SCHEME OF EXAMINATION

&

DETAILED SYLLABUS

For

M Sc. MICROBIOLOGY

KALINGA UNIVERSITY

RAIPUR

(W.e.f. 2021 – 2022)

FACULTY OF SCIENCE

Kalinga University, Naya Raipur, Chhattisgarh

The Syllabus Book presents broad objectives, structure, and contents of our Two-Years Master of Microbiology (M.Sc.) Program. The Syllabus is directional in scope and permits the much-desired flexibility to keep pace with the ever-growing body of knowledge, experiments, and explorations in science education. In order to provide an opportunity to students to discover a method of thinking which will help them realize their true potential. The Faculty of Science offers a Learning Outcome-based Curriculum Framework (LOCF) for Students of M.Sc Microbiology.

I. Introduction to Program:-

The M.Sc. Microbiology programme offered by Kalinga University is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars, assignments and field trips. After obtaining this degree, a microbiologist may enter into the job market or opt for undertaking further higher studies in the subject. After post graduation the students may join industry, academia, and public health and play their role as microbiologists in a useful manner contributing their role in the development of the welfare society. Thus the post graduate level degree in microbiology must prepare the students for all these objectives. Thus the LOCF curriculum developed has a very wide range covering all aspects of Microbiology with reasonable depth of knowledge and skills so to as to diversify them in various specialties of the subject and play their role professionally as expected of them. It is also imperative that microbiologists are evaluated in a manner appropriate to assess their proper development as microbiologists.

II. Nature and Extent of the M.Sc Microbiology Programme offered by Faculty of Science, Kalinga University, Raipur:-

The courses in this program have been created to help students gain a better grasp of advanced biological sciences, with a focus on Microbiology and its applied area. Students will be able to recognize and put ethical concepts into practice in research and studies. In order to align with the mission and goals of Kalinga University, the M.Sc Microbiology Programme is planned to deliver such a higher education in Microbiology subject that carries appropriate practical experiences that will enrich the students with scientific temperament.

III. Aims of Master Degree Programme in Microbiology:-

- Microbiology deals with the study of microbes. The M.Sc. Degree programme aims at providing an in depth understanding of the biochemistry, cell biology,

molecular biology, physiology of microbes and their experimental aspects.

- This programme also aims to study emerging areas of Bioscience along with analytical techniques, bioinformatics and biostatistics. The students need to achieve the program specific outcome listed below.

- The aim of the postgraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in a wide ranging context which involve the use of knowledge and skills of Microbiology. Their understanding, knowledge and skills in Microbiology needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts.

IV. The M.Sc. Microbiology program is designed with Graduate Attributes (Gas) aims to empower the students with:-

1. Disciplinary Knowledge: -

The curriculum is designed to train the students in basic and advanced areas of Microbiology, keeping in mind the latest advances in the field. Particular emphasis is laid on the practical aspects of the field. Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline

2. Problem-solving skills: -

Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively. The student will be able to design a short research problem and plan and execute experiments to investigate the problem, as well as analyze and present the results obtained both qualitatively and quantitatively. The student will be able to take up a suitable position in academia or industry, and will be equipped to pursue a career in research if so desired.

3. Communication Skills: -

To enable them to develop speaking and presentation skills they are encouraged to deliver seminars on a wide range of topics covering the different areas of Microbiology. This also leads them into reading about different themes and enhances their assimilation abilities. The students postgraduating in microbiology should also develop excellent communication skills

both in the written as well as spoken language which are must for them to pursue higher studies from some of the best and internationally acclaimed universities and research institutions spread across the globe

4. Research Related Skill: -

A major component of their course is a research project they work on in their final semester. The student is guided in choosing a research problem, executing experiments related to it, collecting data and analyzing it, and presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in basic microbiology as well as be familiar with the most recent advances in microbiology, and will have gained hands-on experience in microbiology, including fermentation technology and molecular biology techniques.

5. Moral and Ethical Awareness: -

Besides attaining the attributes related to the profession of Microbiology, the graduates in this discipline should also develop ethical awareness which is mandatory for practicing a scientific discipline including ethics of working in a laboratory work and ethics followed for scientific publishing of their research work in future.

6. Environment and Sustainability

The course aim is to sustain student's motivation and enthusiasm and to help them not only to appreciate the beauty of different life forms but also to inspire them in the dissemination of the concept of biodiversity conservation. The courses enlighten the students about biodiversity, conservation and Intellectual Property Rights. Inculcate interest in and love of nature with its myriad living forms.

7. Lifelong Learning: -

Ability to engage in life-long learning in the context of the rapid developments in the discipline.

8. Information/Digital literacy: -

This curriculum allows students to stay technologically current by offering courses, which prepare students to not only work with software but also to be self-sufficient in this digital age. Components relevant to technology advances have been incorporated into all of the courses, where applicable and possible, making them digitally literate.

9. **Individual and team work:** Exhibit the potential to effectively accomplish tasks in dependently and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Technical Skills:

Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

11. Critical thinking and Problem solving

Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

V. Eligibility for Admission: -

Candidates seeking admission to the first year of the degree of Master of Science in Botany shall require to pass graduation degree in Science (BSc (CBZ/Biotechnology/Microbiology/Bioscience).

VI. Assessment/Evaluation of the course: -

Candidates will be Continuously Evaluated/Assessed on the basis of their performance both Internally and Externally. The Weightage of Internal Marks would be 30% and for Term-end is 70%. The External Marks will be imparted on the basis of End-term Examination and Internal Marks will be imparted on the basis of Class attendance and Participation/Tests/ Assignments/Presentations/Activities/Project etc. Candidates should mandatorily pass separately in both Internal & External Exam.

VII. Programme Structure:-

The program is designed as per **CBCS (Choice Based Credit System) Choice Based Credit System.** The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

Definitions to understand while taking admission in the course

(i) Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre

(ii) Course' means a segment of a subject that is part of an Academic Programme

(iii) Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission

(iv) Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course

(v) Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre

(vi) Open Elective' means an elective course which is available for students of all programmes, including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

(vii) Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course

(viii) SGPA' means Semester Grade Point Average calculated for individual semester.

(ix) CGPA‘ is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

Programme Structure-

The M.Sc in Microbiology programme is a two-year course divided into four-semesters. A student is required to complete 92 credits for the completion of course and the award of degree.

This Programme is designed as per the following structure:

1. Core Courses.
2. Generic Elective.
3. Discipline Specific Elective.

List of Core Courses

List of Generic Elective.

List of Discipline Specific Elective.

VIII. Miscellaneous:-

1. **Attendance**: The student must meet the requirement of 75% attendance per semester per course for grant of the term. The institute may condone the shortage in attendance in exceptional circumstances, up to a maximum of 15%. The institute shall have the right to withhold the student from appearing for examination of a specific course if the above requirement is not fulfilled.
2. **Medium of Instruction**: The medium of Instruction & Evaluation shall be English.

