company Ltd., New Delhi.
2. Geeta Sumbali and Mehrotra R.S (2009). Principles of Microbiology. 1st edition, Tata McGraw Hill P. Ltd., New Delhi.
3. Robert F. Boyd (2000). General Microbiology. 2nd Edition, Times Mirror / Moshy College publishing, Virginia.
4. Salle, AJ (2010). Fundamentals & Principles of Bacteriology. 9th edition. Tata McGraw-Hill, New Delhi.
5. Purohit SS (2010). Microbiology - Fundamentals and Applications. Student Edition Publishers, Jodhpur.
6. Alexopoulos C J and C W. Mims. (1993). Introductory Mycology. 3rdedition. WileyEastern Ltd, New Delhi.
7. Mehrotra RS and Aneja KR (2006). An Introduction to Mycology. 1st edition, New age international publishers, Chennai.
8. Bajpai P.K (2010). Biological Instrumentation and Methodology. Revised edition, S.Chand& Co.Ltd., New Delhi.
9. John G Webster (2004). Bioinstrumentation. Student edition. John Wiley and Sons, Ltd., New Delhi.

OER:

E-books

1. www.gutenberg.org
2. www.free-ebooks.net
3. www.e-booksdirectory.com

Video lessons

1. www.learnerstv.com
2. www.webcast.berkeley.edu
3. www.cosmolearning.org

**PCMBB20: FOOD, AGRICULTURE AND ENVIRONMENTAL
MICROBIOLOGY**

| | | | | | | | |
|-----------------------------------|-----------------------------------|--|----------------------------------|------------------------------------|-----------------|---------------------|---------------------|
| Year: I SEM: I | Course Code PCMBB20 | Title of The Course Food, Agriculture and Environmental Microbiology | Course Type Theory | Course Category Core | H/W 6 | Credits 5 | Marks 100 |
|-----------------------------------|-----------------------------------|--|----------------------------------|------------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To make the students familiarize on Food, Agriculture and Environmental aspects of Microbiology.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Analyse the principles in food preservation.

CO2: Communicate diseases associated with food.

CO3: Discuss the role of microorganisms in soil and microbial interaction.

CO4: Utilize the knowledge on biogeochemical cycles to produce biofertilizers.

CO5: Assess information about microbiological quality of air and water.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|------------|------|------|------|------|------|------|
| CO1 | H | H | M | L | H | M |
| CO2 | H | L | L | M | L | H |
| CO3 | H | H | M | H | L | H |
| CO4 | H | L | L | M | M | H |
| CO5 | H | H | M | H | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | M | L | H | M |
| CO2 | H | M | M | L | L | H |
| CO3 | H | H | M | H | L | H |
| CO4 | H | L | L | L | M | H |
| CO5 | H | H | M | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Food Microbiology.

(15 hours)

1.1 Importance of studying Food microbiology- Primary sources of microorganisms in foods. (K1,K2)

1.2 Factors influencing microbial growth in foods - extrinsic and intrinsic.(K1,K2)

1.3 Principles of food preservation - preservation methods - irradiation - drying, heat processing, chilling and freezing, high pressure, modification of atmosphere and chemical preservatives. (K1,K2,K3,K4)

- 1.4 Nutritional value of fermented foods. (K2,K3,K4,K5,K6)
- 1.5 SCP and their uses. (K1,K2,K3)
- 1.6 Contamination, preservation and spoilage of fruits, vegetables, meat and poultry products. (K1,K2,K3)

UNIT-II: Dairy Microbiology. (15 hours)

- 2.1 Microbiology of fermented milk - Starter lactic cultures (K1,K2)
- 2.2 Fermented milk products (cheese, yoghurt, acidophilus milk, kefir, kumis). (K1,K2,K3)
- 2.3 Food sanitation in food manufacture and in the retail trade. (K1,K2,K3)
- 2.4 (HACCP) - Food control agencies and its regulations. (K1,K2,K3)
- 2.5 Food borne disease.(K1,K2)
- 2.6 Milk borne diseases. (K1,K2)

UNIT-III: Soil Microbiology. (15 hours)

- 3.1 Distribution of soil microorganisms in soil. (K1,K2)
- 3.2 Factors influencing the soil microflora. (K1,K2)
- 3.3 Role of microorganisms in soil fertility. (K1,K2)
- 3.4 Interactions among microorganisms, mutualisms, commensalism, competition, amensalism, parasitism, predation. (K1,K2)
- 3.5 Interactions between microbes and plants - rhizosphere, phyllosphere. (K1,K2)
- 3.6 Mycorrhizae, root nodule bacteria. (K1,K2,K3,K4)

UNIT-IV: Biogeochemical cycle and Biofertilizers. (15 hours)

- 4.1 Biogeochemical - carbon cycle - role of microbes in carbon cycle.(K1,K2)
- 4.2 Nitrogen cycle - mechanism of biological nitrogen fixation - ammonification - nitrification - denitrification and microorganisms involved in such processes. (K1,K2)
- 4.3 Phosphorous cycle. (K1,K2)
- 4.4 Sulphur cycle. (K1,K2)
- 4.5 Biofertilizer for sustainable agriculture *Rhizobium, Azospirillum, Azotobacter*.(K1,K2,K3,K4)
- 4.6 *Azolla*, BGA -mass production methods - applications methods and crop response of biofertilizers.(K1,K2,K3,K4)

UNIT-V: Aero Microbiology and Aquatic Microbiology. (15 hours)

- 5.1 Droplet, Droplet nuclei and Aerosol. (K1,K2)
- 5.2 Assessment of air quality. (K2,K3,K4)
- 5.3 Airborne diseases, their symptoms and preventive measures, water borne disease.(K1,K2)
- 5.4 Types of water – Assessment of microbiological quality of water.(K2,K3,K4)
- 5.5 Treatment of municipal water (K4,K5)

5.6 Types of wastes, characterization of solid and liquid waste. Sewage treatment-composting. (K3,K4,K5)

TEXT BOOKS:

1. Frazier W.C. and West Hoff D.C (2008). Food Microbiology. 4th edition. Mc Graw Hill, New York.
2. Joseph C. Daniel (1999). Environmental aspects of Microbiology. 1st edition, Bright Sun publications, Chennai.
3. Subba Rao NS (2004). Soil Microbiology. 4th edition, Oxford and BH Publishing Co.Pvt. Ltd., New Delhi.

REFERENCE BOOKS:

1. Adam M.R. and Moss M.O (2004). Food Microbiology. 2nd edition, New international pvt. Ltd., publishers.UK.
2. Banwart G. J (2004). Basic Food Microbiology. 2nd edition, CBS Publishers and Distributors, New Delhi.
3. James M. Jay (2003). Modern Food Microbiology. 4th edition, CBS Publishers, New Delhi.
4. Vijaya Ramesh K (2004). Environmental Microbiology. 1st edition, MJP publishers. Chennai.
5. Singh D.P and Dwivedi S.K (2005). Environmental Microbiology and Biotechnology. 1st edition, New Age International (P) Ltd., New Delhi.
6. Mishra RR (2004). Soil Microbiology. 1st edition, CBS Publishers and distributors, New Delhi.
7. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India. 4th edition, PHI Learning (P) Ltd., New Delhi.
8. Atlas R.M. and Bartha R (1992). Microbial Ecology, Fundamental and Application, 3rd edition, Bengamin and Cummings. United States.

OER:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PCMBC20: IMMUNOLOGY AND IMMUNOTECHNOLOGY

| | | | | | | | |
|---|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: I SEM: I | Course Code PCMBC20 | Title Of The Course Immunology and Immunotechnology | Course Type Theory | Course Category Core | H/W 5 | Credits 5 | Marks 100 |
|---|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide in depth knowledge on immune cells, immune system- its function and hybridoma technology

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the types of immune response and discuss the role of lymphoid organs in immunity.

CO2: Compile immunoglobulins and antigens.

CO3: Communicate the importance of MHC in organ transplantation.

CO4: Analyse the allergic responses by the immune system leading to hypersensitive conditions and auto immune disorders.

CO5: Plan immunization schedule.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | L | M | M | H | H |
| CO2 | H | L | H | L | M | H |
| CO3 | H | L | H | L | M | H |
| CO4 | H | L | M | M | H | H |
| CO5 | H | M | M | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | L | H | M | H | H |
| CO2 | H | L | H | M | M | H |
| CO3 | H | L | H | L | M | H |
| CO4 | H | L | H | M | H | H |
| CO5 | H | M | H | L | M | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Immunity and Lymphoid Organs.

(15 hours)

- 1.1 Introduction: Infection, immunity, types of immunity - innate and adaptive. (K1,K2)
- 1.2 Phagocytosis and extracellular killing, immunity to specific infection. (K1,K2)
- 1.3 Milestones in immunology - evolution of immunology. (K1,K2)
- 1.4 Immune Systems: Anatomy of the lympho - reticular system, primary lymphoid organs - bone marrow & thymus. (K1,K2)

- 1.5 Secondary lymphoid tissues - spleen, lymph nodes & gut associated lymphoid tissue. (K1,K2)
- 1.6 Immuno reactive cells - T and B lymphocytes, macrophages, granulocyte and NK cells. (K1,K2)

UNIT-II: Antigens and Major Histocompatibility Complex. (15 hours)

- 2.1 Antigens and Immunogenicity: Terminologies and definitions - antigen, immunogen, haptens, superantigens, tolerogen, epitope, paratope and antigenic determinants. (K1,K2)
- 2.2 Features associated with antigenicity and immunogenicity. (K1,K2)
- 2.3 Basis of antigen specificity. (K1,K2)
- 2.4 Antigen receptors: Cell surface proteins of Major Histocompatibility Complex (MHC): types, - class I, II and III distribution and function. (K1,K2)
- 2.5 MHC in relation to transplantation and HLA typing. (K1,K2)
- 2.6 T cell receptor complex (TCR). (K1,K2)

UNIT-III: Immunoglobulin and Complement System. (15 hours)

- 3.1 Antibodies - B cell receptors. Three dimensional structure of immunoglobulin molecule. (K1,K2)
- 3.2 Types of immunoglobulins. Biological and chemical properties of immunoglobulin. (K1,K2)
- 3.3 Antigen, antibody attraction - forces, affinity, avidity and specificity. (K1,K2,K3,K4,K5,K6)
- 3.4 Antibody synthesis and diversity - genetic basis. (K1,K2,K3)
- 3.5 Monoclonal and polyclonal antibody production - Hybridoma technology. (K1,K2,K3,K4)
- 3.6 Complement system: Basics of complement protein - different pathways of complement activation - the pathway of membrane attack (common pathway), classical and alternate. (K1,K2)

UNIT-IV: Hypersensitivity. (15 hours)

- 4.1 Acquired immune response. (K1,K2)
- 4.2 Humoral immune response - various phases of humoral immune response. (K1,K2)
- 4.3 Cell mediated immune response. (K1,K2)
- 4.4 Immune regulation - various events in induction of immune response. (K1,K2)
- 4.5 Hypersensitivity- Type I to IV (K1,K2)
- 4.6 Means of immunosuppression - physical, chemical and biological. (K1,K2,K3)

UNIT-V: Vaccines and Autoimmune Diseases. (15 hours)

- 5.1 Vaccines – Live attenuated and killed inactivated vaccine. (K1,K2)
- 5.2 rDNA vaccine, synthetic peptide vaccine, Plasma derived vaccine, anti - idiotypic vaccine and DNA vaccine. (K1,K2,K3,K4,K5,K6)
- 5.3 Active immunization - vaccines & toxoids – bacterial and viral. (K1,K2,K3,K4)
- 5.4 Immunization Schedule.(K1,K2,K3)
- 5.5 Passive immunization - antitoxins, immunoglobulin, specific immunoglobulin, hyper immune gamma globulin. (K1,K2,K3,K4)

5.6 Autoimmune diseases. (K1,K2)

TEXT BOOKS:

1. Kuby J Richard A. Goldsby, Thomas J. Kindt (2006). Immunology. 6th edition, W.H. Freeman and company, New York.
2. Richard M.Hyde (2011). Immunology. 3rd edition, Williams & Wilkins, *Philadelphia*.

REFERENCE BOOKS:

1. Bashir S.F (2011). Text Book of Immunology. 1st edition, PHI Learning Private limited, New Delhi.
2. Ananthanarayan R & Paniker C.K.J (2013). Text Book of Microbiology, 9th edition, Universities Press, Hyderabad
3. Tizard K (1995). Immunology. An Introduction. 1st edition, Saunders college publishing, Philadelphia.
4. Donal M. Weir, John Steward. (1993). Immunology. 7th edition. ELBS, London
5. Janeway Travers. (1997). Immuno biology - The immuno system in health and Disease. 3rd edition Current Biology Ltd., London, New York.
6. Clark WR (1991). The experimental foundations of modern immunology, 2nd edition. John Wiley and Sons Inc. New York.

OER:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PEMBA20 - ELECTIVE I A: PETROLEUM MICROBIOLOGY

| | | | | | | | |
|--------------------|-----------------------------------|---|----------------------------------|---|-----------------|---------------------|---------------------|
| Year: I | Course Code PEMBA20 | Title Of The Course Petroleum Microbiology | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
|--------------------|-----------------------------------|---|----------------------------------|---|-----------------|---------------------|---------------------|

Course Objective:

To provide in depth knowledge about the microbial communities residing in the oil reservoirs and other hydrocarbon resource environments.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the importance of petroleum Microbiology and predict the impact of the microbial communities in various petroleum fields.

CO2: Design the microbial solutions to the microbiology related problems in the petroleum industry.

CO3: Discuss solutions to enhance production of oil/energy by applying concepts of production related petroleum microbiology.

CO4: Utilize biotechnological aspects in remediation of oil spills.

CO5: Use apparatus for the detection of living microbial contaminants in petroleum products.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | M | L | M | H | H |
| CO2 | H | M | M | L | H | H |
| CO3 | M | H | H | L | H | H |
| CO4 | H | H | H | H | H | H |
| CO5 | M | H | H | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | L | M | H | H |
| CO2 | H | L | M | L | M | H |
| CO3 | M | H | M | L | H | H |
| CO4 | H | M | H | H | H | H |
| CO5 | M | H | H | L | M | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS:

Unit-I: Microbiology of Oil Fields.

(10 hours)

1.1 Introduction to oil fields, formation of oil reservoirs, oil production. (K1,K2)

1.2 Indigenous microbial communities in oil fields. (K1,K2)

- 1.3 Microbiology and molecular biology of sulfate-reducing bacteria. (K1,K2)
- 1.4 Hyperthermophilic archae in oil fields.(K1,K2)
- 1.5 Methanogenic archaea in oil fields. (K1,K2)
- 1.6 Fermentative, iron-reducing and nitrate-reducing microorganisms. (K1,K2)

UNIT–II: Detrimental Effects of Bacterial Activity. (8 hours)

- 2.1 Biodegradation of petroleum in subsurface geological reservoirs. (K1,K2)
- 2.2 Introduction to oil Reservoir souring. (K1,K2)
- 2.3 Mechanism and prevention of reservoir souring. (K1,K2,K3)
- 2.4 Microbial control of hydrogen sulfide production in oil reservoirs. (K1,K2,K3)
- 2.5 Microbial corrosion in the oil industry. (K1,K2)
- 2.6 Biofouling in the oil industry. (K1,K2)

UNIT–III: Application of Biotechnology in Oil Production. (9 hours)

- 3.1 Intoduction to application of Biotechnology in oil production. (K1,K2)
- 3.2 Microbially enhanced oil recovery. (K1,K2,K3)
- 3.3 Past present and future biotechnological upgrading of petroleum. (K1,K2)
- 3.4 Diversity in oil production. (K1,K2,K3)
- 3.5 Function of alkane oxygenases (K1,K2)
- 3.6 Biocatalytic applications of alkane oxygenases, (K1,K2,K3)

UNIT–IV: Microremediation of Oil Spills and Oil Resources. (9 hours)

- 4.1 Introduction to Microremediation. (K1,K2)
- 4.2 Marine oil spill bioremediation. (K1,K2,K3)
- 4.3 Metabolic indicators of anaerobic hydrocarbon biodegradation in petroleum-laden environments. (K1,K2,K3,K4)
- 4.4 Unconventional gas and oil resources- shale gas. (K1,K2,K3)
- 4.5 Unconventional oil resources- oil sands. (K1,K2,K3)
- 4.6 Coal bed methane (CBM). (K1,K2,K3)

UNIT–V: Geo Microbiological Exploration of Petroleum Products. (9 hours)

- 5.1 Introduction to GeoMicrobial Exploration of Petroleum products. (K1,K2)
- 5.2 Impact and Significance of GeoMicrobial Exploration of Petroleum products. (K1,K2)
- 5.3 Apparatus for the detection of living microbial contaminants in petroleum products. (K1,K2)
- 5.4 Microbiological Exploration for Petroleum Deposits. (K1,K2,K3,K4)
- 5.5 Geomicrobiological methods of ore exploration. (K1,K2,K3,K4)

5.6 Geomicrobiological methods Petroleum exploration. (K1,K2,K3,K4)

REFERENCE BOOKS:

1. Bernard Ollivier, Mitchel Magot (2005). Petroleum Microbiology, ASM Press.
2. Corinne Whitby, Torban Lund Skovhus (2011). Applied Microbiology and molecular biology in oil field systems, Springer.
3. Larry L. Barton, W. Allan Hamilton (2007). Sulphate-Reducing Bacteria: Environmental and Engineered Systems, Cambridge University Press.

OER:

1. <http://www.ecomii.com/science/encyclopedia/petroleum-microbiology/>
2. <http://lizinan.wordpress.com/2010/06/24/microbial-enhanced-oil-recovery/>
3. <http://www.metamicrobe.com/petroleum-microbiology/>

PEMBB20 - ELECTIVE I B: ECONOMIC MICROBIOLOGY

| | | | | | | | |
|--------------------------|-------------------------------|---|------------------------------|---|-----------------|---------------------|---------------------|
| Year: I | Course Code PEMBB20 | Title Of The Course Economic Microbiology | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
|--------------------------|-------------------------------|---|------------------------------|---|-----------------|---------------------|---------------------|

Course Objective:

To introduce entrepreneurial skills among students to become entrepreneurs and can decide to make the idea reality.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Utilize microorganisms as biofertilizers and for vermicomposting.

CO2: Analyse microbial cells as fermented products.

CO3: Use yeast in and as food and feed.

CO4: Demonstrate mushroom cultivation and its storage.

CO5: Discuss biotechnological applications of microalgae.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | H | H | H |
| CO2 | H | M | L | M | M | H |
| CO3 | H | M | L | M | M | H |
| CO4 | H | M | H | H | H | H |
| CO5 | H | L | M | L | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | H | H |
| CO2 | H | M | L | M | L | H |
| CO3 | H | M | L | M | L | H |
| CO4 | H | M | H | H | L | H |
| CO5 | H | L | M | L | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Microbes in Agriculture.

(8 hours)

- 1.1 Production and application of biofertilizers - *Rhizobium*, *Azospirillum*, *Azotobacter*. (K1,K2,K3,K4)
- 1.2 *Azolla* - *Anabaena*, BGA. (K1,K2,K3,K4)
- 1.3 Phosphate solubilizing – phosphobacterium and Mycorrhiza. (K1,K2,K3,K4)
- 1.4 Bacterial Biopesticides. (K1,K2,K3,K4)
- 1.5 Fungal Biopesticides. (K1,K2,K3,K4)
- 1.6 Role of microorganisms in vermicomposting. (K1,K2,K3,K4)

UNIT–II: Microbes in Industries.**(10 hours)**

- 2.1 Fermented beverages: wine, beer, whisky, brandy – health benefits and disadvantages. (K1,K2,K3,K4)
- 2.2 Organic acids- Citric acid, acetic acid. (K1,K2,K3,K4)
- 2.3 Organic solvents- Acetone, butanol, ethanol. (K1,K2,K3,K4)
- 2.4 Fermented foods- cheese, yoghurt, sauerkraut, bread, sweeteners, flavor enhancers. (K1,K2,K3,K4)
- 2.5 Traditional fermented foods- Dhokla, Appam, Churpa/Churpi, fermented bamboo shoot. (K1,K2,K3,K4,K5,K6)
- 2.6 Oriental fermented foods- soya sauce, koji & miso(K1,K2,K3,K4).

UNIT–III: Yeast Production.**(9 hours)**

- 3.1 Bottom and Top yeast- Baker's yeast. (K1,K2)
- 3.2 Food and feed yeasts. (K1,K2)
- 3.3 Alcohol yeasts. (K1,K2)
- 3.4 SCP: *Saccharomyces cerevisiae*, *Pichia pastoris*. (K1,K2)
- 3.5 *Candida utilis* and *Geotrichum candidum*. (K1,K2)
- 3.6 Other yeast products. (K1,K2)

UNIT–IV: Mushroom Cultivation.**(9 hours)**

- 4.1 Button mushroom (*Agaricus bisporus*) – composting, spawning (K1,K2,K3,K4,K6)
- 4.2 Button mushroom (*Agaricus bisporus*) – cropping, harvesting and marketing. (K1,K2,K3,K4,K6)
- 4.3 Oyster mushroom (*Pleurotus* sps.), - composting, spawning (K1,K2,K3,K4,K6)
- 4.4 Oyster mushroom (*Pleurotus* sps.), - cropping, harvesting and marketing (K1,K2,K3,K4,K6)
- 4.5 Paddy straw mushroom (*Volvariella volvacea*) – composting, spawning. (K1,K2,K3,K4,K6)
- 4.6 Paddy straw mushroom (*Volvariella volvacea*). cropping, harvesting and marketing. (K1,K2,K3,K4,K6)

UNIT–V: Microalgal Technology.**(9 hours)**

- 5.1 Cultivation methods of Spirulina (K1,K2,K3,K4,K6)
- 5.2 Biotechnological potentials of microalgae- food and feed. (K1,K2)
- 5.3 Fuel production from microalgae- Methane and Hydrocarbon. (K1,K2,K3,K4)
- 5.4 Pharmaceutically valuable compounds from microalgae (K1,K2,K3,K4)
- 5.5 Food and nutraceuticals of Algae: Cyanophyta, Rhodophyta, Heterokontophyta, Chlorophyta. (K1,K2,K3,K4)
- 5.6 Polysaccharides (Agar Agar, Carageenan and Alginic acid). (K1,K2,K3)

TEXT BOOKS:

1. Dubey R.C (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.
2. Subba Rao NS (2004). Soil Microbiology. 4th edition, Oxford and BH Publishing Co.Pvt. Ltd., New Delhi.
3. Patel A.H (2001). Industrial Microbiology. 3rd edition, Mac Millan India Ltd, Chennai.
4. Ismail S.A (2005). The Earthworm Book, 2nd revised edition. Other India Press, Goa, India.
5. Vijaya Ramesh K (2007). Food Microbiology. 1st edition, MJP Publishers, Chennai.

REFERENCE BOOKS:

1. Casida J.E (1986). Industrial Microbiology, 1st edition. Wiley Eastern publishers.UK.
2. Frazier W.C. and West Hoff D.C (2008). Food Microbiology. 4th edition. Mc Graw Hill, New York.
3. Suman B.C and Sharma V.P (2005) Mushroom Cultivation, Processing and Uses. 1st edition, Agribios (India) Publishers, Jodhpur.
4. Lansing M. Prescott, John P. Harley., Donald A. Klein (2011) .Microbiology.8th edition. McGraw Hill Inc., New York.
5. McCandless, E.L. 1981. Polysaccharides of seaweeds. In The Biology of seaweeds, ed. C.S. Lobban and M.J. Wynne, pp. 559-88. Blackwell, Oxford.
6. Melanie N. Johansen. 2011. Microalgae_ Biotechnology, Microbiology and Energy (Marine Biology) --Nova Science Pub Inc
7. Tridevi, P. C. 2001. Algal Biotechnology. Point Publisher, Jaipur, India

OER:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

SEMESTER II

PCMBD20: MEDICAL MICROBIOLOGY

| | | | | | | | |
|--|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: I SEM: II | Course Code PCMBD20 | Title Of The Course Medical Microbiology | Course Type Theory | Course Category Core | H/W 5 | Credits 5 | Marks 100 |
|--|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide an in depth understanding of the pathogenic mechanism of microorganisms, the diseases caused, its laboratory diagnosis and control measures.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the basics of Medical Microbiology and describe the mode of transmission of various pathogens.

CO2: Select methods to identify the causative agents for clinical diagnosis.

CO3: Analyse pathogenic microorganism of bacteria and its mechanism of pathogenesis.

CO4: Discuss on pathogenic fungi and parasites.

CO5: Compile virus structure, multiplication, classification and medical importance.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | M | M | M | H | H |
| CO2 | H | H | H | H | H | H |
| CO3 | H | H | H | M | M | H |
| CO4 | H | L | L | L | M | H |
| CO5 | H | M | L | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | M | M | M | H |
| CO2 | H | H | H | H | M | H |
| CO3 | H | H | H | M | M | H |
| CO4 | H | L | L | L | M | H |
| CO5 | H | M | L | L | M | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Introduction to Medical Microbiology. (10 hours)

1.1 Basics in Medical microbiology - Infectious diseases overview. (K1,K2)

1.2 Medically important microbes. (K1,K2)

1.3 Microbial diseases - sources, route of transmission. (K1,K2)

1.4 Pathogenesis - adhesion, invasion, host cell damage, release of pathogens. (K1,K2)

1.5 Microbial virulence and virulence factors - Signs and symptoms of microbial diseases. (K1,K2)

1.6 Treatment, Prevention and control of microbial infections. (K1,K2,K3)

UNIT-II: Diagnostic Microbiology. (10 hours)

2.1 Diagnosis of microbial diseases – Collection and transport of clinical specimens. (K2,K3,K4,K5)

2.2 Preliminary processing of clinical samples- identification and cultural characteristics. (K2,K3,K4,K5)

2.3 Detection of Biochemical properties of pathogens. (K2,K3,K4,K5)

2.4 Immunodiagnosis. (K2,K3,K4,K5)

2.5 Molecular diagnosis of microbial diseases. (K2,K3,K4,K5)

2.6 Modern methods of microbial diagnosis. (K2,K3,K4,K5)

UNIT-III: Medical Bacteriology. (20 hours)

3.1 Bacteriology - Characteristics, classification, pathogenesis, pathology, diagnosis, treatment, prevention and control of diseases caused by *Staphylococci*, *Streptococci*. (K1,K2,K3,K4)

3.2 *Neisseria*, *Bacillus*, *Clostridium*. (K1,K2,K3,K4)

3.3 *Corynebacterium* and *Mycobacteria*. (K1,K2,K3,K4)

3.4 Members of Family Enterobacteriaceae., (K1,K2,K3,K4)

3.5 *Vibrio*, *Pseudomonas*. (K1,K2,K3,K4)

3.6 Spirochaetes, Rickettsiae and Chlamydiae. (K1,K2,K3,K4)

UNIT-IV: Medical Mycology and Parasitology. (20 hours)

4.1 Mycology - Human mycotic infections caused by Dermatophytes (K1,K2)

4.2 *Histoplasma*, *Cryptococcus*, *Candida*, (K1,K2)

4.3 Mycotic Mycetoma - Mycotoxins. (K1,K2)

4.4 Parasitology - Medical importance of *Entamoeba*, *Giardia*, *Lieshmania*, (K1,K2)

4.5 *Plasmodium*, *Taenia*, *Ascaris*, *Wucherhiria*. (K1,K2)

4.6 Laboratory techniques used in the diagnosis of fungal and parasitic diseases. (K1,K2,K3,K4)

UNIT-V: Virology. (15 hours)

5.1 Viruses – Structure, multiplication, classification and medical importance of DNA viruses – Adeno, Pox. (K1,K2)

5.2 Herpes, Hepatitis Virus. (K1,K2)

5.3 RNA viruses - Picorna, Orthomyxo, Paramyxo. (K1,K2)

5.4 Virus causing SARS, MERS and SARS-CoV2 (K1,K2)

5.5 Oncogenic Viruses (Papilloma and Polyoma), (K1,K2)

5.6 Rhabdo and HIV virus(K1,K2)

TEXT BOOKS:

1. Ananthanarayan R & Paniker C.K.J. (2013). Text Book of Microbiology, 9th edition, Universities Press, Hyderabad.
2. Jawetz, Melnick, & Adelberg's. (2013). Medical Microbiology. 26th edition. McGraw-Hill, New York.
3. Mehrotra RS and Aneja KR (2006). An Introduction to Mycology. 1st edition, New age international publishers, Chennai.

4. Subhash Chandra Parija (2013). Text book of Medical Parasitology. 4th edition, All India Publishers and Distributors (Medical Books Publishers), New Delhi.
5. Dimmok N.J and Primrose S.B (1994). Introduction to modern virology 4th edition, Blackwell scientific company publications, United States.

REFERENCE BOOKS:

1. Tille P. Bailey and Scott (2013). Diagnostic Microbiology, 13th edition, Mosby Publishers, United States.
2. Satish Gupte (2005). The Short Textbook of Medical Microbiology. 8th edition, Jaypee Brothers, Medical publishers (P) Ltd., New Delhi.
3. Monica Cheesbrough (2003). District Laboratory Practice in Tropical Countries. Part 1 & 2, Cambridge University Press.
4. Jagdish Chander (1996). A text book of Medical Mycology. 1st edition. Interprint, New Delhi.
5. Chatterjee K.D (2016). Parasitology, Protozoology & Helminthology. 13th edition. Joe media Publishers. Calcutta.

OER:

1. <http://www.gutenberg.org/>
2. <http://www.free-ebooks.net/>
3. <http://www.bookrix.com>
4. <http://www.e-booksdirectory.com/>
5. <http://bookboon.com/>
6. <http://www.freebooks.com/ebooks/>

PCMBE20 - MICROBIAL PHYSIOLOGY AND BIOMOLECULES

| | | | | | | | |
|--------------------------|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: I | Course Code PCMBE20 | Title Of The Course Microbial physiology and Biomolecules | Course Type Theory | Course Category Core | H/W 5 | Credits 4 | Marks 100 |
| SEM: II | | | | | | | |

Course Objective:

To provide an in depth understanding on the concepts of microbial metabolism, growth and energy generation and the role of biomolecules in biological system.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Explain microbial metabolism, growth and energy generation.

CO2: Analyse microbial physiology, different classes of antimicrobial agents and their mode of action.

CO3: Evaluate the properties of carbohydrates in metabolism.

CO4: Compile the process involved in synthesis of nucleic acid.

CO5: Outline the steps involved in post transcriptional and translational modification

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | L | L | L | H | L | H |
| CO2 | L | M | M | H | L | H |
| CO3 | L | M | M | H | L | H |
| CO4 | L | M | M | H | L | H |
| CO5 | L | M | M | H | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | L | M | M | L | H |
| CO2 | H | L | M | M | L | H |
| CO3 | H | L | M | M | L | H |
| CO4 | H | L | M | M | L | H |
| CO5 | H | L | M | M | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Basic Concepts of Metabolism.

(15 hours)

1.1 Carbohydrate metabolism - Glycolysis – HMD. (K1,K2)

1.2 TCA & ED and other pathways. (K1,K2)

1.3 Aerobic and anaerobic respirations - Generation of energy - substrate level and oxidation phosphorylation - Electron transport chain.

- 1.4 Proteins - primary, secondary, tertiary and quaternary structures. (K1,K2)
- 1.5 Enzymes nomenclatures, classification and general properties - factors affecting enzyme synthesis and activities - Allosteric enzymes. (K1,K2)
- 1.6 Photosynthesis - cyclic and non -cyclic photophosphorylation. (K1,K2)

UNIT-II: Microbial Pathogenicity and Antimicrobial Resistance. (15 hours)

- 2.1 Microbial pathogenicity - Toxins - Characterization - Mechanisms of action. (K1,K2)
- 2.2 Antimicrobial chemotherapy, antibiotics and its classification. (K1,K2)
- 2.3 Mode of action of antibiotics. (K1,K2)
- 2.4 Antimicrobial resistance. (K1,K2)
- 2.5 Tests for sensitivity to antimicrobial agents – Kirby Bauer and MIC (K1,K2,K3,K4,K5)
- 2.6 Metabolic pathways and metabolic control mechanisms. (K1, K2)

UNIT-III: Carbohydrates and Nucleic Acids. (15 hours)

- 3.1 Brief idea about classification, structure and properties of carbohydrates. (K1,K2)
- 3.2 Nucleic acids - DNA and RNA - their topology and functions. (K1,K2)
- 3.3 Brief idea about artificial Nucleic acid - PNA. (K1,K2)
- 3.4 DNA Replication mechanisms and types. (K1,K2)
- 3.5 Chromosome organization in microbes. (K1,K2)
- 3.6 DNA repair - mechanism of excision repair, SOS repair and mismatch repair. (K1,K2)

UNIT-IV: RNA Synthesis. (15 hours)

- 4.1 Process of transcription - initiation, elongation and termination. (K1,K2)
- 4.2 Synthesis of mRNA in prokaryotes. (K1,K2)
- 4.3 Synthesis of mRNA in eukaryotes. (K1,K2)
- 4.4 Synthesis of rRNA. (K1,K2)
- 4.5 Synthesis of tRNA. (K1,K2)
- 4.6 RNA processing - capping and polyadenylation. (K1,K2)

UNIT-V: Synthesis of Proteins. (15 hours)

- 5.1 Post transcriptional modification. (K1,K2)
- 5.2 Post translational modification. (K1,K2)
- 5.3 Protein Synthesis. (K1,K2)
- 5.4 Genetic code. (K1,K2)
- 5.5 Process of translation - initiation, elongation and termination. (K1,K2)
- 5.6 Signal sequences and protein transport. (K1,K2)

TEXT BOOKS:

1. Lansing M. Prescott, Harley J. P and Klein D.A (2005). Microbiology. 6th edition, International edition, McGraw Hill. New York.
2. Nelson D.L. and Cox, M.M. (2001). Lehninger Principles of Biochemistry, 3rd edition, Mac Millan Eworth Publishers.London.
3. Freifelder D. (1996). Molecular Biology, 2nd edition. Narosa Publishing House. New Delhi.