IX. Detailed Course List for each category of courses is provided in Annexure I.

X. Detailed syllabus of each course is provided in Annexure II.

XI. Programme Outcome:-

Program Learning Objectives & Program Specific Outcome

Program	PO	PSO
M.Sc (Microbiology)	**PO I:**Aims to provide an advanced understanding of the core principles and topics of Modern day Microbiology, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a lecture series and a research project.	**PSO I:** Endeavors to instill in students the skills to identify individual microbial species, use aseptic techniques to grow them in pure culture, safely handle and examine them by microbiological methods.
	PO II: To equip the students to apply knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, and higher order organisms to applied aspects.	**PSO II:** The knowledge of microbiology will enable the students to improve the quality of human lives in relation to environment, fighting disease and to exploit microbes in the production of food.
	PO III: The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed.	**PSO III:** Will gain and apply knowledge to solve problems related to field of Microbiology.
	PO IV: Basics and current updates in the areas of Industrial Microbiology, Fermentation Technology, Medical, and Agriculture & Environmental Microbiology are included to train the students and also sensitize them to scope for research.	**PSO IV:** Will be able to design and develop solution to problems by applying appropriate tools and microbes while keeping in mind safety factor for environment and society.
	PO V: Will address the increasing need for skilled scientific manpower with an understanding of research ethics involving animals and humans to contribute to application, advancement, and impartment of knowledge in the field of microbiology globally.	**PSO V:** Will be able design, perform experiments, analyze and interpret data for investigating complex problems in applied science and related fields.

	PO VI: Will enable the students to pursue higher education and research in reputed institute at national and international level.	**PSO VI:** Will be able to undertake any responsibility as an individual and as a team in a multidisciplinary environment.
	PO VII: Is able to work both independently or in groups on complex projects that require collaboration across disciplines.	**PSO VII:** Acknowledges health, safety and environment (HSE) issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.
		PSO VII: Can communicate scientific results to the general public and experts by writing well structured reports and contributions for scientific publications and posters, and by oral presentations

Kalinga University, Naya Raipur

M.Sc. Microbiology

Scheme of Semester System Examination

First Semester						
	Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
Compulsory Core Course	MMB101	Principles of Microbiology	4	30	70	100
	MMB102	Principles of Biochemistry	4	30	70	100
	MMB103	Bacterial Diversity	4	30	70	100
	MMB104	Applied Mycology and Phycology	4	30	70	100
Compulsory Core Course Practicals	MMB101-P	Principles of Microbiology-Lab	1	20	30	50
	MMB102-P	Principles of Biochemistry-Lab	1	20	30	50
	MMB103-P	Bacterial Diversity-Lab	1	20	30	50
	MMB104-P	Applied Mycology and Phycology-Lab	1	20	30	50
GE-I		(**Any One**)	4	30	70	100
	MMB105A	**Research Methodology**				
	MMB105B	**Science Journalism**				
		Total	**24**	**230**	**470**	**700**

Second Semester						
	Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
Compulsory Core Course	MMB201	Microbial Physiology and Metabolism	4	30	70	100
	MMB202	Medical Microbiology	4	30	70	100
	MMB203	Microbial Genetics	4	30	70	100
	MMB204	Biotechnology and Genetic	4	30	70	100
Compulsory Core Course Practicals	MMB201-P	Microbial Physiology and Metabolism-Lab	1	20	30	50
	MMB202-P	Medical Microbiology-Lab	1	20	30	50
	MMB203-P	Microbial Genetics-Lab	1	20	30	50
	MMB204-P	Biotechnology and Genetic Engineering-Lab	1	20	30	50
GE-II		(**Any One**)	**4**	**30**	**70**	**100**
	MMB205A	**Entrepreneurship**				
	MMB205B	**Intellectual Property Rights**				
		Total	**24**	**230**	**470**	**700**

Third Semester						
	Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
Compulsory Core Course	MMB301	Immunology	4	30	70	100
	MMB302	Molecular Microbiology	4	30	70	100
DSE-I & II		**Elective-II (Any one)**	4	30	70	100
	MMB303A	Industrial Microbiology				
	MMB303B	Food Microbiology				
		Elective-III (Any one)	4	30	70	100
	MMB304A	Biochemical and Biophysical				
	MMB304B	Downstream Processing				
	MMB301-P	Immunology-Lab	1	20	30	50
	MMB302-P	Molecular Microbiology-Lab	1	20	30	50
	MMB303-P(A)	Industrial Microbiology-Lab	1	20	30	50
	MMB303-P(B)	Food Microbiology-Lab				
	MMB304-P(A)	Biochemical and Biophysical	1	20	30	50
	MMB304-P(B)	Downstream Processing-Lab				
		Total	**20**	**200**	**400**	**600**

Fourth Semester						
	Paper Code	**SUBJECTS**	**Credits**	**Internal Marks**	**External Marks**	**Total**
Core Course	MMB401	Virology	4	30	70	100
DSE Course(Any One)	MMB402(A)	Environmental Microbiology	4	30	70	100
	MMB402 (B)	Agriculture and Soil Microbiology				
	MMB401-P	Virology	1	20	30	50
	MMB402A(P)	Environmental Microbiology Lab	1	20	30	50
	MMB402B(P)	Agriculture and Soil Microbiology Lab				
	MMB403P	Dissertation/Project Work	10	100	200	300
		Total	**20**	**200**	**400**	**600**

***Project Dissertation 75**
***Presentation 50**
***Viva Voce 50**
***Scientific Paper 25**

MMB101

Principles of Microbiology

Course Objectives:

- Students will be able to understand the basics principles of microbiology along with various morphological and physiological characteristics of bacteria
- The students will be aware with the scope of microorganism and antimicrobial testing.

Course learning Outcomes: After reading this course

- **COI**. Student will know the history and morphological features of bacteria.
- **COII**. Student will be able to general characteristics of bacteria and archaea and specific key features of model archaeal organisms.
- **COIII** Understanding of basic microbial structure and similarities and differences among various groups of microorganisms such as bacteria/archaea/cyanobacteria/fungi/protozoans
- **COIV**. Students will be able to understand Scope of Microbiology
- **COV**-Know about bacterial diseases.

Unit I

History of development of Microbiology; Development of fields of Microbiology in 20^{th} century; The spontaneous generation controversy; Germ theory of disease; Microbes and fermentation; Physical and Chemical methods of sterilization. Microscopy: Light,Confocal and Electron.

Unit II

Binomial Nomenclature; Haeckel's three kingdom classification; Woese's three kingdom classification systems and their utility –

Archaea, Eubacteria, Eukarya; Organization of prokaryotic and eukaryotic cell; Different groups of acellular microorganisms-

Viruses, viriods.

Unit III

General features of microorganisms- Bacteria, Algae, Fungi and Protozoa. Classification of bacteria; Bacterial growth and metabolism. Microbes in Extreme Environment – Special features of the thermophilic, methanogenic and halophilic archaea; Photosynthetic bacteria, Cyanobacteria; microbes in other extreme conditions – deep ocean, and space.

Unit IV

Scope of Microbiology- Cycle of matter in nature. Microbial interactions- mutualism, symbiosis, commensalisms, predation, parasitism, amensalism, competition, bioluminescence, biodegradation, biofilms. Cleaning oil spills, microbes in composting, biopesticides, bioremediation, bioleaching, SCP, microbial enzymes and fermented foods.

Unit V

Human diseases and their causative agents. Definition of aeromicrobiology, air-borne pathogens and allergens, Phytopathogenic bacteria: Angular leaf spot of cotton, crown galls, bacterial cankers of citrus. Diseases caused by Phytoplasmas: Aster yellow, citrus stubborn.

Suggested readings:

1. Brock TD., Milestones in Microbiology, Infinity Books.
2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application.,Tata McGraw Hill.
3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology, Publisher: MacMillan.
4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: Prentice-Hall , Inc USA.
5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
6. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings.Microbiology

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Student will know the history and morphological features of bacteria.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.
II	Student will be able to general characteristics of bacteria and archaea and specific key features of model archaeal organisms.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Understanding of basic microbial structure and similarities and differences among various groups of microorganisms such as bacteria/archaea/cyanobacteria/fungi/protozoans	Presentation/Video.	Quiz,Assignment, seminar.
IV	Students will be able to understand Scope of Microbiology	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Know about bacterial diseases	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

MMB102

Principles of Biochemistry

Course Objectives: This course deals with characteristics, properties and biological significance of the biomolecules of life. In depth knowledge of the energetic and regulation of different metabolic processes in microorganisms.

Course Learning Outcomes: After completion of the course students will be able to understand:

CO I: Understanding of the fundamentals Biochemistry and key principles of Biochemistry.

COII:classification, structure, function, significance and biosynthesis and the degradation pathways of the above mentioned biomolecules

COIII:Conceptual knowledge of properties, structure, function of enzymes, enzyme kinetics and their regulation ,enzyme engineering,

CO IV:Application of enzymes in large scale industrial processes.

COV: Concepts of lipid and nitrogen metabolism, oxidation of fatty acid, assimilation of nitrates, ammonia assimilation.

Unit I

Scope and importance of biochemistry; Fundamental principles governing life; Structure of water; Acid base concept and buffers; pH; Hydrogen bonding; Hydrophobic, Electrostatic and Vander Waal forces. General introduction to physical techniques for determination of structure of biopolymers.

Unit II

Classification, structure and function of carbohydrates; Biomembranes and lipids. Structure and function of amino acids and vitamins. Structure and function of proteins; Types of nucleic acid, their structure and functions.

Unit III

Enzymes: classification, mechanism of action; Factors affecting enzyme action; Immobilized enzymes; Hormones; Thermodynamic principles and biological processes.

Unit IV

Metabolism: Basic concepts and design, Glycolysis and Gluconeogenesis, Citric acid cycle, Oxidative Phosphorylation, Photosynthesis and Respiration, Glycogen metabolism, Fatty acid Metabolism, Biosynthesis of amino acids, Nucleotide biosynthesis, Protein synthesis.

Unit V

Cellular Permeability and Transport process, Bioenergetics of metabolism: oxidation–reduction reactions, coupled reactions and group transfer; enthalpy and free energy of reaction and ATP. Lipid and Nitrogen Metabolism: Oxidation of fatty acid: β-oxidation, activation of a fatty acid, transport and steps of oxidation, α and ω oxidation.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Understanding of the fundamentals Biochemistry and key principles of Biochemistry.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.
II	classification, structure, function, significance and biosynthesis and the degradation pathways of the above mentioned biomolecules	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Conceptual knowledge of properties, structure, function of enzymes, enzyme kinetics and their regulation ,enzyme engineering,	Presentation/Video.	Quiz,Assignment, seminar.
IV	Application of enzymes in large scale industrial processes.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Concepts of lipid and nitrogen metabolism, oxidation of fatty acid, assimilation of nitrates, ammonia assimilation	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested readings:

1. Mathews C.K., VanHolde K.E. and Ahern K.G., Biochemistry, Benjamin /Cummings.
2. Stryer L., Biochemistry, W.H. Freeman and Company.

3. Devlin's Textbook of Biochemistry with Clinical correlations. John Wiley and Sons Inc.
4. Lehninger A.L., Nelson D.L., Principles of Biochemistry, M.M. Cox. Worth Publishing.
5. Robert K., Murray M.D., Granner D.K., Mayes P.A.and Rodwell V.I. Harper's Biochemistry. McGraw-Hill/Appleton and Lange.

6. Shukla P. and Pletschke, Brett I. (Eds.) (2013) Advances in Enzyme Biotechnology, Springer-Verlag Berlin
   Heidelberg. ISBN 978-81-322-1094-8 (ebook); ISBN 978-81-322-1093-1 (Softcover)[URL: http://link.springer.com/book/10.1007%2F978-81-322-1094-8]

MMB103

Bacterial Diversity

Course Objectives:

- Knowledge on Landmark discoveries in Microbiology and different domains classification of living organisms.
- Familiarity with general Organization of Bacterial Cell.
- Knowledge of cellular organization, life cycle and economic importance of prokaryotic (Eubacteria, Archaea, Cyanobacteria) and Eukaryotic (Algae, Fungi and protozoans)

Course Learning outcomes: After completion of the course students will be able to understand:

- **COI:** Know about bacterial Classifications
- **COII**: Understanding of basic microbial structure and similarities and differences among various groups of microorganisms such as bacteria/archaea/cyanobacteria/fungi/protozoans.
- **COIII:** Acquaintance on study of microbial diversity using different methods and systematics of bacteria and archaea using polyphasic approach.
- **COIV:** Understand the Morphology; metabolism; ecological significance and economic importance of gram negative bacterial group
- **COV:** Understand the Morphology; metabolism; ecological significance and economic importance of gram positive bacterial group.

Unit I

Bacterial Classification- Basis of Bacterial classification; conventional; molecular and recent approaches to polyphasic bacterial taxonomy; evolutionary chronometers; rRNA oligonucleotide sequencing; signature sequences; and protein sequences. Differences between eubacteria and archaebacteria.

Unit II

Organization of Bacterial Cell- Structure and function of Cell Wall; Cell Membrane; Cytoplasm; Flagella; Endoflagella; Fimbriae; Glycocalyx; Capsule; Endospore; Growth and Nutrition- Cultivation of aerobic; anaerobic and accessing non-cultureable bacteria. Maintenance and preservation of bacterial cultures; Components of media and different types of culture media. Bacterial nutrition: Transport of nutrients; Salient features of bacterial growth curve.

Unit III

Important archaeal groups- According to Brock's 2009 and Bergey's Manual of Systematic Bacteriology. Archaebacteria: General characteristics; phylogenetic overview; genera belonging to Nanoarchaeota (*Nanoarchaeum*); Crenarchaeota (Sulfolobus; Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium; Methanocaldococcus); thermophiles (*Thermococcus; Pyrococcus; Thermoplasma*); and Halophiles (*Halobacterium; Halococcus*)]

Unit IV

Eubacteria- Non Proteobacteria and Proteobacteria:Morphology; metabolism; ecological significance and economic importance of following groups:

Gram Negative- Non proteobacteria*(Aquifex, Thermotoga, Deinococcus, Thermus, Chlorobium, Chloroflexus, Chlamydiae, Spirochaete*), Alpha proteobacteria(*Rickettsia, Coxiella, Caulobacter, Rhizobium, Hyphomicrobium, Agrobacterium),*Beta proteobacteria (*Neisseria, Burkholderia, Thiobacillus*), Gamma proteobacteria (*Enterobacteriaceae* family, Purple sulphur bacteria, *Pseudomonas, Vibrio, Beggiatoa, Methylococcus, Haemophilus*), Delta proteobacteria (*Bdellovibrio, Myxococcus*), Epsilon proteobacteria (*Helicobacter, Campylobacter*).