REFERENCE BOOKS:

1. Campbell MK (1999). Biochemistry, 3rd edition, Saunders College Publishing / Harcourt Brace College Publishers.
2. Moat G, John W. Foster and Michael P. Spector (2002). Microbial physiology, 4th edition, A John Wiley sons, Inc. publication. New Delhi.
3. David white (2011).The physiology and biochemistry of prokaryotes. 4th edition, Oxford university press, UK
4. Freidberg EC, Walker GC, Siede W. (1995). DNA Repair and Mutagenesis, ASM Press. USA
5. Lewin, B. (2000) Genes VII. 2nd edition. Oxford University Press. London
6. Voet D. and Voet J (1995) Biochemistry, 2nd edition, John Wiley and Sons Inc. London.

OER:

1. <http://www.gutenberg.org/>
2. <http://www.free-ebooks.net/>
3. <http://www.bookrix.com>
4. <http://www.e-booksdirectory.com/>
5. <http://bookboon.com/>
6. <http://www.freebooks.com/ebooks/>

PCMBF20: INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY

| | | | | | | | |
|--|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: I SEM: II | Course Code PCMBF20 | Title Of The Course Industrial and pharmaceutical Microbiology | Course Type Theory | Course Category Core | H/W 5 | Credits 4 | Marks 100 |
|--|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide an in depth understanding about industrially important organisms, strain improvement and production of major products.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the importance of production strain in industries.

CO2: Discuss on fermentors and fermentation process.

CO3: Describe the upstream and downstream processing.

CO4: Analyse the steps involved in vaccine, toxoid and antisera production and evaluate the standardization of antiseptics and disinfectants..

CO5: Assess good practice and regulation involved in utilizing microbial product for pharmaceutical applications.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | H | M | H |
| CO2 | H | M | M | L | H | H |
| CO3 | H | M | M | L | H | H |
| CO4 | H | M | M | L | H | H |
| CO5 | H | H | H | L | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | M | H |
| CO2 | H | M | M | H | H | H |
| CO3 | H | M | M | H | H | H |
| CO4 | H | M | M | H | H | H |
| CO5 | H | H | H | H | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT- I: Introduction to Fermentation.

(9 hours)

- 1.1 Introduction to fermentation – the range of fermentation process. (K1,K2)
- 1.2 The chronological development of the fermentation industry. (K1,K2)
- 1.3 The component parts of a fermentation process. (K1,K2)
- 1.4 Isolation of Industrially important organisms. (K1,K2,K3,K4)
- 1.5 Preservation of industrially important organisms. (K1,K2,K3,K4)
- 1.6 Strain improvement of industrially important microorganisms. (K1,K2,K3,K4, K5)

UNIT-II: Fermentors and Development of Inoculum.**(9 hours)**

- 2.1 Development of inoculum - Scale up (Pilot study). (K1,K2)
- 2.2 Upstream processing – media for industrial fermentation – formulation – sterilization – Microbial growth kinetics. (K1,K2,K3,K4)
- 2.3 Fermentation – types. (K1,K2)
- 2.4 Downstream processing. (K1,K2)
- 2.5 Fermentor/ Bioreactors – Parts and Design. (K1,K2)
- 2.6 Types of Bioreactors – Instrumentation and control.(K1,K2,K3)

UNIT- III: Microbial Productions.**(12 hours)**

- 3.1 Production of Organic acids (Citric acid, Acetic acid). (K1,K2,K3)
- 3.2 Production of Amino acids (L - Glutamic acid , L - Lysine). (K1,K2,K3)
- 3.3 Production of Antibiotics (Penicillin, Streptomycin, Tetracyclines). (K1,K2,K3)
- 3.4 Production of Enzymes (Amylases, Proteases and Pectinases). (K1,K2,K3)
- 3.5 Production of vitamins (B12, B2 and C). (K1,K2,K3)
- 3.6 Production of alcoholic beverages (wine and beer). (K1,K2,K3)

UNIT- IV: Vaccine Production and Pharmaceutical Standardisation. (8 hours)

- 4.1 Production of different types of vaccines. (K1,K2,K3)
- 4.2 Toxoid, antisera production and their standardization. (K1,K2,K3)
- 4.3 Preparation of Antiseptics and their uses. (K1,K2,K3)
- 4.4 Preparation of disinfectants and their standardization. (K1,K2,K3)
- 4.5 Types of water used in pharmaceutical industries (DM/Purified water). (K1,K2,K3)
- 4.6 Water for injection used in pharmaceutical industry and pyrogen testing. (K1,K2,K3,K5)

UNIT –V: Microbial Assay of Antibiotics.**(7 hours)**

- 5.1 Sub culturing and culture suspension preparation. (K2,K3,K4,K5)
- 5.2 Microbial assay of antibiotics and vitamins. (K2,K3,K4,K5)
- 5.3 Sterility testing. (K2,K3,K4,K5)
- 5.4 Bacterial Endotoxin Test (BET). (K2,K3,K4,K5)
- 5.5 Good Documentation Practice (GDP) – SOP – GLP. (K2,K3,K4,K5)
- 5.6 Failure investigation. (K1,K2,K3)

TEXT BOOKS:

1. Patel A.H (2001). Industrial Microbiology. 3rd edition, Mac Millan India ltd, Chennai.
2. Chisti, Y., (2006) Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology, Vol. 5, John Wiley and Sons, New York

REFERENCE BOOKS:

1. Casida J.E (1986). Industrial Microbiology, 1st edition. Wiley Eastern publishers.UK

2. Stanbury P.F., Whitaker A and Hall S.J (1995). Principles of Fermentation technology. 1st edition, Pergamon, UK.
3. Prescott and Dunn, S., (1982) Industrial Microbiology. 4th edition .The AVI Publishing Company Inc., USA.
4. Belter, P.A., Cussler, E.L. and Hu, W.S., (2005) Bioseparation: Downstream processing for Biotechnology, 1st edition. John Wiley and Sons, N.Y

OER:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PEMBC20 - ELECTIVE II A: BIOLOGICAL TECHNIQUES

| | | | | | | | |
|--------------------------|-------------------------------|---|------------------------------|---|-----------------|---------------------|---------------------|
| Year: I | Course Code PEMBC20 | Title Of The Course Biological Techniques | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
| SEM: II | | | | | | | |

Course Objective:

To demonstrate proper and safe laboratory practices, use of various laboratory equipment, and to enhance the use of advanced techniques.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Discuss about various microscopes, its parts and their working mechanism.

CO2: Apply the principle and usage of spectroscopic, centrifugation, biosensors and radioactive analysis.

CO3: Analyse principles and applications of chromatographic techniques.

CO4: Demonstrate principles and applications of electrophoresis.

CO5: Compile the techniques involved in molecular biology.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|------------|------|------|------|------|------|------|
| CO1 | L | H | M | L | M | H |
| CO2 | L | H | M | L | M | H |
| CO3 | L | H | M | L | M | H |
| CO4 | L | H | M | L | M | H |
| CO5 | L | H | M | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | L | H |
| CO2 | H | H | H | H | L | H |
| CO3 | M | M | M | M | L | H |
| CO4 | H | H | H | H | L | H |
| CO5 | H | H | H | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Microscopy.

(15 hours)

1.1 Applications of various types of microscopy such as bright field, dark field, phase contrast. (K2,K3,K4,K5)

1.2 Immunofluorescence - In situ hybridization confocal Microscope, Atomic Force Microscope (AFM). (K2,K3,K4,K5)

1.3 Electron Microscopy - Principle, specimen preparation and applications. (K2,K3,K4,K5)

- 1.4 Transmission Electron microscope (TEM) and Scanning Electron Microscope (SEM) (K2,K3,K4,K5)
- 1.5 Brief account on Photomicrography and Video micrography. (K2,K3,K4,K5)
- 1.6 Developing and Printing of microphotographs. (K2,K3,K4,K5)

UNIT-II: Analytical Techniques. (15 hours)

- 2.1 Spectroscopic methods - UV-Visible (K2,K3,K4,K5)
- 2.2 Atomic Absorption Spectrophotometer, Atomic Emission Spectroscopy. (K2,K3,K4,K5)
- 2.3 Centrifugation - Principles, various types including centrifugation. (K2,K3,K4,K5)
- 2.4 Electroanalytical methods - electrolytic all 4 galvanic cell - Potentiometric, conductimetric, coulometric & voltametric analysis. (K2,K3,K4,K5)
- 2.5 Biosensors. (K2,K3,K4,K5)
- 2.6 Radioactive Analysis: Principles of radioactivity, GM counter & LS counter. (K2,K3,K4,K5)

UNIT-III: Chromatography. (15 hours)

- 3.1 Account on Principles & Applications of Chromatographic Techniques. (K1,K2)
- 3.2 Adsorption and gel permeation in chromatography. (K2,K3,K4,K5)
- 3.3 Ion exchange chromatography. (K2,K3,K4,K5)
- 3.4 Affinity Chromatography. (K2,K3,K4,K5)
- 3.5 Gas Chromatography. (K2,K3,K4,K5)
- 3.6 HPLC. (K2,K3,K4,K5)

UNIT-IV: Electrophoresis. (15 hours)

- 4.1 Principle and types of Electrophoretic techniques. (K1,K2)
- 4.2 Significance and Application of Electrophoresis. (K1,K2)
- 4.3 Factors affecting electrophoretic mobility. (K1,K2)
- 4.4 Support medium-Agarose and Polyacrylamide gels. (K1,K2)
- 4.5 Electrophoresis of proteins. (K2,K3,K4,K5)
- 4.6 Electrophoresis of nucleic acids. (K2,K3,K4,K5)

UNIT-V: Molecular Biological Techniques. (15 hours)

- 5.1 Isolation of nucleic acid - Plasmid isolation, chromosomal DNA isolation. (K2,K3,K4,K5)
- 5.2 Gene cloning techniques - Restriction digestion and ligation of vector and foreign gene. (K2,K3,K4,K5,K6)
- 5.3 Separation and staining of DNA, quantification of DNA. (K2,K3,K4,K5)
- 5.4 Gene transfer mechanisms – Transformation, transfection and electroporation. (K2,K3,K4,K5)
- 5.5 Methods of detection of clones - Nucleic acid transfer by blotting, Hybridization- plaque & colony hybridization. (K2,K3,K4,K5)
- 5.6 Amplification of nucleic acid- Polymerase chain reaction. (K2,K3,K4,K5)

TEXT BOOKS:

1. Westermeier, R (1993). Electrophoresis in practice – VCH – Federal Republic of Germany. Germany.

2. Willett, J.E. (1991). Gas Chromatography, 1st edition. John Wiley & Sons. New York.
3. Wilson, K. and Walker (1995). Practical Biochemistry Principles and Techniques, Cambridge University Press, London.
4. James G Cappuccino and Natalie Sherman (2004). Microbiology: A laboratory manual. Sixth edition, Published by Pearson Education, United States.
5. Sambrook, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd edition, Vol. 1,2 & 3) Cold Spring Laboratory Press, New York.

REFERENCE BOOKS :

1. Bajpai P.K (2010). Biological Instrumentation and Methodology. Revised edition, S.Chand& Co.Ltd., New Delhi.
2. John G Webster (2004). Bioinstrumentation. Student edition. John Wiley and Sons, Ltd., New Delhi.
3. Palanivelu P (2004). Analytical Biochemistry and Separation techniques. 3rd edition, MKU Coop,Press Ltd., Palkalai Nagar, Madurai.
4. Gurumani N (2006). Research Methodology for Biological Sciences. 1st edition, MJP Publishers,A Unit of Tamil Nadu Book House, Chennai.
5. Subramanian M.A (2005). Biophysics - Principles and Techniques. 1st edition, MJP Publishers, AUnit of Tamil Nadu Book House, Chennai.

OER:

1. <http://www.learnerstv.com/>
2. <http://webcast.berkeley.edu/>
3. <http://cosmolearning.org/>
4. <http://www.world-lecture-project.org/>
5. <http://cec.nic.in/>
6. <http://epgp.inflibnet.ac.in/>
7. <http://www.co-learn.in/>

PEMBD20 - ELECTIVE II B: HUMAN ANATOMY AND PHYSIOLOGY

| | | | | | | | |
|----------------------------|-------------------------------|--|------------------------------|---|-----------------|---------------------|---------------------|
| Year: I SEM: II | Course Code PEMBD20 | Title Of The Course Human Anatomy and Physiology | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
|----------------------------|-------------------------------|--|------------------------------|---|-----------------|---------------------|---------------------|

Course Objective: To provide an in depth understanding about anatomy and physiology of the human body.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Discuss protective mechanism of respiratory system and sensory organs.

CO2: Explain the role of gastrointestinal system and lympho - reticular system.

CO3: Identify the major components of musculoskeletal and nervous system.

CO4: Analyse the production of RBC, compare the role and function of endocrine system.

CO5: Revise the anatomical differences between male and female reproductive and urinary system.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | L | L | L | M | L | H |
| CO2 | L | L | L | M | L | H |
| CO3 | L | L | L | M | L | H |
| CO4 | L | L | L | M | L | H |
| CO5 | L | L | L | M | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | L | M | M | L | H |
| CO2 | H | L | M | M | L | H |
| CO3 | H | L | M | M | L | H |
| CO4 | H | L | M | M | L | H |
| CO5 | H | L | M | M | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Respiratory System and Special Sensory Organs.

(9 hours)

- 1.1 Introduction to applied human anatomy and physiology. (K1,K2)
- 1.2 Respiratory System: Different organs of the Respiratory System. (K1,K2)
- 1.3 Functions of the different organs of the Respiratory System. (K1,K2)
- 1.4 Special Sensory Organs: Introduction to special sensory organs. (K1,K2)
- 1.5 Function and functions of, ear, nose, tongue. (K1,K2)
- 1.6 Functions of eye and skin. (K1,K2)

UNIT-II: Gastro Intestinal System and Lympho-Reticular System. (9 hours)

- 2.1 Gastro Intestinal System: Introduction and different organs associated with the Gastro Intestinal system. (K1,K2)
- 2.2 Salivary glands and its functions. (K1,K2)
- 2.3 Liver and its function. (K1,K2)
- 2.4 Pancreas and Gall bladder- its functions. (K1,K2)
- 2.5 Lympho-reticular System- Introduction to different organs of LRS. (K1,K2)
- 2.6 Lymph, Lymphatic vessels and Lymph nodes - functions of the different organs of Lympho-reticular system. (K1,K2)

UNIT-III: Musculoskeletal System, Skin and Nervous System. (9 hours)

- 3.1 Musculoskeletal System- Introduction of musculo-skeleton system. (K1,K2)
- 3.2 Different parts of involved in skeleton system. (K1,K2)
- 3.3 Function of muscular system. (K1,K2)
- 3.4 Skin – Parts and function of skin. (K1,K2)
- 3.5 Nervous System: Introduction to nervous system and its functions. (K1,K2)
- 3.6 Central nervous system and peripheral nervous system. (K1,K2)

UNIT-IV: Circulatory System and Endocrine System. (9 hours)

- 4.1 Circulatory System: Blood: Site of formation. (K1,K2)
- 4.2 Composition, functions of blood cells. (K1,K2)
- 4.3 Different parts of the circulatory system and its function. (K1,K2)
- 4.4 Endocrine System: Introduction to endocrine system. (K1,K2)
- 4.5 Different organs of endocrine system. (K1,K2)
- 4.6 Functions of endocrine system. (K1,K2)

UNIT-V: Reproductive System and Urinary System. (9 hours)

- 5.1 Reproductive System: Introduction Male reproductive system – physiological anatomy, spermatogenesis and its regulation. (K1,K2)
- 5.2 Testicular hormones, composition of semen. (K1,K2)
- 5.3 Female reproductive system – menstrual cycle, pregnancy and parturition. (K1,K2)
- 5.4 Lactation and family planning. (K1,K2)
- 5.5 Urinary System: Different organs and Functions of Urinary System. (K1,K2)
- 5.6 Mechanism of urine formation and composition of urine. (K1,K2)

TEXT BOOKS:

1. Sampath Madhyastha, (2016) Manipal Manual of Anatomy, 3rd Edition, CBS Publishers and Distributors Pvt Ltd. Chennai.
2. Chandar Sekar, C.N. (2006). Manipal Manual of Physiology, CBS Publishers and distributors Pvt Ltd., Chennai.
3. Chaurasia, B.D, (2005) Handbook of Human anatomy 3rd Edition, CBS Publishers and Distributors Pvt Ltd. Chennai.
4. Human physiology, 2nd edition- BJ Mejer, HS Meij, AC Meyer, AITBs publishers and distributors.

REFERENCES BOOKS:

1. Srivastava, (2013), Text book of Anatomy, Books and Allied (P) Ltd, Kolkatha.
2. Suresh.R, (2012), Essentials of Human Physiology, Books and Allied (P) Ltd, Kolkatta.
3. Asis Das (2006), Medical Physiology, Books and Allied (P) Ltd, Kolkatta.
4. A Text book of Animal Physiology, KA Goel, KV Sastri, (2005) Rastogi publications Meerut.
5. A Hand Book of Basic Human physiology- K. Saradha subramanyam, S. (2000)Chand & Co., Ltd.

OER:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

**PCMBG20 - MAIN PRACTICAL –I: APPLIED MICROBIOLOGY AND
IMMUNOLOGY**

| | | | | | | | |
|------------------------------------|-----------------------------------|--|-------------------------------------|------------------------------------|-----------------|---------------------|---------------------|
| Year: I SEM: II | Course Code PCMBG20 | Title Of The Course Main Practical I: Applied Microbiology and Immunology | Course Type Practical | Course Category Core | H/W 5 | Credits 5 | Marks 100 |
|------------------------------------|-----------------------------------|--|-------------------------------------|------------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To enable the students to get hands-on training on various aspects of general, food, agricultural, environmental microbiology and immunotechnology.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Identify morphology of bacteria using different staining procedure and isolating them by pure culture techniques.