Unit V

Gram Positive -Low G+C or Firmicutes (Mycoplasmas,*Clostridium, Heliobacterium, Lactobacillus, Lactococcus, Staphylococcus, Streptococcus, Leuconostoc, Bacillus*), High G+C or Actinobacteria (*Arthrobacter, Bifidobacterium, Corynebacterium, Frankia, Mycobacterium, Nocardia, Streptomyces, Thermomonospora, PropionibacteriumCyanobacteria*).

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Know about bacterial Classifications	Discussion &Presentation/Lecture.	Evaluation of Students on the basis of Presentation,Assignment Evaluation,Quiz.
II	Understanding of basic microbial structure and similarities and differences among various groups of microorganisms such as bacteria/archaea/cyanobacteria/fun	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.

	gi/protozoans.		
III	Acquaintance on study of microbial diversity using different methods and systematics of bacteria and archaea using polyphasic approach.	Presentation/Video.	Quiz,Assignment, seminar.
IV	Understand the Morphology; metabolism; ecological significance and economic importance of gram negative bacterial group	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Understand the Morphology; metabolism; ecological significance and economic importance of gram positive bacterial group.	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested readings:

1. Salle A.J., Fundamental Principles of Bacteriology.
2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application, Tata McGraw Hill.
3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology. Publisher: MacMillan.
4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: Prentice-Hall, Inc USA.
5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
6. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings. Microbiology

MMB104

Applied Mycology and Phycology

Course Objectives:

- To impart in-depth knowledge of applied Mycology and Phycology.
- To train the students to pursue further education.
- To be familiar with microbiological tools.
- To increase expertise of the course.

Course Learning outcomes:

After completion of the course students will be able to understand:

COI: Understand about the Introduction of algae and Fungi.

COII: Know about the life cycle of representative genera.

COIII: Students will be able to understand the importance of algae.

COIV: Students will be able to understand the role of fungi.

COV: Know about the importance of fungi in food,medicine and industry.

Unit I

Introduction of algae: Occurrence and distribution, thallus structure, characteristics, nutrition, classification and reproduction.

Introduction of fungi: Occurrence and distribution, somatic structure, hyphal growth, nutrition, heterothallism, sex hormones in fungi, Classification of fungi. Reproduction in fungi: asexual, sexual and parasexual.

Unit II

Study of the different classes with reference to occurrence, somatic structure and life cycle and economic importance representing the following genera: Acrasiomycetes (*Dictyosteluim*), Myxomycetes (Endosporus and exosporus), Chytridiomycetes (*Neocallimastrix*), Oomycetes (*Phytopthora*), Zygomycetes (*Rhizopus*), Ascomycotina (Hemiascomycetes-*Saccharomyces*, Plectomycetes - *Penicillium*Pyrenomycetes – *Xylaria*, Discomycetes - *Peziza*), Basidiomycotina (Hymenomycetes *Agaricus*, Teliomycetes - *Puccinia*), Deuteromycetes

Unit III

Algae as pollution indicators, eutrophication agent and role in bioremediation, algae in global warming and environmental sustainability, cyanobacteria and selected microalgae in agriculture

as biofertilizer, importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecule.

Unit IV

Lichens and Mycorrhiza: Occurrence, Structure, Types and Importance. Fungi as insect symbionts, fungi as biocontrol agents, attack of fungi on other microorganisms, potential application in Environment, industry, food. Role of fungi in Biodeterioration of wood, paper, textile. Myxotoxins, quorum sensing in fungi

Unit V

Fungi in Industry: Production of alcohol and organic acids. Fungi in Medicine: Types of metabolites used in medicine and production of antibiotics. Fungi in Agriculture and Forestry. Fungi as biopesticides: mycofungicides, weedicides, and insecticides. Fungi as human and animal parasites (medical mycology) Fungi as food: Mushrooms: Types of mushrooms, biology and growth of mushrooms, nutritional and medicinal value of edible mushrooms; Fungal protein (Yeast and Fusarium).

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Understand about the Introduction of algae and Fungi.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis of Presentation,Assignment Evaluation,Quiz.
II	Know about the life cycle of representative genera.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Students will be able to understand the importance of algae.	Presentation/Video.	Quiz,Assignment, seminar.

IV	Students will be able to understand the role of fungi.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Know about the importance of fungi in food,medicine and industry	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings:

1. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.) Wiley Eastern Ltd., New Del
2. Charlile M. & Watkinson S.C. The Fungi, Publisher: Academic Press.
3. E.Moore –Landeekeer: Fundamentals of the fungi, Publisher: Prentice Hall.
4. L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology
5. Ayhan Demirbas, M. Fatih Demirbas: Algae Energy: Algae as a New Source of Biodiesel (2010)
6. Linda E. Graham, James Graham, James M. Graham: Algae (2009)
7. Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.

MMB101P

Principles of Microbiology-Lab

- Microscopic examination of bacteria, actinomycetes, algae, fungi and protozoa;
- Differential staining methods;

- Study of shape and arrangement of bacterial cells;
- Preparation of microbiological media;
- Sterilization: principles & operations;
- Preparation of specific media for isolation of bacteria, actinomycetes and fungi from natural sources;
- Sampling and quantification of microorganisms in air, soil and water;
- Isolation of thermophiles from compost.

MMB102P

Principles of Biochemistry -Lab

Biochemistry:

- Preparation of standard and buffer solutions;
- Use of simple techniques in laboratory (spectrophotometery-verification of Beer's law, relation between O.D. and percentage transmission; Centrifugation)
- Estimation of sugars,
- Estimation of Proteins by Lowry‘s method;

- Estimation of DNA and RNA by diphenylamine and orcinol methods;
- Determination of enzyme activity and study of enzyme kinetics;
- Separation of biomolecules by electrophoresis.

MMB103P

Bacterial Diversity -Lab

- Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food).
- Staining of bacteria and actinomycetes,
- Use of selective media,
- Enrichment culture technique – isolation of asymbiotic nitrogen fixing bacteria;
- Isolation of symbiotic nitrogen fixing bacteria from nodules,
- Isolation of antibiotic producing microorganisms.
- Morphological, physiological and biochemical characterization of isolated bacterial cultures.

MMB104P

Applied Mycology and Phycology-Lab

- Isolation and identification of fungi from different environmental samples,
- Study the nutritional requirement of fungi,
- Cultivation of fungi in submerged and solid state fermentation,
- Production of enzymes, organic acids and other metabolites by fungi,
- Collection and study of basidiomycetous fungi,
- Study and culturing of yeasts, study yeast dimorphism,
- Isolation and identification of algae from different habitats,
- Culturing of algae under lab conditions,
- Study hydrogen and bioethanol production by algae,
- Algae as a source of SCP,
- study pollution control by algae.

MMB105A

Research Methodology

Objectives:

1. Understand some basic concepts of research and its methodologies
2. Identify appropriate research topics
3. Select and define appropriate research problem and parameters
4. Prepare a project proposal (to undertake a project)
5. Organize and conduct research (advanced project) in a more appropriate manner

Unit I

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Unit II

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance , Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Unit III

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Unit IV

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit V

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Learning Outcomes:

1. Students will understand a general definition of research design.
2. Students will know why educational research is undertaken, and the audiences that profit from research studies.
3. Students will be able to identify the overall process of designing a research study from its inception to its report.
4. Students will be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research

Assessment Tools:

Written examinations, Case study discussions, Viva examinations.

Books Recommended:-

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

MMB105B

SCIENCE JOURNILISM

Objectives

- Students will learn the mechanics of science writing, including research, sourcing, and generating story ideas; interviewing, note-taking, and organization; fact-checking, editing, writing for story, structure, and formatting.

- Students will practice writing for multiple public, academic, and professional audiences and contexts using writing strategies, conventions, genres, technologies, and formats to communicate effectively.

UNIT 1 Science communication at the end of the Enlightenment and the importance of notions of the public in the origin of modern science - development of new audiences for science in the Nineteenth century and the emergence of new science communication media (e.g. mechanics' institutes, science journalism, public museums and zoos) - advent of the figure of the scientist as public expert and the debate about 'Two Cultures' – difference between science journalism and science communication

UNIT 2 Introduction of Western science in India through missionaries, travelers, army and civilian army of the East India Company– science in the 18th and 19th century –emergence of Indian pioneer scientists – science teaching–– developments during post-Independence period – emerging areas of science and technology – convergence in study of science

UNIT 3 Institutions of science in India - the role of the Asiatic Society – Bose Institute – Indian Institute of Science - Council of Scientific and Industrial Research (CSIR) – Indian Space Research Organization (ISRO) – Indian Science Congress organizations for popularization of science – NCSTC and Vigyan Prasar – noted science societies at state level – Science and Technology Academies – awards for science communication and popularization.

UNIT 4 The boom in new media during the twentieth century and their impact on science journalism - role of a science page editor – popular science magazines in the west – science magazines in India – the ideal science reporter - scope of science journalism on radio & television in developing countries – science serials on radio and television – Bharat ki Chaap on Doordarshan – Science serials on All India Radio - tech news - understanding present market trends.

UNIT 5 Science as an essential element in political, corporate and community news – major issues in science journalism – environmental pollution – genetically modified crops – research for disease prevention and eradication – nuclear power – disaster mitigation – scientific knowledge for effective governance – the North-South divide in science research and scientific development.

Learning Outcomes

- They will appreciate the digital landscape within which science journalism exists today by learning: blogging in science journalism (honing your craft, developing a voice); how to get work (pitching and staying relevant); the value of social networks for science journalism (sharing stories, finding stories, joining discussions and finding sources); digital strategies employed by major news organizations (data visualization, multimedia, community building).
- Students will analyze and learn about the structure of several types of data including numbers, texts and documents. Students will learn the skills to examine, evaluate, and critique those data, extract patterns, summarize features, create visualizations, and provide insights, while learning to be sensitive to ethical concerns associated

Assessment Tools: Written examinations, Case study discussions, Viva examinations.

Reference Book:

1. Mass Communication: A Critical analysis, Keval J Kumar
2. Professional Journalism, M V Kamat
3. Theory and Practice of Journalism, B N Ahuja
4. Professional Journalist, John Hohenberg
5. Understanding Media, Marshall McLuhan 6. Journalism in India,Nadig Krishnamurthy, Mysore University Press
6. Barbara Gastel, Presenting Science to the Public.

7. Blum, Deborah, Knudson, Mary & Marantz Henig, Robin. A Field Guide for Science Writers: The Official Guide of the National Association of Science Writers. (2005)
8. D. Perlman, Science and the Mass Media.
9. Elise Hancock, Ideas into Words: Mastering the Craft of Science Writing. Baltimore and London: Johns Hopkins, 2003.
10. N Corcoran (Ed.). Communicating health: strategies for health promotion. Sage. (2013).
11. O.P. Jaggi, A Concise History of Science including Science in India.
12. R. Sundara, Popular Science in Mass Media.
13. Renata Schiavo, Health Communication: From Theory to Practice. John Wiley & Sons. 2013
14. Sharon, M. Friedman, Sharon, Woody, Carlol, L. Rogers (Ed) : Scientists and Journalists, Reporting Science as News.
15. Warren Burkett, News Reporting : Science Medicine and High Technology

MMB201

Microbial Physiology and Metabolism

Course Objectives:

- To develop understanding about microbial metabolism, growth and energy generation.
- To acquaint various life process like photosynthesis, respiration and fermentation, anaerobic respiration, and bacterial sporulation
- To understand bacterial membrane transport
- To understand the concept of chemolithotrophy and nitrogen metabolism .

Course Learning Outcomes:

After completion of the course students will be able to understand:

COI: Acquaint with basics of metabolism and growth under normal and stressed conditions.

COII: Get well versed with various life process like photosynthesis, respiration and fermentation, anaerobic respiration, and bacterial sporulation

COIII: Elucidate bacterial membrane transport

COIV: Understand major fermentation, aerobic and anaerobic pathways for energy generation in microbial cells.

COV: Discuss the concept of nitrogen metabolism

Unit I

Nutritional Categories of microorganisms based on carbon and energy sources, Metabolite Transport- Passive and facilitated, Primary and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

Unit II

Microbial Growth- Definition balanced and unbalanced growth, growth curve, the mathematics of growth, Generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve. Types of Culture media, Isolation of pure cultures.

Unit III

Brief account of photosynthetic and accessory pigments - chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins; Carbohydrates- anabolism. Autotrophy, oxygenic, anoxygenic photosynthesis – autotrophic generation of ATP; fixation of CO2, Calvin cycle, C3,

C4 pathway. Chemolithotrophy:sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis, luminescence.

Unit IV

Respiratory metabolism, Embden-Mayer Hoff pathway, EntnerDoudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis, Pasteur effect; Fermentation of carbohydrates, homo and heterolactic fermentations.

Unit V

Biosynthesis of peptidoglycan, polysaccharides, major amino acids, polyamines, Lipids, Nucleotides:Purines and Pyrimidines; Assimilation of nitrogen; Dormancy and germination; Microbial Differentiation, sporulation and morphogenesis, Cell division cycle in *E.coli* and yeast.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Acquaint with basics of metabolism and growth under normal and stressed conditions.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis of Presentation,Assignment Evaluation,Quiz.
II	Get well versed with various life pro cess like photosynthesis, respiration and fermentation, anaerobic respiration, and bacterial sporulation	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignmen t,Class test.
III	Elucidate bacterial membrane transp ort	Presentation/Video .	Quiz,Assignment, seminar.

IV	Understand major fermentation, aerobic and anaerobic pathways for energy generation in microbial cells.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Discuss the concept of nitrogen metabolism	Lecturing / ResearchStudy/vide o	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009

MMB202

Medical Microbiology

Course Objective:

- To impart basic knowledge of Medical Microbiology.
- Develop understanding about immune system, antigen antibody interactions.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.

Course Learning Outcomes:

- **COI:** Understanding of the fundamentals of Medical Microbiology and key principles of it.
- **COII:** Upon completion, students gained the knowledge of most common medically important organism and the infections they cause.
- **COIII:** Different approaches, techniques and tools used to identify pathogens and control them.
- **COIV:** Diagnostic approaches for microbial pathogens
- **COV:** Know about important bacterial and viral disease.