CO2: Assess the quality of air, water, food and soil samples.

CO3: Examine the activity of extracellular enzymes.

CO4: Apply agglutination and precipitation methods to detect antigen and antibody.

CO5: Select appropriate chromatographic methods to separate aminoacids, pigments and from crude extracts.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | H | L | H |
| CO2 | H | H | H | L | M | H |
| CO3 | H | H | M | M | L | H |
| CO4 | L | H | H | H | L | H |
| CO5 | L | H | M | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | M | H | L | H |
| CO2 | H | H | H | L | L | H |
| CO3 | H | M | M | M | L | H |
| CO4 | H | M | H | H | L | H |
| CO5 | H | M | M | L | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

1. Cleaning of glassware and sterilization.
2. Preparation and use of glassware cleaning solutions, sterilization.
3. Micrometry - counting and measurements.
4. Pure and axenic culture techniques - serial dilution - pour plate, spread plate, streak plate methods and stab culture techniques.

5. Bacterial Staining methods - simple, Gram's, acid fast, flagella, capsule and spore.
6. Fungal staining method – Lacto phenol cotton blue.
7. Motility of bacteria – Hanging drop technique.
8. Determination of growth - growth curve - generation time and a synchronous growth.
9. Microbial analysis of food products - bacterial and fungal.
10. Extracellular enzyme activities - cellulase, protease, lipase and phosphatase.
11. Dairy microbiology - Direct microscopic count - Standard plate count - reductase test (resazurin/methylene blue) - isolation of microbes from yoghurt, curd.
12. Quantification of microorganisms in air - solid and liquid impingement techniques.
13. Analysis of water – Most probable number test and membrane filter technique.
14. Microbial flora from different soil types and habitats - isolation of nitrogen fixing bacteria, phosphate solubilizing organisms- development of Winogradsky Column
15. Precipitation techniques: Agar gel diffusion - Ouchterlony's method, Single radial immunodiffusion, Counter immuno electrophoresis & Rocket Immuno Electrophoresis.
16. Agglutination techniques: Blood grouping and Rh factor - Latex agglutination - RF & ASO. Haemagglutination RPHA / IHA.
17. Labelled Assays: Demo: Enzyme Linked Immunosorbent Assay (ELISA).
18. Separation of pigments using paper chromatography.
19. Separation of compounds from crude extracts using TLC.

REFERENCE BOOKS

1. Dubey, R.C. and Maheshwari, D.K. (2002) Practical Microbiology, 1st Edn. S. Chand & Co. Ltd., New Delhi.
2. Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, 6th Edn. Pearson Education Publication, New Delhi.
3. Collee, J.C., Duguid, J.P., Fraser, A.C. and Marimon, B.P. (1996) Mackie and McCartney Practical Medical Microbiology, 14th Edn. Churchill Livingstone, London.
6. Holt, J.S., Krieg, N.R., Sneath, P.H.A. and Williams, S.S.T. (1994) Bergey's Manual of Determinative Bacteriology, 9th Edn. Williams & Wilkins, Baltimore.
7. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Eds) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC.

8. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis.

OER:

VIRTUAL LABS/ INTERACTIVE SIMULATIONS:

1. www.vlab.co.in
2. www.aview.in/aview
3. www.pbs.org
4. www.micro.magnet.fsu.edu/primer/java/scienceopticsu

VIDEO LESSONS:

1. www.learnerstv.com
2. www.webcast.berkeley.edu
3. www.cosmolearning.org

PCMBH20: MAIN PRACTICAL – II: MEDICAL MICROBIOLOGY

| | | | | | | | |
|----------------------------|-----------------------------------|---|-------------------------------------|------------------------------------|-----------------|---------------------|---------------------|
| Year: I SEM: II | Course Code PCMBH20 | Title Of The Course Main Practical II: Medical Microbiology | Course Type Practical | Course Category Core | H/W 5 | Credits 5 | Marks 100 |
|----------------------------|-----------------------------------|---|-------------------------------------|------------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To enable the students to get hands-on training on various aspects of Clinical Microbiology, Microbial physiology and Biomolecules.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Demonstrate collection, transport and processing of clinical specimens.

CO2: Identify the bacterial pathogens from various clinical samples and detect their antimicrobial activity.

CO3: Analyse the clinical specimens for the examination and cultivation of pathogenic fungi.

CO4: Estimate worm burden stool for the identification of parasite.

CO5: Enumerate blood cells.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | H | L | H |
| CO2 | H | H | M | H | L | H |
| CO3 | H | H | M | H | L | H |
| CO4 | H | H | H | H | L | H |
| CO5 | H | H | H | H | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | L | H |
| CO2 | H | H | H | H | L | H |
| CO3 | H | H | M | M | M | H |
| CO4 | H | H | M | M | M | H |
| CO5 | H | H | L | M | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

1. Collection and transport of pathological specimens for microbiological examinations.
2. Bacteriological methods: Microscopic examination - blood - faeces - pus - sputum - throat swab and nose swab - urine - body fluids
3. Isolation and identification of the pathogen – Pure and mixed culture and biochemical tests.
4. Antimicrobial assay - sensitivity test - Stokes and Kirby Bauer methods - Disc diffusion - agar dilution - broth dilution - MBC/MIC. Quality control for antibiotics.

5. Mycological methods: Macroscopic observation - microscopic observation - culture. Identification of *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Candida*, *Trichophyton*, *Microsporum*, *Epidermophyton* - SDA/Corn Meal Agar - Slide culture method - Germ tube method - Sugar assimilation/fermentation tests.
6. Examination of parasites in clinical specimens - ova/cyst in faeces.
7. Haematology: Total count (TC): RBC and WBC, - Differential count (DC) - Haemoglobin level, - Bleeding time - Clotting time – ESR.

REFERENCE BOOKS:

1. Dubey, R.C. and Maheshwari, D.K. (2002) Practical Microbiology, 1st Edn. S. Chand & Co. Ltd., New Delhi.
2. Cappuccino, J. and Sherman, N. (2002) Microbiology: A Laboratory Manual, 6th Edn. Pearson Education Publication, New Delhi.
3. Collee, J.C., Duguid, J.P., Fraser, A.C. and Marimon, B.P. (1996) Mackie and McCartney Practical Medical Microbiology, 14th Edn. Churchill Livingstone, London.
4. Holt, J.S., Krieg, N.R., Sneath, P.H.A. and Williams, S.S.T. (1994) Bergey's Manual of Determinative Bacteriology, 9th Edn. Williams & Wilkins, Baltimore.
5. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edn. C.V. Mosby Company, St. Louis.

OER:

VIRTUAL LABS/ INTERACTIVE SIMULATIONS:

1. www.vlab.co.in
2. www.aview.in/aview
3. www.pbs.org
4. www.micro.magnet.fsu.edu/primer/java/scienceopticsu

VIDEO LESSONS:

1. www.learnerstv.com
2. www.webcast.berkeley.edu
3. www.cosmolearning.org

INDEPENDENT ELECTIVE COURSES

PIMBA20 - IEC- I: PUBLIC HEALTH MICROBIOLOGY

| | | | | | | | |
|-----------------------------------|-----------------------------------|---|----------------------------------|---|-----------------|---------------------|---------------------|
| Year: I SEM: I | Course Code PIMBA20 | Title Of The Course Public Health Microbiology | Course Type Theory | Course Category Independent elective | H/W - | Credits 2 | Marks 100 |
|-----------------------------------|-----------------------------------|---|----------------------------------|---|-----------------|---------------------|---------------------|

Course Objective:

To provide in depth knowledge about significance of public health at theoretical and practical levels.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Explain the significance of public health.

CO2: Communicate the mode of transmission of human diseases.

CO3: Discuss the role of medically important pathogens and the diseases caused.

CO4: Outline the vector complex interactions between the pathogens and host.

CO5: Create awareness on hospital-acquired infections, prevention and its control measures.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | H | L | H |
| CO2 | H | H | H | H | L | H |
| CO3 | H | H | M | M | M | H |
| CO4 | H | H | M | M | M | H |
| CO5 | H | H | L | M | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | H | H |
| CO2 | H | L | M | H | L | H |
| CO3 | H | L | M | H | L | H |
| CO4 | H | L | M | H | L | H |
| CO5 | H | M | H | M | M | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT–I: Water Borne Diseases.

1.1 Overview on common water borne diseases. (K1,K2)

1.2 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of hepatitis. (K1,K2,K3,K4)

1.3 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of cholera, typhoid. (K1,K2,K3,K4)

1.4 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of amoebiasis, giardiasis. (K1,K2,K3,K4)

1.5 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of poliomyelitis. (K1,K2,K3,K4)

1.6 Non Diarrhoeal diseases (bacterial and viral). (K1,K2,K3,K4)

UNIT–II: Air Borne Diseases.

2.1 Overview on common air-borne diseases. (K1,K2)

2.2 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis of pneumonia. (K1,K2,K3,K4)

2.3 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis of diphtheria. (K1,K2,K3,K4)

2.4 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis of tuberculosis. (K1,K2,K3,K4)

2.5 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis of anthrax. (K1,K2,K3,K4)

2.6 Microbiology of causative agents, epidemiology, pathogenesis, laboratory diagnosis of influenza and measles. (K1,K2,K3,K4)

UNIT–III: Food Borne Diseases.

3.1 Concept on food borne infections and food intoxication. (K1,K2)

3.2 Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of Staphylococcal food intoxication. (K1,K2,K3,K4)

3.3 Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of Clostridial food poisoning. (K1,K2,K3,K4)

3.4 Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of Salmonellosis. (K1,K2,K3,K4)

3.5 Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of Shigellosis. (K1,K2,K3,K4)

3.6 Microbiology of causative microorganisms, epidemiology, pathogenesis, laboratory diagnosis, prevention and control of travelers' diarrhea. (K1,K2,K3,K4)

UNIT–IV: Vector Borne Diseases.

4.1 Overview on common vector-borne diseases and their vectors (K1,K2)

4.2 Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of visceral leishmaniasis. (K1,K2,K3,K4)

4.3 Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of malaria. (K1,K2,K3,K4)

4.4 Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of filariasis. (K1,K2,K3,K4)

4.5 Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of Japanese encephalitis and dengue. (K1,K2,K3,K4)

4.6 Microbiology of causative organisms, epidemiology, pathogenesis, laboratory diagnosis and prevention and control of West Nile fever and plague. (K1,K2,K3,K4)

UNIT–V: Hospital Acquired Infection

5.1 Concept on common nosocomial infections (K1,K2)

- 5.2 Disinfection procedures of hospital environment. (K1,K2,K3)
- 5.3 Equipments and materials used in hospitals. (K1,K2,K3)
- 5.4 Methods of disposal of infective hospital waste. (K1,K2,K3,K4)
- 5.5 Methods of disposal of laboratory materials. (K1,K2,K3,K4)
- 5.6 Monitoring of sanitation in hospital environment. (K1,K2,K3,K4)

TEXT BOOKS:

1. Ananthanarayan R & Paniker C.K.J. (2013). Text Book of Microbiology, 9th edition, Universities Press, Hyderabad.
2. Jawetz, Melnick, & Adelberg's. (2013). Medical Microbiology. 26th edition. McGraw-Hill, New York.
3. Mehrotra RS and Aneja KR (2006). An Introduction to Mycology. 1st edition, New age international publishers, Chennai.
4. Subhash Chandra Parija (2013). Text book of Medical Parasitology. 4th edition, All India Publishers and Distributors (Medical Books Publishers), New Delhi.
5. Dimmok N.J and Primrose S.B (1994). Introduction to modern virology 4th edition, Blackwell scientific company publications, United States.

REFERENCE BOOKS:

1. Tille P. Bailey and Scott (2013). Diagnostic Microbiology, 13th edition, Mosby Publishers, United States.
2. Satish Gupte (2005). The Short Textbook of Medical Microbiology. 8th edition, Jaypee Brothers, Medical publishers (P) Ltd., New Delhi.
3. Monica Cheesbrough (2003). District Laboratory Practice in Tropical Countries. Part 1 & 2, Cambridge University Press.
4. Jagadish Chander (1996). A text book of Medical Mycology. 1st edition. Interprint, New Delhi.
5. Chatterjee K.D (2016). Parasitology, Protozoology & Helminthology. 13th edition. Joe media Publishers. Calcutta.

OER:

1. <http://www.gutenberg.org/>
2. <http://www.free-ebooks.net/>
3. <http://www.bookrix.com>
4. <http://www.e-booksdirectory.com/>
5. <http://bookboon.com/>
6. <http://www.freebooks.com/ebooks/>

PIMBB20: IEC-II: ANIMAL TISSUE CULTURE

| | | | | | | |
|--------------------------|-------------------------------|---|------------------------------|-----------------|---------------------|---------------------|
| Year: I | Course Code PIMBB20 | Title Of The Course Animal Tissue Culture | Course Type Theory | H/W - | Credits 2 | Marks 100 |
|--------------------------|-------------------------------|---|------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To acquaint students with a clear background on processing, culturing animal cells and cell lines in laboratory.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Introduce the importance of cell culture.

CO2: Demonstrate knowledge of cell lines used in tissue culture, their origins and applications and explain major components of cell and tissue culture media.

CO3: Identify methods to maintain cultures of animal cells and established cell lines with good viability and minimal contamination.

CO4: Utilize hybridoma technology for monoclonal and polyclonal antibodies production.

CO5: Outline the applications of animal cell culture.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | H | L | M |
| CO2 | M | H | M | L | H | H |
| CO3 | H | H | M | M | M | H |
| CO4 | H | H | M | M | M | H |
| CO5 | H | M | L | L | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | L | H | L | H |
| CO2 | H | L | M | H | L | H |
| CO3 | H | H | M | M | M | H |
| CO4 | H | H | M | M | M | H |
| CO5 | H | M | L | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Cell Culture and Types.

- 1.1 Introduction and Importance of cell culture. (K1,K2)
- 1.2 Historical background of cell culture technology. (K1,K2)
- 1.3 Tissue culture techniques – primary culture. (K1,K2,K3)
- 1.4 Tissue culture Techniques - secondary culture. (K1,K2,K3)
- 1.5 Continuous cell lines, suspension cultures. (K1,K2,K3)

1.6 Organ cultures. (K1,K2,K3)

UNIT–II: Culture Media and Behaviour of Cells.

2.1 Different types of media for culturing cells and tissues. (K1,K2,K3)

2.2 Natural and defined media and growth supplements. (K1,K2,K3)

2.3 Culture of different tissues and its application. (K1,K2,K3)

2.4 Behaviour of cells in terms of growth differentiation and metabolism. (K1,K2,K3)

2.5 Cell division, growth patterns of cells. (K1,K2,K3)

2.6 Estimation of cell number. (K1,K2,K3)

UNIT–III: Characterization and Maintenance of Cell.

3.1 Development of cell lines. (K1,K2,K3)

3.2 Characterization of cell lines (K1,K2,K3)

3.3 Maintenance of cell lines (K1,K2, K3).

3.4 Stem cells and their applications. (K1,K2)

3.5 Cryopreservation. (K1,K2,K3)

3.6 Common cell culture contaminants. (K1,K2)

UNIT–IV: Hybridoma Technology.

4.1 Hybridoma technology: Production of monoclonal and polyclonal antibodies with different types of antigens. (K1,K2,K3)

4.2 Antigen preparation and modification. (K1,K2,K3)

4.3 Adjuvants dose. (K1,K2,K3)

4.4 Routes of antigen administration. (K1,K2,K3)

4.5 Collection of sera and purification of antibodies. (K1,K2,K3)

4.6 Production and applications of monoclonal antibodies for diagnosis and therapy. (K1,K2,K3)

UNIT–V: Applications of Animal Cell Culture.

5.1 Applications of Animal Cell Culture: Use in gene therapy. (K1,K2,K3)

5.2 Cloning from short-term and long term cultured cells. (K1,K2,K3,K4,K5)

5.3 Cloning for production of transgenic animals. (K1,K2,K3,K4,K5,K6)

5.4 Cloning for conservation. (K1,K2,K3)

5.5 Application of animal cell culture for in vitro testing of drugs. (K1,K2,K3)

5.6 Testing of toxicity of environmental pollutants in cell culture. (K1,K2,K3,K4,K5)

TEXTBOOKS:

1. Freshney RI. 2005. Culture of Animal Cells. 1st edition. Wiley Press.
2. Portner R. 2007. Animal Cell Biotechnology. 1st edition. Humana Press.
3. Mishra Bina 2011. Animal Cell Culture. 1st edition. Studium Press.

REFERENCES BOOKS:

1. Basanth Kumar Sinha, Rinesh Kumar. 2008. Principles of animal Cell Culture. IBDC Press.
2. John Masters. 2000. Animal Cell Culture: A Practical Approach. Oxford University Press.
3. Ian Freshney.R, 2010.Culture of Animal Cells: A Manual of Basic Technique and Specialized Application. Wiley-Blackwell.