Unit I

Early discovery of pathogenic microorganisms, development of medical microbiology as a discipline, normal microbial flora of the human body and their importance. Host parasite relationships: Definitions: infection, invasion, pathogen, pathogenicity, toxigenicity, virulence, carrier, types of carriers, opportunistic infections. Role of aggressins, depolymerizing enzymes, organotrophism. Transmission and spread of infection. Hospital acquired infections and their management

Unit II

Principle of different diagnostic tests (ELISA, Immunofluorescence, agglutination based tests). Modern approaches for diagnosis of infectious diseases: Basic concepts of gene probes, dot hybridization and PCR assays. Mechanism of action of various chemotherapeutic agents (antibacterial, antifungal and antiviral). Principle of drug resistance. Various methods of drug susceptibility testing, passive and active prophylactic measures

Unit III

Study of important bacterial diseases caused by the following generawith reference to causative agent, pathogenesis, symptoms, transmission, control measures, epidemiology and diagnosis. *Bacillus anthracis, Staphylococcus, E.coli, Salmonella typhii, Shigella dysenteriae, Vibrio cholerae, Haemophilus influenzae, Mycobacterium tuberculosis, Corynebacterium diptheriae, Treponema palladium*. Emerging and reemerging bacterial pathogens.

Unit IV

Study of important viral diseases wih reference to causative agent, pathogenesis, symptoms, transmission, control measures, epidemiology and diagnosis. Hepatitis, influenza, rabies, polio, chicken pox, herpes, dengue fever, AIDS and viral cancers. An overview of emerging and reemerging viral diseases: Ebola, SARS, Hanta and Chikungunya.

Unit V

Introduction to protozoan, fungal and helminthes diseases:Malaria, Giardiasis, & leishmaniasis; Superficial, subcutaneous, systemic and opportunistic mycoses.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Understanding of the fundamentals of Medical Microbiology and key principles of it.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis of Presentation,Assignment Evaluation,Quiz.
II	Upon completion, students gained the knowledge of most common medically important organism and the infections they cause.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Different approaches, techniques and tools used to identify pathogens and control them.	Presentation/Video .	Quiz,Assignment, seminar.
IV	Diagnostic approaches for microbial pathogens	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment

			Evaluation,Classtest.
V	Know about important bacterial and viral disease.	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings

1. Ananthanarayanan R. and C.K. Jayaram Panicker Orient Longman Text of Microbiology, 1997.

2. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection.

   Vol.2: Practical Medical Microbiology Churchill Livingstone, 1996.

3. Shanson D.C., Wright PSG, Microbiology in Clinical Practice., 1982.

4. Baron EJ, Peterson LR and Finegold SM Mosby, Bailey and Scott's Diagnostic Microbiology, 1990.

5. Smith, C.G.C. "Epidemiology and Infections' (1976): Medowfief Press Ltd., Shildon, England.

Microbial Genetics

Course Objectives:

The objective of this course is to understand how microorganisms can be used as tools to understand various biological phenomena. The student will become familiar with methods of transfer of genetic material in bacteria, and will understand the biology of lytic and lysogenic phages. The student will be acquainted with the different modes of gene regulation in bacteria, and the importance of bacterial transposition and its applications.

Course Learning Outcomes:

Upon successful completion of the course, the student:

COI: Can discuss the importance of mutation analysis, can analyze mutations by complementation and recombination tests, and can design a strategy to create gene replacement in bacteria

COII: Is able to explain how plasmid copy number is regulated, can differentiate between Hfrstrains and strains carrying F plasmid, and can construct a genetic map of bacterial genome using conjugation-based method

COIII: Is able to compare and contrast generalized versus specialized transduction, knows how to construct genetic linkage maps using two-factor and three factor cross, is able to discuss the basis of natural competence in bacteria.

COIV: Is able to list the events in the lytic and lysogenic phases of lambda phage life cycle and the regulatory factors and events involved.

COV: Can differentiate between positive and negative regulation of gene expression, inducible and repressible systems. Can describe the regulation of the lac, trp, gal,ara and tol operons.

Unit I

Mendel's work on transmission of traits; Genetic Variation; Molecular basis of Genetic Information;Mitosis and Meiosis; Linkage and crossing over; Molecular mechanism of crossing over; Recombination and recombination frequency

Unit II

Mutations-Induced versus Spontaneous mutations, Suppressor mutations, Molecular basis of Mutations,mutant enrichment; Complementation tests; recombination tests and gene

replacements; Cloning genes by complementation and marker rescue; DNA repair mechanisms, Mutation and Microbial evolution.

Unit III

Molecular mechanism of gene transfer by conjugation. Regulation of gene transfer by conjugation. Mapping bacterial genomes using Hfr strains. Transfer systems in gram positive bacteria. Ti plasmid and application

Unit IV

Transformation and transduction:Natural transformation and competence. Molecular basis of natural transformation; Regulation of competence in *B.subtilis*. Artificially induced competence. Generalized versus specialized transduction, Mapping bacterial genes by transduction;Tetrad analysis in fungi,Positive and negative gene regulation and attenuation, using the *lac*, *gal*, *trp* and *ara* operons, with emphasis on recent advances.

Unit V

Lytic cycle of T4 and T7 bacteriphages, Regulation of expression of genes in phage T4 and T7. Replication and packaging of filamentous phages M13 . Benzer's experiments with the rII genes of phage T4 to construct phage genetic linkage maps. Lambda phage – Lytic and lysogenic cycles. Other lysogenic phages – P1 and □x174. Transposons and gene regulation.Yeast Ty-1 transposon. Phase variation in bacteria , Transplantation (Synthetic genome).

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Can discuss the importance of mutation analysis, can analyze mutations by complementation and recombination tests, and can design a strategy to create gene replacement in bacteria	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.

II	Is able to explain how plasmid copy number is regulated, can differentiate between Hfrstrains and strains carrying F plasmid, and can construct a genetic map of bacterial genome using conjugation-based method	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Is able to compare and contrast generalized versus specialized transduction, knows how to construct genetic linkage maps using two-factor and three factor cross, is able to discuss the basis of natural competence in bacteria.	Presentation/Video.	Quiz,Assignment, seminar.
IV	Is able to list the events in the lytic and lysogenic phases of lambda phage life cycle and the regulatory factors and events involved.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Can differentiate between positive and negative regulation of gene expression, inducible and repressible systems. Can describe the regulation of the lac, trp, gal,ara and tol operons.	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings

1. Snyder L. and Chapness W. Molecular Genetics of Bacteria 2007.
2. Birge EA. 1981. Bacterial and Bacteriophage Genetics. Springer Verlag.
3. Gardner JE, Simmons MJ & Snustad DP. 1991. Principles of Genetics. John Wiley& Sons.
4. Lewin B.1999. Gene. Vols. VI,IX. John Wiley & Sons.
5. Maloy A & Friedfelder D. 1994. Microbial Genetics. Narosa.
6. Scaife J, Leach D & Galizzi A 1985. Genetics of Bacteria. Academic Press.

7. William Hayes 1981. Genetics of Bacteria. Academic Press.
8. Microbial Genetics. Maloy et. al. 1994. Jones & Bartlett Publishers.
9. Dale J.W., Molecular genetics of bacteria. 1994. John Wiley & Sones.
10. Streips & Yasbin. Modern microbial genetics. 1991. Niley. Ltd.