OER:

1. <http://www.gutenberg.org/>
2. <http://www.free-ebooks.net/>
3. <http://www.bookrix.com>
4. <http://www.e-booksdirectory.com/>
5. <http://bookboon.com/>
6. <http://www.freebooks.com/ebooks/>

PIMBC20 - IEC III: HAEMATOLOGY AND BLOOD BANKING

| | | | | | | | |
|--|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|
| Year: I SEM: II | Course Code PIMBC20 | Title Of The Course Haematology and blood banking | Course Type Theory | Course Category Independent elective | H/W - | Credits 2 | Marks 100 |
|--|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|

Course Objective:

To acquaint students with a clear background on haematology and blood banking procedures

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the ABO blood grouping and Rh typing.

CO2: Apply techniques to collect and store blood samples.

CO3: Describe the composition of blood and discuss on various blood disorders.

CO4: Perform routine haematological tests.

CO5: Elaborate the clinical significance of blood transfusion.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|------------|------|------|------|------|------|------|
| CO1 | L | H | H | M | H | H |
| CO2 | L | H | H | M | H | H |
| CO3 | L | L | M | M | M | H |
| CO4 | M | H | H | H | M | H |
| CO5 | M | H | H | H | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | M | L | H |
| CO2 | H | H | H | M | L | H |
| CO3 | H | L | M | M | L | H |
| CO4 | H | H | H | H | L | H |
| CO5 | H | H | H | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT- I: ABO blood grouping and collection of blood samples

- 1.1 ABO blood grouping and Rh typing. (K1,K2)
- 1.2 Blood - Specimen collection. (K1,K2,K3)
- 1.3 Laboratory preparation in Haematology – Veinpuncture method (K1,K2,K3)
- 1.4 capillary method and finger prick method of blood sample collection (K1,K2,K3)
- 1.5 Anticoagulants. (K1,K2,K3)
- 1.6 Storage of blood specimen. (K1,K2,K3)

UNIT -II: Composition of blood

- 2.1 Composition of blood- cellular fraction. (K1,K2)
- 2.2 Composition of blood- plasma fraction. (K1,K2)
- 2.3 Morphological study of RBC. (K1,K2,K3)
- 2.4 WBC- Granulocytes -Neutrophils, Eosinophils, Basophils (K1,K2,K3)
- 2.5 Non granulocytes- lymphocytes, monocytes. (K1,K2,K3)
- 2.6 Platelet and its significance. (K1,K2,K3)

UNIT- III: Blood disorders

- 3.1 Blood Disorder- Leukemia. (K1,K2,K3,K4)
- 3.2 Anaemia- its causes. (K1,K2,K3,K4)
- 3.3 Leucopaenia- its causes. (K1,K2,K3,K4)
- 3.4 Eosinophilia- its causes. (K1,K2,K3,K4)
- 3.5 Thrombocytopaenia - its causes (K1,K2,K3,K4)
- 3.6 Haematology - Normal values. (K1,K2,K3,K4)

UNIT- IV: Routine Haematological test

- 4.1 Introduction to Routine Haematological tests. (K2,K3,K4,K5)
- 4.2 Haemocytometer -WBC counting. (K2,K3,K4,K5)
- 4.3 Haemocytometer- RBC counting. (K2,K3,K4,K5)
- 4.4 Buffy coat (determination of Haematocrit). (K2,K3,K4,K5)
- 4.5 Determination of erythrocyte sedimentation rate. (K2,K3,K4,K5)
- 4.6 Differential count of leucocytes. (K2,K3,K4,K5)

UNIT- V: clinical significance of blood transfusion.

- 5.1 Clinical significance of blood transfusion. (K1,K2)
- 5.2 Collection of blood for transfusion. (K1,K2,K3)
- 5.3 Processing of blood for transfusion. (K1,K2,K3)
- 5.4 Routine laboratory procedure in Blood bank. (K1,K2)
- 5.5 Transfusion reaction. (K1,K2)
- 5.6 Haemolytic disease of new born. (K1,K2)

REFERENCE BOOKS:

1. Maiti. C.R . 2002. “A Concise note on Medical laboratory technology” – New central book agency:Page 1-49.
2. Kanai. L. Mukherjee. 1988. “Medical Laboratory technology”- Volume I – Tata McGraw Hill.

OER:

1. <http://www.gutenberg.org/>
2. <http://www.free-ebooks.net/>
3. <http://www.bookrix.com>
4. <http://www.e-booksdirectory.com/>
5. <http://bookboon.com/>
6. <http://www.freebooks.com/ebooks/>

PIMBD20: IEC -IV: FORENSIC SCIENCE

| | | | | | | | |
|--------------------------|-------------------------------|--|------------------------------|--|-----------------|---------------------|---------------------|
| Year: I | Course Code PIMBD20 | Title Of The Course Forensic science | Course Type Theory | Course Category Independent elective | H/W - | Credits 2 | Marks 100 |
| SEM: II | | | | | | | |

Course Objective:

To provide students psychological understanding of the scientific principles of crime scene investigation and reconstruction, including evidence collection and preservation.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the history, scope and development of forensic science.

CO2: Evaluate the methods underpinning forensic science, from crime scene investigation to report evidential value within a case.

CO3: Reflect on the use of various divisions of forensic science in the crime investigation.

CO4: Explain the theory of DNA fingerprints, blood pattern analysis, footwear and tool mark impression evidence, and drugs of abuse in the context of Forensic Science.

CO5: Utilize psychological principles in crime investigation.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|------------|------|------|------|------|------|------|
| CO1 | L | H | H | M | H | H |
| CO2 | L | H | H | M | H | H |
| CO3 | L | L | M | M | M | H |
| CO4 | M | H | H | H | M | H |
| CO5 | M | H | H | H | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | M | L | H |
| CO2 | H | H | H | M | L | H |
| CO3 | H | L | M | M | L | H |
| CO4 | H | H | H | H | L | H |
| CO5 | H | H | H | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: History, Scope and Development of Forensic Science.

- 1.1 Definition of Forensic science (K1)
- 1.2 Development of Forensic science. (K1,K2)
- 1.3 Scope of Forensic Science.(K1,K2)
- 1.4 History of Forensic Science in India. (K1,K2)

1.5 Development and scope of Forensic Science in India. (K1,K2)

1.6 Growth of Core laboratories, set up in country. (K1,K2)

UNIT–II: Sociological and Scientific Aspects of Crime.

2.1 Introduction to crime, Sociological aspect in society. (K1,K2)

2.2 Types of crimes. (K1,K2)

2.3 Crimes in India. (K1,K2)

2.4 Crime Scene Management, Crime Scene procedures. (K1,K2,K3)

2.5 Protection of crime scene physical evidence - Scientific collection of physical evidence.
(K1,K2,K3)

2.6 Crime scene management in manmade and natural disaster. (K1,K2,K3)

UNIT–III: Divisions of Crime Investigation.

3.1 Duties of forensic scientist. (K1,K2)

3.2 Introduction to various divisions of crime investigation. (K1,K2)

3.3 Crime investigation- Biology, Serology. (K1,K2,K3)

3.4 Crime investigation -Chemistry, Physics. (K1,K2,K3)

3.5 Crime investigation -Toxicology, Ballistics. (K1,K2,K3)

3.6 Crime investigation -Prohibition Document and other divisions. (K1,K2)

UNIT–IV: Forensic Science Laboratory Techniques.

4.1 Specialised facilities offered by forensic science laboratory – DNA fingerprinting.
(K1,K2,K3)

4.2 Polygraph Narco analysis. (K1,K2,K3)

4.3 Brain electrical oscillation. (K1,K2,K3)

4.4 Signature proficiency (BEOSP) Cyber forensic. (K1,K2,K3)

4.5 Tape and video authentication. (K1,K2,K3)

4.6 Speaker identification. (K1,K2,K3)

UNIT–V: Investigative Psychology.

5.1 Concepts of psychology. (K1,K2)

5.2 History of psychology. (K1,K2)

5.3 Modern perspectives of Psychology. (K1,K2)

5.4 Types of psychology. (K1,K2)

5.5 Professionals psychology - The science and research methods. (K1,K2,K3)

5.6 Professional and ethical issues in psychology. (K1,K2)

REFERENCE BOOKS:

1. Dr.Rukmani Krishnamurty. 2011. Introduction to Forensic Science in Crime Investigation. 1st edition. Scientific Books publishers.India.
2. Richard Saferstein. 2016. Criminalistics - An Introduction to Forensic Science. 8thEdition Pearson Prentice Hall.
3. Morgan, King, Weiss and Schopler. 1989. Introduction to Psychology, 7th edition.McGraw Hill, India.
4. Carson RC & Butcher JN .2012. Abnormal psychology & modern life.10th Ed. Harper-Collins.
5. Patterson, Lewis E.&Welfel, Elizabeth Reynold. 2000. The Counseling process – Hilgard.publishers.

OER:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

SEMESTER III

PCMBI20: MOLECULAR BIOLOGY AND MICROBIAL GENETICS

| | | | | | | | |
|--|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: II SEM: III | Course Code PCMBI20 | Title Of The Course Molecular Biology and Microbial Genetics | Course Type Theory | Course Category Core | H/W 6 | Credits 4 | Marks 100 |
|--|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide an insight into the various aspects of microbial genetics and be proficient on cloning vectors used in rDNA technology.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Discuss molecular mechanisms underlying mutations.

CO2: Explain the concepts of gene transfer mechanism in prokaryotes and eukaryotes.

CO3: Identify the role of plasmids as cloning vectors.

CO4: Evaluate on the role of transposable elements with gene mapping.

CO5: Analyse the control methods for gene expression.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | L | M | M | H | H |
| CO2 | H | L | H | L | M | H |
| CO3 | H | L | H | L | M | H |
| CO4 | H | L | M | M | H | H |
| CO5 | H | M | M | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | L | H | M | H | H |
| CO2 | H | L | H | M | M | H |
| CO3 | H | L | H | L | M | H |
| CO4 | H | L | H | M | H | H |
| CO5 | H | M | H | L | M | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Genetic Material and Mutations.

(15 hours)

1.1 Identification of Genetic Material (Griffith, Avery and Hershey and Chase Experiments).

(K1,K2)

1.2 Gene as a unit of mutation and Recombination. (K1,K2)

1.3 Mutagenesis, Mutations and Auxotrophic mutants. (K1,K2)

1.4 Spontaneous and induced mutations. (K1,K2)

1.5 Isolation of mutants, mutagenesis, reversion, suppression. (K1,K2, K3)

1.6 Genetic analysis of mutants. (K1,K2, K3, K4)

UNIT-II: Gene Transfer Mechanisms.**(15 hours)**

- 2.1 Transformation - competence cells. (K1,K2)
- 2.2 Regulation and importance of natural transformation. (K1,K2)
- 2.3 Transduction - general transduction. (K1,K2)
- 2.4 Transduction- specialized transduction. (K1,K2)
- 2.5 Conjugation - Hfr, Triparental mating. (K1,K2)
- 2.6 Self-transmissible and mobilizable plasmids – functions of pili. (K1,K2)

UNIT-III: Natural and Artificial Plasmids.**(15 hours)**

- 3.1 Biology of Plasmids – Extra chromosomal heredity - biology of bacterial plasmids. (K1,K2)
- 3.2 General Structure of the plasmids - F1 & ColE1 plasmids. (K1,K2)
- 3.3 Natural resistant plasmid - pSC101. (K1,K2)
- 3.4 Artificial cloning vector- pBR322. (K1,K2, K3,K4)
- 3.5 Ti plasmids. (K1,K2, K3,K4)
- 3.6 Replication of plasmid , control, partitioning, incompatibility and gene transfer methods. (K1,K2, K3, K4)

UNIT-IV: Transposable Elements and Gene Mapping.**(15 hours)**

- 4.1 Transposable genetic elements and Gene Mapping - Introduction - Discovery, insertion sequences. (K1,K2)
- 4.2 Complex and Compound transposons - T10, T5, and retroposon. (K1,K2)
- 4.3 Genetic mapping – *E. coli*. (K1,K2)
- 4.4 Virus T4 phage – using r II system. (K1,K2)
- 4.5 Bacteriophage vectors - λ phage. (K1,K2, K3,K4)
- 4.6 Bacteriophage vector- M13 phage. (K1,K2, K3,K4)

UNIT-V: Gene Regulation and Expression**(15 hours)**

- 5.1 Concept of gene and Gene regulation. (K1,K2)
- 5.2 Organization of gene in prokaryotes and eukaryotes. (K1,K2)
- 5.3 Introduction to Operon concept, lac and Trp operons, promoters and repressors. (K1,K2)
- 5.4 Regulation of gene expression. (K1,K2)
- 5.5 Transcriptional control – functions of promoters, terminators, attenuators. (K1,K2)
- 5.6 Induction and repression control mechanism. (K1,K2, K3, K4)

TEXT BOOKS

1. Robert H Tamarin (2002). Principles of Genetics. 7th edition, Tata McGraw Hill P. Ltd., New Delhi.
2. Benjamin A. Pierce (2002). Genetics: A Conceptual Approach. W.H.Freeman and Company, United States.
3. Brown T. A (2016). Gene cloning and DNA analysis- An introduction. 7th edition, Black wiley, United States.
4. Old R.S and Primrose S.B (2001). Principles of Gene Manipulation: An introduction to Genetic Engineering. 6th edition, Blackwell Scientific publication, London.

REFERENCE BOOKS

1. Gardner Simion Snustad (2005). Principles of Genetics. 8th edition, John Wiley and Sons Inc, New York.
2. Peter Snustad D and Michael J Simmons (2003). Principles of Genetics. 3rd edition, John Wiley and Sons, Inc. publication, New Delhi.
3. Bernad R Glick and Pasternak, J.J (2003). Molecular Biotechnology - Principles and Applications of Recombinant DNA.3rd edition, ASM Press, Washington, D.C.
4. Jogdnand S.N (2005). Gene biotechnology. 2nd edition, Himalaya Publishing House, Mumbai.
5. Satyanarayana U (2005). Biotechnology. 1st edition, Books and Allied (P) Ltd., Kolkata.
6. Dubey R.C (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.

OER:

VIDEOS/VIDEO LESSONS / E-CONTENT FOR LEARNING

1. <http://www.learnerstv.com/>
2. <http://webcast.berkeley.edu/>
3. <http://cosmolearning.org/>
4. <http://www.world-lecture-project.org/>
5. <http://cec.nic.in/>
6. <http://epgp.inflibnet.ac.in/>
7. <http://www.co-learn.in/>

PCMBJ20: ADVANCED MICROBIOLOGY

| | | | | | | | |
|--|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: II SEM: III | Course Code PCMBJ20 | Title Of The Course Advanced Microbiology | Course Type Theory | Course Category Core | H/W 6 | Credits 4 | Marks 100 |
|--|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide the learners an overview on the advanced aspects of Microbiology.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Utilize microorganisms in the preparation of cosmetics.

CO2: Evaluate the biological potential in samples return from satellites and solar system.

CO3: Discuss the role of antimicrobial fabrics, carpets, tiles and colorants.

CO4: Produce bacteriostatic sanitary napkins and towels.

CO5: Comprehend on paper, rubber and plastic Microbiology

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | L | H | M |
| CO2 | H | L | L | M | L | H |
| CO3 | H | H | M | H | L | H |
| CO4 | H | L | L | M | M | H |
| CO5 | H | H | M | H | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | M | L | H | M |
| CO2 | H | M | M | L | L | H |
| CO3 | H | H | M | H | L | H |
| CO4 | H | L | L | L | M | H |
| CO5 | H | H | M | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Cosmetic Microbiology.

(15 hours)

1.1 Definition; Preparations of Skin whitening compositions from microbes like Ascomycetes and Black yeast. (K1,K2, K3)

1.2 Preparations of Skin whitening compositions- enzymes. (K1,K2, K3)

1.3 Preparations of Skin whitening compositions- Mineral yeast ferments. (K1,K2,K3)

1.4 Microbial Production of Alpha Arbutin. (K1,K2,K3)

1.5 Microbial production of Hyaluronic acid. (K1,K2,K3)

1.6 Kojic acid and their use in Cosmetics preparations. (K1,K2)

UNIT–II: Space Microbiology. (15 hours)

- 2.1 Introduction to Space Microbiology. (K1,K2)
- 2.2 Monitoring of astronauts microbial flora. (K1,K2,K3)
- 2.3 Alterations in the load of medically important microorganisms. (K1,K2)
- 2.4 ESA STONE experiment. (K1,K2,K3,K4)
- 2.5 Evaluating the Biological Potential in Samples Returned from Planetary Satellites. (K1,K2, K3,K4)
- 2.6 Evaluating the Biological Potential of Small Solar System Bodies. (K1,K2,K3,K4)

UNIT–III: Textile Microbiology. (15 hours)

- 3.1 Introduction to Textile Microbiology. (K1,K2)
- 3.2 Antimicrobial fabrics. (K1,K2)
- 3.3 Antimicrobial garments. (K1,K2)
- 3.4 Antimicrobial carpets. (K1,K2)
- 3.5 Antimicrobial colorants. (K1,K2)
- 3.6 Bacteriostatic sanitary napkins and towels. (K1,K2,K3)

UNIT–IV: Paper and Rubber Microbiology. (15 hours)

- 4.1 Paper Microbiology- Introduction & Definition. (K1,K2)
- 4.2 Antimicrobial papers and its production. (K1,K2)
- 4.3 Antimicrobial currency. (K1,K2)
- 4.4 Rubber Microbiology – Introduction & Definition. (K1,K2)
- 4.5 Note on Antimicrobial rubbers. (K1,K2)
- 4.6 Antimicrobial rubber compositions. (K1,K2)

UNIT–V: Plastic Microbiology. (15 hours)

- 5.1 Definition- Bacteriostatic plastics. (K1,K2)
- 5.2 Antimicrobial plastic composition and production. (K1,K2)
- 5.3 Antiseptic plastics. Fungistatic plastics: Definition and production. (K1,K2)
- 5.4 Production of plastics materials from microorganisms. (K1,K2,K3)
- 5.5 Methods for producing anti-microbial plastic product. (K1,K2,K3,K4)
- 5.6 Plastic article containing a metallic bactericidal agent. Casein plastic. (K1,K2,K3)

TEXT BOOKS:

1. Vimaladevi M (2015) Text book of Herbal Cosmetics.1st edition, CBS Publishers and Distributors, New Delhi.
2. Alfonso F Davila (2010). Astromicrobiology.1st edition, John Wiley & Sons, Inc. New Delhi.
3. Srikanth Pilla (2011). Handbook of Bioplastics and Biocomposites Engineering and Applications.1st edition, John Wiley and Sons Inc., New Delhi.
4. Nierstrasz V and Cavaco Paulo A (2010). Advances in Textile Biotechnology. 1st edition, Elsevier, London.

REFERENCE BOOKS:

1. Philip A. Geis (2006) *Cosmetic Microbiology: A Practical Approach*. 2nd edition, CRC Press, Taylor and Francis Group, New York, London.
2. David M. Klaus (2003). *Space Microbiology: Microgravity and Microorganisms*. 1st edition, John Wiley & Sons, Inc. New Delhi
3. Ashish Kumar Sen (2007). *Coated Textiles: Principles and Applications*. 2nd edition, CRC Press, New Delhi
4. Tappi (2007). *Monograph on Microbiology of Papermaking systems*. Tappi publishers, New York.
5. Roberts A.D (1988). *Natural Rubber Science and Technology*. 1st edition, Oxford University Press. UK.
6. Chen, George Guo- Qiang (2010). *Plastics from Bacteria: Natural Functions and Applications*. 1st edition, Springer, United States.

OER:**DIGITAL LIBRARIES:**

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PCMBK20: RESEARCH METHODOLOGY

| | | | | | | | |
|---|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year : II SEM: III | Course Code PCMBK20 | Title Of The Course Research Methodology | Course Type Theory | Course Category Core | H/W 5 | Credits 4 | Marks 100 |
|---|-------------------------------|--|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide the learners knowledge about the concept of research, its importance and learn the art of thesis, paper writing and publication.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Explain basic concepts of research and its methodologies.

CO2: Identify the relationship between methodology, framework and data collection.

CO3: Analyze the diverse cases using statistical methods.

CO4: Use of digital library as a resource of microbiological research.

CO5: Discuss the principles and algorithms of pairwise and multiple alignments, and sequence database searching.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | L | L | H |
| CO2 | H | H | H | L | L | H |
| CO3 | H | H | H | L | L | H |
| CO4 | H | H | H | L | L | H |
| CO5 | H | H | H | L | L | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | L | H |
| CO2 | H | H | H | H | L | H |
| CO3 | H | H | H | H | L | H |
| CO4 | H | H | H | H | L | H |
| CO5 | H | H | H | H | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS:

UNIT-I: Methodologies in Research.

(15 hours)

- 1.1 Research Methodology - Meaning and importance. Statement, Constraints. (K1,K2)
- 1.2 Review of literature - Review and synopsis presentation. (K1,K2,K3,K4,K5,K6)
- 1.3 Types of research, Research tools, Qualities of a good researcher. (K1,K2,K3,K4,K5,K6)
- 1.4 Research process, Research designs – Experimental and non-experimental. (K1,K2,K3,K4,K5,K6)
- 1.5 Preparation of research report. Guidelines for preparing an article. (K1,K2,K3,K4,K5,K6)

1.6 Computers in biological research- Plagiarism checking softwares. (K1,K2,K3,K4,K5)

UNIT-II: Data Collection and Analysis. (15 hours)

2.1 Introduction to Data collection. (K1,K2)

2.2 Source of data- Primary and Secondary. (K1,K2,K3,K4,K5)

2.3 Types of classification of data. (K1,K2,K3,K4,K5)

2.4 Tabulation of data. (K1,K2,K3,K4,K5,K6)

2.5 Diagrammatic representation of data (line, bar diagram, pie diagram, pictogram and cartogram). (K1,K2,K3,K4,K5,K6)

2.6 Graphical representation of data. (K1,K2,K3,K4,K5,K6)

UNIT-III: Statistical Methodology-I. (15 hours)

3.1 Introduction to statistical methodology in research. (K1,K2)

3.2 Measures of central tendency – mean, median, mode. (K1,K2,K3,K4,K5)

3.3 Standard deviation. (K1,K2,K3,K4,K5)

3.4 Correlation – coefficient of correlation (Karl Pearson method, group bi –variable data). (K1,K2,K3,K4,K5)

3.5 Coefficient of variation. (K1,K2,K3,K4,K5)

3.6 Probability. (K1,K2,K3,K4)

UNIT-IV: Statistical Methodology-II. (15 hours)

4.1 ANOVA (one way and two ways). (K1,K2,K3,K4,K5)

4.2 Chi square test. (K1,K2,K3,K4,K5)

4.3 Student's T test. (K1,K2,K3,K4,K5)

4.4 Testing of hypothesis-null hypothesis- level of significance-standard error. (K1,K2,K3,K4,K5)

4.5 F Test Web. (K1,K2,K3,K4,K5)

4.6 Resources for Microbiology – Use of Digital Library. (K1,K2,K3,K4)

UNIT-V: Bioinformatics. (15 hours)

5.1 Bioinformatics - Introduction and skills for a bioinformatician. (K1,K2)

5.2 Biological databases- An introduction. (K1,K2,K3)

5.3 Database searching, Sequence analysis, Pair alignment. (K1,K2,K3,K4)

5.4 Visualizing protein structures. (K1,K2,K3,K4)

5.5 Predicting structure and function of protein using sequences. (K1,K2,K3,K4)

5.6 Tools for genomics and proteomics. (K1,K2,K3,K4)

TEXT BOOKS:

1. Kothari, C.R., (1988). Research methodology, 2nd edition. Wiley Eastern Ltd., New Delhi.
2. Anderson, J., Duros, B.H. and Poole, M. (1986). Thesis and assignment writing, 1st edition, Wiley Eastern Ltd., New Delhi.
3. Gurumani N. (2002). Research Methodology for Biological sciences, MJP publishers, Chennai. 2006.

REFERENCES BOOKS:

1. Frederic H. Erbisch, Karim M. Maredia (2004). “Intellectual Property Rights in Agricultural Biotechnology”, CABI Publisher. London
2. Felix Thiele, Richard E. Ashcroft (2005). “Bioethics in a Small World”. Springer. USA
3. John Bryant (2002) “Bioethics for Scientists”. John Wiley and Sons Publisher. New York
4. Mittal D.P. (1999). “Indian Patents Law”. Taxmann Allied Services (p) Ltd. New Delhi

OER:**DIGITAL LIBRARIES:**

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PEMBE20 – ELECTIVE III A: BIOINOCULANTS TECHNOLOGY

| | | | | | | | |
|---------------------------|-------------------------------|--|------------------------------|---|-----------------|---------------------|---------------------|
| Year: II | Course Code PEMBE20 | Title Of The Course Bioinoculants Technology | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
|---------------------------|-------------------------------|--|------------------------------|---|-----------------|---------------------|---------------------|

Course Objective:

To provide the learners an overview on the potentials of microbes as fertilizers and their beneficial impacts in soil and agriculture.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the importance of bioinoculant technology and discuss on the significance of biofertilizers.

CO2: Demonstrate the mass production and applications of bio fertilizer and their impact on plant growth.

CO3: Identify in-depth information on the mycorrhizal taxonomy, occurrence and distribution.

CO4: Explain the types of mycorrhizal associations and quantification.

CO5: Formulate the growth of phosphate solubilizing microbes.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | M | L | H |
| CO2 | H | H | H | L | L | H |
| CO3 | H | M | M | H | M | H |
| CO4 | H | M | H | H | M | H |
| CO5 | H | M | H | M | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | H | H | L | H |
| CO2 | H | L | H | M | L | H |
| CO3 | H | M | H | L | L | H |
| CO4 | H | H | H | M | L | H |
| CO5 | H | L | H | L | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS:

UNIT– I: Symbiotic Bacterial N₂ fixers.

(9 hours)

1.1 General account of the microbes used as biofertilizers for crop plants. (K1,K2)

1.2 Advantages of Biofertilizers over chemical fertilizers. (K1,K2)

1.3 Symbiotic N₂ fixers: Rhizobium - Isolation, characterization, identification, classification. (K1,K2, K3,K4)

1.4 Inoculum production and field application. (K1,K2,K3,K4,K6)

- 1.5 Frankia - Isolation, characterization. (K1,K2,K3,K4)
1.6 Actinorrhizal nodules – non-leguminous crop symbiosis. (K1,K2)

UNIT – II: Non Symbiotic N₂ fixers. (9 hours)

- 2.1 Introduction to non-symbiotic N₂ fixation. (K1,K2)
2.2 Non - Symbiotic N₂ fixers – Azospirillum. (K1,K2)
2.3 Free living - Azotobacter . (K1,K2)
2.4 Isolation of free living nitrogen fixers from soil. (K1,K2,K3)
2.5 Characterization of non-symbiotic N₂ fixers. (K1,K2,K3)
2.6 Mass inoculum production and field application. (K1,K2, K3, K4,K6)

UNIT – III: Algal Biofertilizers. (9 hours)

- 3.1 Symbiotic N₂ fixers – Cyanobacteria. (K1,K2)
3.2 Azolla – Isolation and characterization. (K1,K2,K3)
3.3 Mass multiplication- production. (K1,K2,K3,K4)
3.4 Role of Azolla in rice cultivation .(K1,K2)
3.5 Crop response to algal biofertilizers. (K1,K2)
3.6 Field application - immobilization. (K1,K2,K3)

UNIT – IV: Phosphate Solubilizers. (9 hours)

- 4.1 Phosphate solubilizers - Phosphate solubilizing microbes. (K1,K2)
4.2 Isolation of phosphate solubilizers from soil. (K1,K2,K3,K4)
4.3 Characterization of phosphate solubilizers, (K1,K2, K3,K4)
4.4 Mass inoculum production. (K1,K2, K3,K4)
4.5 Field application and crop response. (K1,K2,K3)
4.6 Mechanism of Phosphate solubilization. (K1,K2)

UNIT – V: Mycorrhizal Biofertilizers. (9 hours)

- 5.1 Mycorrhizal bioinoculants – classification. (K1,K2)
5.2 Importance of mycorrhizal Ectomycorrhizae - Endomycorrhizae - Ectendo mycorrhizae - Taxonomy of mycorrhizae. (K1,K2)
5.3 Isolation of VA mycorrhizae. (K1,K2, K3,K4)
5.4 Quantification and assessment of VAM in roots . (K1,K2,K3,K4)
5.5 Mass inoculum production of VAM . (K1,K2,K3,K4,K6)
5.6 Field applications and advantages of Ectomycorrhizae and VAM. (K1,K2,K3)

TEXT BOOKS

1. Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.
2. Dubey R.C (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.
3. Subba Rao NS (2004). Soil Microbiology. 4th edition, Oxford and BH Publishing Co.Pvt. Ltd., New Delhi.

REFERENCES:

1. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
2. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
3. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
4. Subba Rao N.S. (1988) Biofertilizers in Agriculture and forestry Oxford and IBH Publishing Co., Ltd., New Delhi.

OER:**DIGITAL LIBRARIES:**

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

**PEMBF20 - ELECTIVE III B: FUNGAL BIOTECHNOLOGY AND
BIOPROSPECTING**

| | | | | | | | |
|--|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|
| Year: II SEM: III | Course Code PEMBF20 | Title Of The Course Fungal biotechnology and bioprospecting | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
|--|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|

Course Objective:

This paper is designed to provide an exposure to the students about the potential of fungi as food and in field of biotechnology as source of different enzymes, secondary metabolites, vitamins, polysaccharides, polyhydric alcohols, pigments, lipids, glycolipids, biofertilizers and biopesticides.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Perform screening and strain development for production of different bio-molecules.

CO2: Design a bioreactor with special emphasis on fungal systems.

CO3: Comprehend about different secondary metabolites of fungal origin.

CO4: Demonstrate methods of recombinant technology with special emphasis on fungal system.

CO5: Explain the role of fungi in food and feed industries.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | H | M | H |
| CO2 | H | M | M | L | H | H |
| CO3 | H | M | M | L | H | H |
| CO4 | H | M | M | L | H | H |
| CO5 | H | H | H | L | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | M | H |
| CO2 | H | M | M | H | H | H |
| CO3 | H | M | M | H | H | H |
| CO4 | H | M | M | H | H | H |
| CO5 | H | H | H | H | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT- I: Fungal diversity and industrial important fungal strains. (9 hours)

1.1 Fungal diversity; habitat relationship. (K1,K2)

1.2 Different ecological groups of fungi Ecotaxonomic approach in chemical screening. (K1,K2)

1.3 Primary and secondary products of metabolism; Screening of industrially useful fungal metabolites. (K1,K2)

1.4 Classification of secondary metabolites in fungi. (K1,K2)

1.5 Primary and secondary screening of antibiotic producers; auxanography; enrichment culture. (K1,K2, K3,K4)

1.6 Industrial important fungal strains. (K1,K2)

UNIT- II: Fungal Biotechnology. (9 hours)

1.1 Fungal Biotechnology: Fungal biotechnological processes, Principles of fermenter design and operation with respect to Fungal process. (K1,K2)

1.2 Types of fermenters used in Fungal Biotechnology, formulation of fermentation medium. (K1,K2,K3,K4,K6)

1.3 Analysis of fermentation products especially for fungal biotechnology. (K1,K2K3,K4)

1.4 Techniques for strain improvement and strain development. (K1,K2,K3,K4)

1.5 Recombinant technology in fungi: composition of the different types of fungal vectors, selection markers, transformation strategies. (K1,K2,K3,K4,K5,K6)

1.6 Gene replacement or inactivation, applications and future perspectives. (K1,K2,K3,K4)

UNIT- III: Edible fungi. (9 hours)

3.1 Introduction to Edible fungi; Mycoproteins. (K1,K2)

3.2 Advancement in mushroom cultivation technology. (K1,K2,K3)

3.3 Commercial mushroom species. (K1,K2)

3.4 Strain improvement and cultivation. (K1,K2, K3)

3.5 Tropical mushrooms and their cultivation; mushroom spawns. (K1,K2, K3, K4)

3.6 Nutritional and medicinal values of mushrooms. (K1,K2)

UNIT- IV: Fungi in food processing and agriculture application. (9 hours)

4.1 Introduction to food processing technology. (K1,K2)

4.2 Fungi in food processing, (K1,K2)

4.3 Fungus for Biomass pretreatment for ethanol production. (K1,K2)

4.4 Fungi in agriculture application. (K1,K2)

4.5 Fungal biofertilizers and Biopesticides. (K1,K2, K3)

4.6 Myconematicides . (K1,K2)

UNIT-V: Biotechnological application of fungi. (9 hours)

5.1 Biotechnological applications of fungi and their derivatives. (K1,K2,K3)

5.2 Production of Industrially important products from fungi-organic acids (citric acid). (K1,K2,K3)

5.3 Production of enzymes from fungi (cellulase xylanase, amylase, protease). (K1,K2, K3)

5.4 Applications of Fungi in medical and pharmaceutical products. (K1,K2,K3)

5.5 Production of antibiotic (Penicillin). (K1,K2,K3)

5.6 Vitamins and therapeutic peptides from fungi. (K1,K2)

TEXT BOOKS:

1. Poonam Singh & Ashok Pandey, Biotechnology for agro-Industrial residues utilisation. (2009), Springer.
2. Satyanarayana T. and Johri B.N. (2005). Microbial diversity, Current Perspectives and Potential Applications , IK international

REFERENCE BOOKS:

1. Nair, L. N. (2007). Topics in Mycology and Pathology, New Central Book agency, Kolkata.
2. Oliver R. P. and Michael Schweizer (1999). Molecular Fungal Biology, CUP.
2. Berry D. R. (1988). Physiology of industrial Fungi, Blackwell Scientific Publishers.
3. Zhingiang Ann (2005). Handbook of Industrial Mycology, CRC Press

OER:**DIGITAL LIBRARIES:**

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

SEMESTER IV

PCMBL20 - MICROBIAL GENE TECHNOLOGY

| | | | | | | | |
|---|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: II SEM: IV | Course Code PCMBL20 | Title Of The Course Microbial Gene Technology | Course Type Theory | Course Category Core | H/W 6 | Credits 4 | Marks 100 |
|---|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide the learners an insight on the concepts of genetic engineering and techniques employed in recombinant DNA technology.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Analyze the various techniques involved in identification and quantification of nucleic acids.

CO2: Utilize the tools and techniques of genetic engineering and the role of DNA manipulative enzymes.