MMB204

Biotechnology and Genetic Engineering

Course Objectives:

- To impart information on the historical aspects development of Biotechnology and Genetic Engineering
- To provide knowledge and in-depth study on plant & animal tissue culture techniques, Fermentation techniques & Biosensors, Environment &Energy, Concepts & Scope in Genetic Engineering and Applications of Genetic engineering
- To expose the students on the basic understanding of various techniques used in Biotechnology and Genetic Engineering

Course Learning outcomes:

Upon successful completion of the course, the student:

COI: The students are be able to understand in-depth knowledge on the history and concepts and scope in bio-technology

COII : The students are be able to gain knowledge on biotransformation & production of useful compounds and uses of biosensors.

COIII : The students are able to know the alternate energy sources and generation of energy from biomass energy

COIV : The students are be able to understand the concepts and methods in genetic Engineering

COV: The students are be able to acquire knowledge on applications of genetic engineering

Unit – I :

Concepts and Scope in bio-technology Plant cell and tissue culture – Culture techniques – Protoplast technique – Anther and pollen culture. Animal tissue culture- culture techniques – Animal bio reactors. Gene banks and Germ plasm storage. Immobilization of microbial cells / enzymes – Adsorption, entrapping, ionic bonding, cross linking, encapsulation and microencapsulation. Application of immobilized enzymes.

Unit-II :

Fermentation and Biosensors Biotransformation and production of useful compounds – Glycerol, acetons, Alkene oxide, Ploy hydroxy butyrate, Xanthangum and Microbial Leaching. Biosensors – definition, outline design and types – Biosensors nutrients – glucose and acetic acid sensors. Sensor for cell population – Fuel cell type electrode, potentiostatic, piezoelectric membrane – Dye-coupled electrode membrane filter – Oxygen electrode system and Lactate sensor.

Biosensor for products - alcohol sensor, formic acid sensor and methane sensor. Biosensor for environmental control – BOD sensor, Ammonia sensor, Nitrite sensor and Sulfite Ion sensor.

Unit-III :

Environment and Energy Energy sources – nuclear energy, fossil fuel energy and non-fossil and non-nuclear energy. Biomass energy – Composition of biomass-wastes as sources of renewable source of energy – Composition wastes – sources of wastes (Industrial, agricultural, forestry, municipal sources). Biomass conversion – non-biological process, direct combustion (Pyrolysis, Gasification, liquefaction); biological process (enzymatic digestion, anaerotic digestion, aerobic digestion). Bioenergy products – ethanol, biogas and Hydrogen. Bioremediation – microbial degradation of xenobiotics.

Unit – IV :

Genetic Engineering Definition and outline strategy. Enzymology – Restrict enzymes, DNA ligases, reverse transcriptase, klenow fragment, Alkaline phosphatase, Polynucleotide kinase, terminal transferase, Dnase and Rnase. Cloning vehicles- Plasmids – pBR 322 & pUC; phage, cosmid, shuttle and YAC vectors. Gene cloning strategy – Isolation of foreign DNA and recombinant DNA construct – Transformation – Screening and Storage. Expression of cloned genes in prokaryotic and eukaryotic systems – minicell, maxicell, Fused and unfused gene expression.

Unit-V :

Applications of Genetic engineering GMOS – Transgenic plants – Bt Cotton - Development of crops for disease resistance, Salt tolerances, drought tolerance, herbicide tolerance and nutritional quality. Transgenic animals and its applications. Genetically modified Microorganisms and its applications. Rules and regulation in biotechnology – biosafety, bioethics hazards of environmental engineering, and intellectual property rights (IPR) and protection (IIP).

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	The students are be able to understand in-depth knowledge on the history and concepts and scope in bio-technology	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.

II	The students are be able to gain knowledge on biotransformation & production of useful compounds and uses of biosensors.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	The students are able to know the alternate energy sources and generation of energy from biomass energy	Presentation/Video.	Quiz,Assignment, seminar.
IV	The students are be able to understand the concepts and methods in genetic Engineering	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	The students are be able to acquire knowledge on applications of genetic engineering	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings:

Text Books

1. Dubey R.C., 2001. A text book of Biotechnology 1st Edition. S.Chand &Company Ltd., New Delhi.

2. Chhatoval G.R., 1995. Text book of Biotechnology, 1st Edi, Anmol Publications Pvt. Ltd., New Delhi.

3. Kumar H.D., 1991. A text book on Biotechnology 2nd Ed, East-west Press Private Ltd., New Delhi. Pg.1-250; 411-472; 534-555.

Reference Books

1. Dubey, R.C. 2001. A Text Book of Biotechnology .S. Chand & Company Ltd., Ramnagar, New Delhi.

2. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.

3. Kumar, H.D. 1993. Molecular Biology & Biotechnology, Vikas Publishing House Pvt., Ltd., New Delhi.

4. Kumar, H.D. 1991 Biotechnology, 2nd Ed., East – West Press Private Ltd., New Delhi.

5. Trevan, M.D, Boffey, S., Goulding, K.H. and Stanbury, P. 1990. Biotechnology- The basic Principles. Tata McGraw Hill, New Delhi.

6. Demain, A.L., Solomon, N.A. 1986. "Manual of Industrial Microbiology and Biotechnology", ASM Press, Washington.

MMB201-P

Microbial Physiology and Metabolism-Lab

Microbial Physiology and Metabolism:

- Determination of viable number of Bacterial cells in a given sample.
- Determination of bacterial growth by turbidity measurements (Bacterial growth curve).
- To study the microscopic measurements.
- To study the types of growth (synchronous, diauxic, batch).
- Effects of incubation temperature on the growth of microorganisms.
- To study the lethal effect of temperature.
- Effects of different pH on the growth of microorganisms.
- To study the bacterial growth under aerobic, microaerophilic and anaerobic conditions.
- Effect of salt concentration on the growth of microorganisms.
- Preparation of selective and differential media for the growth of microorganisms.
- Ferrmentation of different carbohydrates.Morphological, Physiological and Biochemical tests of selected bacterial cultures.

MMB202-P

Medical Microbiology -Lab

Medical Microbiology:

- Fixation of smears for microscopy by different methods,
- Different staining techniques, Simple staining, Negative staining, Gram's staining,
- Ziehl-Neelsen method for AFB,
- Fluorchrome staining,
- Leishman's stain,
- Giemsa's staining,

- Preparation of culture media: Simple tissue culture methods for growing different pathogenic microorganisms,
- Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi.
- Anaerobic culture method-Principles of automated methods for diagnostic microbiology, Isolation of pure cultures and preservation techniques,
- Drug susceptibility testing by various methods.

MMB203-P

Microbial Genetics-Lab

Microbial Genetics:

- Inactivation of microorganisms by different mutagens.
- Production, isolation and characterization of mutants.
- Determination of mutation rate.
- Isolation, characterization and curing of plasmids.
- Preparation of competent cells,
- Transformationof*E.coli*. using plasmid DNA
- Transfer of plasmid by conjugation, electroporation. T
- etrad and random spore analysis

MMB204-P

Biotechnology and Genetic Engineering-Lab

- Isolation of plasmid and genomic DNA, Plasmid as cloning vector,
- Restriction enzymes and their role in biotechnology,
- Ligation method,
- Expression of recombinant proteins using bacterial, animal and plant vectors,
- Agrobacterium-mediated gene transformation,
- Preparation of competent cells and transformation,
- Study microbial cell and enzyme immobilization. Designing of gene specific primers.