CO3: Compile DNA sequencing methods.

CO4: Explain about genomic libraries and artificial chromosomes.

CO5: Discuss the modern tools and techniques of genomics and application of antisense technologies.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | M | L | M |
| CO2 | H | H | H | L | L | M |
| CO3 | H | H | H | M | M | L |
| CO4 | H | H | H | H | M | M |
| CO5 | H | H | H | L | L | M |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | L | L | H |
| CO2 | H | H | H | L | M | H |
| CO3 | H | H | H | L | M | M |
| CO4 | H | H | H | M | L | H |
| CO5 | H | H | H | L | M | M |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Gene Analysis and Techniques.

(15 hours)

1.1 Isolation of DNA and RNA from microbes. (K1,K2, K3, K4)

1.2 Handling & Quantification of Nucleic acids.. (K1,K2,K3,K4)

1.3 Radiolabelling of Nucleic acids - End labeling - Nick translation - Labelling by primer extension. (K1,K2, K3,K4)

1.4 PAGE and its applications. (K1,K2)

1.5 Nucleic acid hybridization- colony and plaque hybridization. (K1,K2, K3)

1.6 Blotting techniques – Southern, northern and western blots. (K1,K2, K3)

UNIT-II: DNA manipulative enzymes (15 hours)

2.1 DNA manipulative enzymes - Restriction enzymes : Nomenclature - Classification - restriction and DNA Methylation . (K1,K2)

2.2 Type II restriction endonuclease - use of type II restriction endonucleases in gene cloning. (K1,K2)

2.3 Restriction mapping and its applications. (K1,K2)

2.4 DNA modifying enzymes, helicase, gyrase & topoisomerases. (K1,K2)

2.5 Polymerases – DNA polymerases, Klenow polymerase and Reverse Transcriptase. (K1,K2)

2.6 DNA ligases and its function. (K1,K2)

UNIT-III: DNA sequence analysis (15 hours)

3.1 DNA sequence analysis: Maxam - Gilbert (Chemical) sequencing - Sangar - Coulson (DiDeoxy/enzymatic) sequencing . (K1,K2, K3,K4)

3.2 Automated DNA sequencing. (K1,K2,K3)

3.3 Genome sequencing by Physical Mapping of genomes. (K1,K2)

3.4 PCR - methods and its application. (K1,K2, K3)

3.5 DNA fingerprinting in forensic application. (K1,K2)

3.6 RFLP - Microarray and its applications. (K1,K2)

UNIT-IV: Vectors and gene libraries (15 hours)

4.1 Vectors - nature - uses of vectors- types of vectors . (K1,K2)

4.2 Plasmids, Bacteriophages , Cosmid and Shuttle vectors - An introduction. (K1,K2)

4.3 Cloning strategies – Screening, selection and isolation of recombinants clones. (K1,K2,K3,K4)

4.4 Gene libraries - Genomic and cDNA. (K1,K2)

4.5 Artificial chromosomes – BAC. (K1,K2)

4.6 Artificial chromosomes - YAC. (K1,K2)

UNIT-V: Gene Annotations and Nanobiologics (15 hours)

5.1 Gene Annotations. (K1,K2)

5.2 Gene silencing. (K1,K2)

5.3 Human Genome Project. (K1,K2)

5.4 Legal aspects of rDNA technology and cloning. (K1,K2, K3)

5.5 Recombinant DNA products and applications – Humulin, Hepatitis B antigen vaccine, TPA. (K1,K2, K3, K4)

5.6 Nanobiologics - Bioactive peptides as hormones, antimicrobials, vaccines, drug carriers and therapeutics. (K1,K2, K3)

TEXT BOOKS:

1. Brown T. A (2016). Gene cloning and DNA analysis- An introduction. 7th edition, Black wiley, United States.
2. Old R.S and Primrose S.B (2001). Principles of Gene Manipulation: An introduction to Genetic Engineering. 6th edition, Blackwell Scientific publication, London.

REFERENCE BOOKS:

1. Jogdnand S.N (2005). Gene biotechnology. 2nd edition, Himalaya Publishing House, Mumbai.
2. Satyanarayana U (2005). Biotechnology. 1st edition, Books and Allied (P) Ltd., Kolkata.
3. Dubey R.C (2005). A Text of Biotechnology. Multicolour Illustrative edition, S.Chand and Company Ltd., New Delhi.
4. Bernad R Glick and Pasternak, J.J (2003). Molecular Biotechnology - Principles and Applications of Recombinant DNA. 3rd edition, ASM Press, Washington, D.C.

OER:**VIDEOS/VIDEO LESSONS / E-CONTENT FOR LEARNING**

1. <http://www.learnerstv.com/>
2. <http://webcast.berkeley.edu/>
3. <http://cosmolearning.org/>
4. <http://www.world-lecture-project.org/>
5. <http://cec.nic.in/>
6. <http://epgp.inflibnet.ac.in/>
7. <http://www.co-learn.in/>

PCMBM20 - BIOETHICS AND BIOSAFETY

| | | | | | | | |
|---------------------------|-------------------------------|---|------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: II | Course Code PCMBM20 | Title Of The Course Bioethics and Biosafety | Course Type Theory | Course Category Core | H/W 6 | Credits 4 | Marks 100 |
| SEM: IV | | | | | | | |

Course Objective:

To provide the learners knowledge about biosafety concerns at the level of individuals, institution, society, region, country and the world.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the principles of bioethics and explain the biosafety concerns with safeguard measures.

CO2: Compile the BSA statement for the industrial production of pharmaceuticals.

CO3: Adapt the WHO quality standards in food process technology.

CO4: Discuss on the global scenario of patenting.

CO5: Comprehend the forms of patents, patentability and process of patenting.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|------------|------|------|------|------|------|------|
| CO1 | H | H | M | M | M | H |
| CO2 | H | H | M | L | L | H |
| CO3 | H | M | L | H | M | H |
| CO4 | H | M | L | H | M | H |
| CO5 | H | H | M | M | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|------------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | L | H | H |
| CO2 | H | H | H | M | L | H |
| CO3 | H | H | H | L | M | H |
| CO4 | H | M | H | L | M | H |
| CO5 | H | H | H | L | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Principles of Bioethics.

(15 hours)

- 1.1 Definition- Bioethics. (K1,K2)
- 1.2 Legality, morality and ethics- An introduction (K1,K2)
- 1.3 Introduction to the principles of Bioethics. . (K1,K2)
- 1.4 Principles of autonomy. . (K1,K2)
- 1.5 Human rights. . (K1,K2)
- 1.6 Beneficence and privacy justice equality. . (K1,K2)

UNIT-II: Biosafety concerns. (15 hours)

- 1.1 Introduction to Biosafety. . (K1,K2)
- 1.2 Concept and issues of Biosafety. . (K1,K2)
- 1.3 Rational Vs subjective perceptions of risks and benefits. . (K1,K2)
- 1.4 Relationship between risk hazard, exposure, and safe guard. . (K1,K2)
- 1.5 Biosafety concerns at the level of individuals, institutions, society, region, country and the world. . (K1,K2,K3)
- 1.6 Lab associated infections. . (K1,K2,K4)

UNIT-III: Statement of Ethical practice (15 hours)

- 3.1 Introduction to BSA. . (K1,K2)
- 3.2 History of BSA. (K1,K2)
- 3.3 British Sociological Association (BSA) statement of ethical practices of biotechnology in the production of pharmaceutical products. . (K1,K2)
- 3.4 BSA statement ethical practices of biotechnology in the production of drugs. . (K1,K2,K3)
- 3.5 BSA statement ethical practices of biotechnology in the production vaccines . (K1,K2,K3)
- 3.6 BSA statement ethical practices of biotechnology in the production biomolecules. (K1,K2,K3)

UNIT-IV: WHO quality standards. (15 hours)

- 4.1 Introduction to WHO and its functions. (K1,K2)
- 4.2 WHO standards – Quality control. (K1,K2,K3)
- 4.3 Quality control in food process technology. (K1,K2,K3,K4,K5)
- 4.4 Quality control in dairy product technology. (K1,K2,K3,K4,K5)
- 4.5 Quality control for potable water. (K1,K2,K3,K4,K5)
- 4.6 Quality control measures in pharmaceutical industries. (K1,K2,K3,K4,K5)

UNIT-V: IPR and Patenting. (15 hours)

- 5.1 Introduction to IPR and Patenting. (K1,K2)
- 5.2 GATT and IPR, forms of IPR, IPR in India, WTO Act. (K1,K2,K3,K4,K5)
- 5.3 Convention on Biodiversity (CBD), Patent Co-operation Treaty (PCT). (K1,K2,K3,K4,K5)
- 5.4 Forms of patents and patentability, process of Patenting. (K1,K2,K3,K4,K5)
- 5.5 Indian and international agencies involved in IPR & patenting. (K1,K2,K3,K4,K5)
- 5.6 Global scenario of patents and India's position, patenting of biological material, GLP, GMP. (K1,K2,K3,K4,K5)

TEXT BOOKS:

1. Frederic H. Erbisch, Karim M. Maredia (2004). Intellectual Property Rights in Agricultural Biotechnology, CABI Publisher.
2. John Bryant (2002) Bioethics for Scientists. John Wiley and Sons Publisher.

REFERENCES BOOKS:

1. Mittal D.P. (1999). Indian Patents Law. Taxmann Allied Services (p) Ltd.
2. Christian Lenk, Nils Hoppe, Roberto Andorno (2007). Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology, Ashgate Publisher (p) Ltd.
3. Felix Thiele, Richard E. Ashcroft (2005). Bioethics in a Small World. Springer.

OER:**DIGITAL LIBRARIES:**

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PEMBG20: ELECTIVE IV-A: TAXONOMY AND MICROBIAL BIODIVERSITY

| | | | | | | | |
|---------------------------|-------------------------------|---|------------------------------|---|-----------------|---------------------|---------------------|
| Year: II | Course Code PCMBG20 | Title Of The Course Taxonomy and Microbial Biodiversity | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
| SEM: IV | | | | | | | |

Course Objective:

The aim of the course is to impart knowledge on Microbial diversity, principles of classification, rules and its applications.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Introduce Microbial classification and Taxonomy.

CO2: Describe the classification system in prokaryotes.

CO3: Comprehend the classification of virus.

CO4: Discuss on the eukaryotic diversity and endosymbiotic theories.

CO5: Compile cytology of algae and protozoa.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | H | M | L | H |
| CO2 | H | H | H | L | L | H |
| CO3 | H | M | M | H | M | H |
| CO4 | H | M | H | H | M | H |
| CO5 | H | M | H | M | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | H | H | L | H |
| CO2 | H | L | H | M | L | H |
| CO3 | H | M | H | L | L | H |
| CO4 | H | H | H | M | L | H |
| CO5 | H | L | H | L | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT- I: Introduction to microbial Classification.

(9 hours)

- 1.1 An Introduction to Microbial Classification. (K1,K2)
- 1.2 Taxonomy and Taxonomic Ranks. (K1,K2)
- 1.3 Techniques used for determination of Microbial Taxonomy. (K1,K2)
- 1.4 Phylogenetic analysis method. (K1,K2, K3,K4)
- 1.5 Systems of Prokaryotic phylogeny. (K1,K2,K3,K4)
- 1.6 Systems of Eukaryotic Phylogeny. (K1,K2,K3,K4)

UNIT- II: Classification system in prokaryotes. (9 hours)

- 2.1 Classification systems in Prokaryotes, Bergey's Manual of Systematic Bacteriology. (K1,K2)
- 2.2 Prokaryotic groups with unusual characteristics: Cyanobacteria. (K1,K2)
- 2.3 Green and Purple sulphur bacteria, Gliding bacteria. (K1,K2)
- 2.4 Rickettsia and Chlamydia. (K1,K2)
- 2.5 Actinomycetes. (K1,K2)
- 2.6 Archaea- Classification, Significance. (K1,K2)

UNIT-III: Viruses. (9 hours)

- 3.1 Viruses - Definition, Viroids and Prions. (K1,K2)
- 3.2 Classification systems of Viruses-LHT, Baltimore. (K1,K2)
- 3.3 General Structure and properties of viruses. (K1,K2)
- 3.4 Concepts of Lytic and Lysogenic life cycles. (K1,K2)
- 3.5 Basic Concepts of Virus cultivation- An introduction. (K1,K2)
- 3.6 Egg inoculation, cell culture and Tissue culture techniques. (K1,K2)

UNIT- IV: Eukaryotic diversity. (9 hours)

- 4.1 Eukaryotic Diversity- Three Domains of Life. (K1,K2)
- 4.2 Endosymbiotic theories, Eukaryotic cell cycle and Cell division – Mitosis and Meiosis. (K1,K2)
- 4.3 Fungi: Distribution and importance. (K1,K2)
- 4.4 Morphology of fungi –cell wall structure, fungal thallus and filamentous. (K1,K2)
- 4.5 Cytology of fungi- Mitochondria, Golgi bodies- Endoplasmic reticulum. (K1,K2)
- 4.6 Recent classification of fungi. Study of yeasts and molds. (K1,K2)

UNIT-V: Algae and protozoa. (9 hours)

- 5.1 Algae: photosynthetic protists. (K1,K2)
- 5.2 Algal classification with their characteristics features. (K1,K2)
- 5.3 Type of vegetative forms- heterocyst and non-heterocyst forms. (K1,K2)
- 5.4 Cytology of algae- pigment and cell inclusions. Distribution and importance. (K1,K2)
- 5.5 Classification of protozoa. Morphology of protozoa – shapes and size. (K1,K2)
- 5.6 Cytology of protozoa- Body covering and skeletons, locomotory and internal organelles. (K1,K2)

TEXT BOOKS:

1. Willey, Joanne M. (2014). Prescott's Microbiology. 9th Edition: McGraw-Hill Education – Europe.
2. Kathleen Park Talaro (2011) , Foundations in Microbiology . 8th International edition, McGraw Hill.

REFERENCE BOOKS:

1. R.C. Dubey . (2007). A Textbook of Biotechnology, 4th edition, First Multicolor Illustrative Edition, Reprint
2. Michael.T.Madigan, John.M.Martinko, Paul V. (2009). Brock Biology of Microorganisms. 12th edition .Pearson Benjamin Cummings.
3. Gerard J.Tortora, BerdellR.Funke, Christine L. Case (2008) Microbiology – An Introduction, , 10th ed., Pearson Education.

OER:**DIGITAL LIBRARIES:**

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PEMBH20 - ELECTIVE IV-B: MICROBIAL NANOTECHNOLOGY

| | | | | | | | |
|---------------------------|-------------------------------|--|------------------------------|---|-----------------|---------------------|---------------------|
| Year: II | Course Code PCMBH20 | Title Of The Course Microbial Nanotechnology | Course Type Theory | Course Category Core Elective | H/W 3 | Credits 3 | Marks 100 |
| SEM: IV | | | | | | | |

Course Objective:

To provide in depth knowledge on microbial bionanotechnology.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the history of bionanotechnology.

CO2: Describe about molecular nanotechnology and microbial synthesis of nanoparticles.

CO3: Discuss on types, function and characterization of nanoparticles.

CO4: Comprehend the use of nanoparticles in cancer therapy and in biology.

CO5: Elaborate the advantages and disadvantages of nanoparticles.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | M | M | H |
| CO2 | H | H | H | L | L | M |
| CO3 | H | M | M | H | L | M |
| CO4 | H | M | H | H | M | M |
| CO5 | H | L | M | M | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | L | M | H |
| CO2 | H | H | H | L | L | M |
| CO3 | H | H | H | L | L | M |
| CO4 | H | H | H | M | M | M |
| CO5 | H | H | H | M | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: History of Bionanotechnology.

(9 hours)

- 1.1 Introduction and History of bionanotechnology. (K1,K2)
- 1.2 Concept and future prospects of bionanotechnology. (K1,K2)
- 1.3 Application of nanotechnology in Life Sciences. (K1,K2)
- 1.4 Terminologies – nanotechnology Vs bionanotechnology, (K1,K2)
- 1.5 Nanomedicine and Nanowires. (K1,K2,K3,K4)
- 1.6 Quantum Dots, nanocomposite, nanoparticles. (K1,K2,K3,K4)

UNIT- II: Molecular nanotechnology. (9 hours)

- 2.1 Molecular nanotechnology - nanomachines - collagen. (K1,K2)
- 2.2 Uses of nanoparticles - cancer therapy. (K1,K2)
- 2.3 Manipulation of cell and biomolecules. (K1,K2)
- 2.4 Cytoskeleton and cell organelles. (K1,K2)
- 2.5 Types of nanoparticles production - physical, chemical and biological. (K1,K2)
- 2.6 Microbial synthesis of nanoparticles. (K1,K2, K3,K4)

UNIT-III: Types and characterization of nanoparticles. (9 hours)

- 3.1 Nanoparticles - types, functions - Silver, Gold and Titanium. (K1,K2)
- 3.2 Physical and chemical properties of nanoparticles. (K1,K2)
- 3.3 Characterization of nanoparticles - UV-Vis spectroscopy. (K1,K2, K3,K4)
- 3.4 Characterization of nanoparticles Electron Microscopy - HRTEM, SEM. (K1,K2, K3,K4)
- 3.5 Characterization of nanoparticles AFM. (K1,K2, K3,K4)
- 3.6 Characterization of nanoparticles EDS and XRD. (K1,K2, K3,K4)

UNIT-IV: Uses of nanoparticles in biology. (9 hours)

- 4.1 Uses of nanoparticles in biology. (K1,K2)
- 4.2 Drug delivery - protein mediated and nanoparticle mediated. (K1,K2, K3)
- 4.3 Uses of nanoparticles in MRI, DNA and Protein Microarrays. (K1,K2, K3)
- 4.4 Nanotechnology in health sectors. (K1,K2, K3)
- 4.5 Toxicology in nanoparticles. (K1,K2)
- 4.6 Dosimetry. (K1,K2, K3)

UNIT-V: Advantaged and disadvantages of nanoparticles. (9 hours)

- 5.1 Advantages of nanoparticles. (K1,K2)
- 5.2 Drug targeting, protein detection and MRI. (K1,K2, K3,K4)
- 5.3 Development of green chemistry. (K1,K2)
- 5.4 Commercial viability of nanoparticles. (K1,K2)
- 5.5 Disadvantages - health risk associated with nanoparticles. (K1,K2)
- 5.6 Adequate and inadequate knowledge on nanoparticles research. (K1,K2)

TEXT BOOKS:

1. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan & Claypool Publishers.
2. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Global Prospects. CRC Press.

REFERENCES BOOKS:

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
3. Ehud Gazit (2006). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press.

OER:

DIGITAL LIBRARIES:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PCMBN20 - MAIN PRACTICAL – III: GENETIC ENGINEERING

| | | | | | | | |
|---------------------------|-------------------------------|--|---------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: II | Course Code PCMBN20 | Title Of The Course Main Practical III: Genetic Engineering | Course Type Practical | Course Category Core | H/W 5 | Credits 5 | Marks 100 |
|---------------------------|-------------------------------|--|---------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide hands-on training and acquire adequate skill required to isolate, demonstrate and quantitate nucleic acids, transfer DNA to bacteria and separate biomolecules by electrophoresis.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Utilize technical skills in isolation of DNA, their quantification and plasmid.

CO2: Analyse gene transfer mechanism and protein.

CO3: Use the basic skill on blotting techniques & PCR.

CO4: Select methods for the immobilization of enzymes.

CO5: Demonstrate the process of induction of mutation.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | H | L | H |
| CO2 | H | H | H | L | M | H |
| CO3 | H | H | M | M | L | H |
| CO4 | L | H | H | H | L | H |
| CO5 | L | H | M | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | M | H | L | H |
| CO2 | H | H | H | L | L | H |
| CO3 | H | M | M | M | L | H |
| CO4 | H | M | H | H | L | H |
| CO5 | H | M | M | L | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

1. Isolation of DNA and RNA from microbial system - quantification - chemical methods dinitrophenol, orcinol - physical methods - UV absorption.
2. Isolation of plasmid DNA from bacteria.
3. Size characterization of DNA by agarose gel electrophoresis.
4. Enzyme immobilization technique.
5. Induction of mutation by ultra-violet radiation and chemical mutagens.

6. Preparation of competent *E. coli* cells.
7. Transformation of Plasmid DNA to the *E. coli* cells.
8. Southern blotting
9. Western blotting.
10. Separation of proteins by SDS - PAGE
11. PCR amplification – Demonstration.

REFERENCE BOOKS :

1. Ausubel, F.M., Roger, B., Robert E. Kingston, David A. Moore, Seidman J.G., John A. Smith. and Kelvin, S. 1992. Third Edition, Short Protocols in Molecular Biology, John Wiley & Sons Inc., New York.
2. Berger, S.L. and Kimmel, R. 1987. Guide to Molecular Cloning Techniques, Academic Press, Inc., New York.
3. Brown, T.A. 1998. Molecular Biology Lab Fax 11 Gene Analysis, Academic Press, London.
4. Cappuccino, J.H. and Sherman, N 2007. Microbiology – A Lab Manual, seventh Edition, the Benjamin Publishing Company, Singapore.
5. Malov, S.R. 1990. Experimental Techniques in Bacterial Genetics, Jones and Bartlett Publishers, Boston.
6. Miller, J.H. 1992. A Short Course in Bacterial Genetics: A Lab Manual & Hand Book for *E. coli* and related Bacteria. Cold Spring Harbor Lab press, Cold Spring Harbour.

OBE:

VIDEOS/VIDEO LESSONS / E-CONTENT FOR LEARNING:

1. <http://www.learnerstv.com/>
2. <http://webcast.berkeley.edu/>
3. <http://cosmolearning.org/>
4. <http://www.world-lecture-project.org/>
5. <http://cec.nic.in/>
6. <http://epgp.inflibnet.ac.in/>
7. <http://www.co-learn.in/>

PCMBO20 - MAIN PRACTICAL – IV: TEXTILE AND COSMETIC

MICROBIOLOGY

| | | | | | | | |
|---|-------------------------------|--|---------------------------------|--------------------------------|-----------------|---------------------|---------------------|
| Year: II SEM: IV | Course Code PCMBO20 | Title Of The Course Main Practical IV: Textile and cosmetic Microbiology | Course Type Practical | Course Category Core | H/W 5 | Credits 5 | Marks 100 |
|---|-------------------------------|--|---------------------------------|--------------------------------|-----------------|---------------------|---------------------|

Course Objective:

To provide hands-on training and acquire adequate skill required for testing the quality of cosmetics and textile materials.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Utilize the techniques for decolourization of textile industrial waste.

CO2: Estimate of BOD, COD and total solids in effluent sample.

CO3: Demonstrate the antimicrobial activity of textile materials.

CO4: Evaluate the antifungal property of treated textile materials.

CO5: Enumerate microorganisms in cosmetics, perfumes and essential oils.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | H | L | H |
| CO2 | H | H | H | L | M | H |
| CO3 | H | H | M | M | L | H |
| CO4 | L | H | H | H | L | H |
| CO5 | L | H | M | L | M | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | M | M | H | L | H |
| CO2 | H | H | H | L | L | H |
| CO3 | H | M | M | M | L | H |
| CO4 | H | M | H | H | L | H |
| CO5 | H | M | M | L | L | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

1. Determination of biological oxygen demand (BOD) of water.
2. Determination of chemical oxygen demand (COD) of water.
3. Estimation of total solids in effluent sample.
4. Analysis of TDS of effluent content.
5. Estimation of total suspended solids of effluent.
6. Decolorization of distillery or textile industrial waste.
7. Antibacterial activity assessment of textile materials.
8. Evaluation of antifungal property of treated textile materials.

9. Testing for antibacterial activity and efficacy on textile products, Qualitative and quantitative.
10. Determination of antibacterial activity of Textile fabrics by Agar diffusion plate test.
11. Microbiological Enumeration Tests of Cosmetics, Perfumes and Essential Oils.

REFERENCES:

1. R.C. Dubey and D.K.Maheswari. (2005) Practical Microbiology. S.Chand & Company.
2. S.Rajan and R.Selvi Christy. (2007) Experimental Procedures in Life Sciences. Anjana Book House Publishers & Distributors.
3. Philip A. Geis. (2006). Cosmetic Microbiology. A Practical Approach. 2nd edition. Taylor and Francis Group.

OER:

VIDEOS/VIDEO LESSONS / E-CONTENT FOR LEARNING:

1. <http://www.learnerstv.com/>
2. <http://webcast.berkeley.edu/>
3. <http://cosmolearning.org/>
4. <http://www.world-lecture-project.org/>
5. <http://cec.nic.in/>
6. <http://epgp.inflibnet.ac.in/>
7. <http://www.co-learn.in/>

PIMBE20: IEC-V: ENTREPRENEURSHIP AND MANAGEMENT IN MICROBIAL TECHNOLOGY

| | | | | | | | |
|--|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|
| Year: II SEM: III | Course Code PIMBE20 | Title Of The Course Entrepreneurship and Management in Microbial Technology | Course Type Theory | Course Category Independent elective | H/W - | Credits 2 | Marks 100 |
|--|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|

Course Objective:

To provide an understanding on the concepts of entrepreneurship such as Planning, decision making, leadership, organizations and authority and to provide idea on the basic requirements for establishing a bio-based start-up programme.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Acquaint basic concepts of management such as planning, decision making, leadership, organization and authority.

CO2: Compile the motivational theories.

CO3: Explain the concepts of centralization and decentralization.

CO4: Discuss on IPR and Bioethics with an understanding of government policies.

CO5: Attain skill to manage start up and run an organization.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|---------------|-------------|-------------|-------------|-------------|-------------|-------------|
| CO1 | H | H | M | M | M | H |
| CO2 | H | H | M | L | L | H |
| CO3 | H | M | L | H | M | H |
| CO4 | H | M | L | H | M | H |
| CO5 | H | H | M | M | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|--------------|------------|------------|------------|------------|------------|------------|
| CO1 | H | H | H | L | H | H |
| CO2 | H | H | H | M | L | H |
| CO3 | H | H | H | L | M | H |
| CO4 | H | M | H | L | M | H |
| CO5 | H | H | H | L | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT -I: Understanding management and administration.

1.1 Understanding management and administration. (K1,K2)

1.2 Management: Nature and scope. (K1,K2)

1.3 Management: functional aspects/areas. (K1,K2)

1.4 Evolution of management thought: early, contemporary and modern. (K1,K2)

- 1.5 Roles of Management. (K1,K2)
- 1.6 Levels of managements. (K1,K2)

UNIT-II: Major components of management skills.

- 2.1 Major component of management skills. (K1,K2,K3)
- 2.2 Planning: nature, purpose and importance. (K1,K2,K3)
- 2.3 Types of plans. (K1,K2,K3,K4,K5,K6)
- 2.4 Steps in planning & planning premises. (K1,K2,K3,K4,K5,K6)
- 2.5 Hierarchy of plans. (K1,K2,K3,K4,K5,K6)
- 2.6 Components of planning, Decision making. (K1,K2,K3,K4,K5,K6)

UNIT- III: Motivational theories

- 3.1 Leadership Meaning and nature of directing. (K1,K2,K3)
- 3.2 Understanding, Supervision, motivation . (K1,K2,K3)
- 3.3 Leadership styles, Motivation Theories (Abraham Maslo, Herzberg and Victor Hvrom's). (K1,K2)
- 3.4 Communication – Meaning and importance. (K1,K2,K3)
- 3.5 Meaning and steps in controlling – Essentials of a control system. (K1,K2,K3)
- 3.6 Methods of establishing control (in brief). (K1, K2,K3)

UNIT-IV: Centralization Vs Decentralization

- 4.1 Centralization Vs Decentralization of authority and responsibility. (K1,K2)
- 4.2 Nature and importance of staffing–Process of Recruitment and Selection. (K1,K2,K3)
- 4.3 Organisation: nature and purpose. (K1,K2,K3)
- 4.4 Principles of organization. (K1,K2,K3)
- 4.5 Types of organization. (K1,K2,K3)
- 4.6 Departmental Committees. (K1,K2,K3,K4,K5,K6)

UNIT-V: Structure of biobased technology company.

- 5.1 Structure of a Bio based technology Company. (K1,K2,K3)
- 5.2 Start-up of Bio based technology Company. (K1,K2,K3,K4,K5,K6)
- 5.3 New Product Development. (K1,K2,K3,K4,K5,K6)
- 5.4 Market Research. (K1,K2,K3,K4,K5,K6)
- 5.5 Capital and source investors. (K1,K2,K3,K4,K5, K6)
- 5.6 Sales & Marketing Principles. (K1,K2,K3, K4, K5)

TEXT BOOKS:

1. Naidu, NVR. (2013) Management and Entrepreneurship . 1st edn. I. K. International Pvt Ltd
2. Tripathi, PC., Reddy, PN. (2008) Principles of Management — Tata McGraw Hill,

REFERENCE BOOKS:

1. Desai V. (2004) .Dynamics of Entrepreneurial Development & Management– Vasant Desai – Himalaya Publishing House
2. Charantimath , PM. (2006) Entrepreneurship Development Pearson Education – 2006

3. Thomson Robbins, S. (2003) Entrepreneurship Development– 17th Edition - Pearson Education/PHI

OER:

DIGITAL LIBRARIES:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>

PIMBF20: IEC-VI: CYANOBACTERIOLOGY

| | | | | | | | |
|---------------------------|-------------------------------|---|------------------------------|--|-----------------|---------------------|---------------------|
| Year: II | Course Code PIMBF20 | Title Of The Course Cyanobacteriology | Course Type Theory | Course Category Independent elective | H/W - | Credits 2 | Marks 100 |
| SEM: III | | | | | | | |

Course Objective:

To provide an understanding on the structure, genomics, molecular regulation and applications of Cyanobacteria.

Course Outcomes (CO):

At the end of the course, the learners will be able to;

CO1: Outline the diversity of cyanobacteria.

CO2: Discuss on the genomics of Cyanobacteria.

CO3: Explain the molecular biology of Cyanobacteria.

CO4: Demonstrate molecular regulation of Cyanobacteria.

CO5: Comprehend the mass cultivation and applications of Cyanobacteria.

| CO/PSO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|--------|------|------|------|------|------|------|
| CO1 | H | H | M | M | M | H |
| CO2 | H | H | H | L | L | M |
| CO3 | H | M | M | H | L | M |
| CO4 | H | M | H | H | M | M |
| CO5 | H | H | M | M | H | H |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|-------|-----|-----|-----|-----|-----|-----|
| CO1 | H | H | H | H | L | H |
| CO2 | H | M | H | M | L | H |
| CO3 | H | M | H | M | L | H |
| CO4 | H | M | H | M | L | H |
| CO5 | H | H | H | H | H | H |

H – High (3), M – Moderate (2), L – Low (1)

COURSE SYLLABUS

UNIT-I: Introduction to cyanobacteria

- 1.1 Overview on cyanobacteriology. (K1,K2)
- 1.2 Introduction: Origins of life. (K1,K2)
- 1.3 Photosynthesis in cyanobacteria. (K1,K2)
- 1.4 Diversity of cyanobacteria. (K1,K2)
- 1.5 Fossil history of cyanobacteria. (K1,K2)
- 1.6 The Oceanic Cyanobacterial Picoplankton. (K1,K2)

UNIT-II: Genomics of Cyanobacteria

- 2.1 Gene transfer in cyanobacteria in nature. (K1,K2)
- 2.2 Gene transfer to cyanobacteria in lab. (K1,K2,K3)

- 2.3 Molecular ecology of Cyanobacteria. (K1,K2)
- 2.4 Environmental genomics of cyanobacteria. (K1,K2)
- 2.5 Comparative genomics of marine cyanobacteria. (K1,K2)
- 2.6 Stress response-regulatory system and regulated genes. (K1,K2)

UNIT-III: Molecular Biology of Cyanobacteria

- 3.1 Molecular Biology of Cyanelles and Chloroplast Origins and Evolution. (K1,K2)
- 3.2 Supramolecular Membrane Organization. (K1,K2)
- 3.3 Phycobilisome and Phycobiliprotein Structures. (K1,K2)
- 3.4 The Use of Cyanobacteria in the Study of the Structure and Function of Photosystem II. (K1,K2)
- 3.5 The Cytochrome Complex. (K1,K2)
- 3.6 Photosystem I in Cyanobacteria. (K1,K2)

UNIT-IV: Biochemistry and molecular regulation in cyanobacteria

- 4.1 The Biochemistry of cyanobacteria. (K1,K2)
- 4.2 Molecular Regulation of Carbon Dioxide Metabolism in Cyanobacteria. (K1,K2)
- 4.3 Genetic Analysis of Cyanobacteria. (K1,K2)
- 4.4 Heterocyst development. (K1,K2)
- 4.5 Heterocyst Metabolism. (K1,K2)
- 4.6 Differentiation of Hormogonia. (K1,K2)

UNIT-V: Applications of Cyanobacteria

- 5.1 Mass cultivation of cyanobacteria under outdoor and indoor conditions. (K1,K2)
- 5.2 Cyanobacteria as a source of fine chemicals: polysaccharides and bioactive molecules. (K1,K2,K3)
- 5.3 Cyanobacteria as a source of pigments and antioxidants. (K1,K2,K3)
- 5.4 Cyanobacteria as a source of lipids and polyunsaturated fatty acids. (K1,K2,K3)
- 5.5 Cyanobacteria as biofertilizer for paddy cultivation. (K1,K2,K3)
- 5.6 Hydrogen production by cyanobacteria: Mechanism, progress and prospects. (K1,K2)

TEXT BOOKS:

1. Samit Ray. (2006). Cyanobacteria. 1st edition. New Age International Pvt Ltd Publishers.
2. Percy M. Gault and Harris J. Marler. (2009) .Handbook on Cyanobacteria: Biochemistry, Biotechnology and Applications (Bacteriology Research Developments), Nova Science publishers, Inc.

REFERENCE BOOKS:

1. Antonia Herrero and Enrique Flores. (2008). The Cyanobacteria: Molecular Biology, Genomics and Evolution, Caister academic press.
2. T. A. Sarma. (2012) Handbook of Cyanobacteria, CRC press.
3. D.A. Bryant. (1995). The Molecular Biology of Cyanobacteria (Advances in Photosynthesis and Respiration) Springer.

OER:

DIGITAL LIBRARIES:

1. <http://www.loc.gov/>
2. <http://library.clark.edu/>
3. <http://www.dli.ernet.in/>
4. <http://www.loc.gov/education/>