- Estimation of protein, RNA and DNA;
- SDS-PAGE of proteins; DNA isolation;
- Purification; polymerase chain reaction; DNA restriction analysis; RFLP and RAPD analysis; Transformation of *E. coli* using plasmid DNA,
- Genetic improvement of Isolated industrially important microorganisms for production of microbial metabolites.
- Comparative studies of ethanol production using different substrates,
- Production of antibiotics and microbial enzymes.

Suggested readings:

1. Cappuccino J.G. and Sherman N., A Laboratory Manual, Addison-Wesley.

2. Becker J.M., Coldwell G.A. & Zachgo E.A., Biotechnology – a Laboratory Course,Academic Press.

3. Sambrook J., Fritsch T. & Maniatis T. 2001.

MMB205A

Entrepreneurship

Course Objective: The goals of this programme are to inspire students and help them imbibe an entrepreneurial mind-set. The students will learn what entrepreneurship is and how it has impacted the world and their country. They will be introduced to key traits and the DNA of an entrepreneur, and be given an opportunity to assess their own strengths and identify gaps that need to be addressed to become a successful entrepreneur. The programme comprises several short courses, each focusing on a specific entrepreneurial knowledge or skill requirement such as creative thinking, communication, risk taking, and resilience and helping them become career ready, whether it is entrepreneurship or any other career.

Course Learning Outcomes: After completion of these courses students will be able to understand-

C At the end of the course, the students will:

- Develop awareness about entrepreneurship and successful entrepreneurs.
- Develop an entrepreneurial mind-set by learning key skills such as design, personal selling, and communication.
- Understand the DNA of an entrepreneur and assess their strengths and weaknesses from an entrepreneurial perspective.

Unit I **Contact Hours: 12**

Entrepreneurship: Concept of Entrepreneur, Entrepreneurship and Manager, Difference between Entrepreneur and Entrepreneur, Entrepreneurship, Attributes and Characteristics of successful entrepreneurs. Functions of an Entrepreneurs Function of an Entrepreneur, Classification of Entrepreneurs, Role of Entrepreneur in Indian Economy, Developing Entrepreneurial culture, Factors influencing Entrepreneurship Growth – Economic, Non-Economic Factors, For profit or Not for profit entrepreneurs, Constraints for the Growth of Entrepreneurial Culture, Entrepreneurship as a career, Entrepreneurship as a style of management, Emerging Models of Corporate Entrepreneurship, India's start up revolution-Trends, Imperatives, benefits: the players involved in the ecosystem, Business Incubators-Rural Entrepreneurship, social entrepreneurship, women entrepreneurs, Cases of Tata, Birlas, Kirloskar and new generation entrepreneurs in India.Case study on related topics.

Unit II **Contact Hours: 12**

Theories of entrepreneurship: Innovation Theory by Schumpeter & Imitating, Theory of High Achievement by McClelland, X-Efficiency Theory by Leibenstein, Theory of Profit by Knight, Theory of Social change by Everett Hagen.Case study on related topics.

Unit III **Contact Hours: 12**

Entrepreneurship development: Entrepreneurial Competencies, Developing competencies, concept of entrepreneurship development, Entrepreneur Training and developing, Role of Entrepreneur development Programs (EDP), Role of DIC, EDII, NIESBUD, NEDB, EDP – Objectives – contents – methods – execution, Mudra Yojna: Shishu, Kishore and Tarun Scheme. Role of Mentors. Innovation and Entrepreneurship, Design Thinking Process, Role of consultancy organizations in promoting Entrepreneurs, Problems and difficulties of Entrepreneurs – Marketing Finance, Human Resource, Production; Research – external problems, Mobility of Entrepreneurs,Entrepreneurial change, occupational mobility – factors in mobility.Case study on related topics.

Unit IV **Contact Hours: 12**

Role of Central government and State Government in promoting Entrepreneurship:Introduction to various incentives, subsidies and grants, Export Oriented Units, Fiscal and Tax concessions available, Women Entrepreneurs – Role, Problems and Prospects, Reasons for low women Entrepreneurs, Assistance Programme for Small Scale Units – Institutional Framework – Role of SSI Sector in the Economy – SSI Units – Failure, Causes and Preventive Measures – Turnaround Strategies. Future of Entrepreneurship Development and Government, Start Up India, Make in India.Case study on related topics.

Unit V **Contact Hours: 12**

Enterprise Promotion: Creating Entrepreneurial Venture, Entrepreneurship Development Cycle, Business Planning Process The business plan as an entrepreneurial tool, Elements of Business Plan, Objectives, Market Analysis, Development of product/ idea –Resources, Capabilities, and strategies, identifying attributes of strategic resources, Opportunity Analysis, innovator or imitator, SWOT analysis, Internal and External Environment Analysis, Industry Analysis, Embryonic Companies and Spin off's, Porter's five forces model, Identifying the right Business Model Canvas, Seven Domains of John Mullins, Opportunities in Emerging/Transition/Decline industries, Opportunities at the bottom of the pyramid, Opportunities in social sector, Opportunities arising out of digitization, Marketing, Finance, Organization & Management, Ownership – Franchising, networking and alliances, Buying an existing business, Critical risk contingencies of the proposal, Scheduling and milestones.Case study on related topics.

Text Books:

1. Vasant Desai (2011), Dynamics of Entrepreneurship Development, Himalaya Publishing House.
2. David H. Holt, (1991) Entrepreneurship: New Venture Creation, Prentice Hall.
3. K. Nagarajan, (2017) Project Management, New Age International Pvt Ltd.

Reference book:

1. The Culture of Entrepreneurship, Brigitte Berger.
2. Entrepreneurship: Strategies and Resources, Marc J, Dollinger.

MMB205A

INTELLECTUAL PROPERTY RIGHTS

Objectives

1. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries and Research.
2. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
3. To disseminate knowledge on copyrights and its related rights and registration aspects
4. To disseminate knowledge on trademarks and registration aspects
5. To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
6. To aware about current trends in IPR and Govt. steps in fostering IPR and case studies .

Objectives

7. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries and Research.
8. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
9. To disseminate knowledge on copyrights and its related rights and registration aspects
10. To disseminate knowledge on trademarks and registration aspects
11. To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
12. To aware about current trends in IPR and Govt. steps in fostering IPR and case studies .

Unit-1 Overview and Introduction of Intellectual Property

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994, Phonograms or Geneva Convention, History of IPR.

Unit-2 Patents and Drafting

Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board, Patent Filing and Drafting
Case studies, Patent Agents role in India.

Unit-3 Copyrights in IPR

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights, Filing and Drafting the Copyrights.

Unit-4 Trademarks and Trading licences

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board, Trading licence importance of exports and imports in trading.

Unit-5 IP transactions; Enforcement of IP, Commercialisation

Implications of Intellectual Property Rights in promoting innovations and their commercialization; technology transfer, Due diligence in patent transactions. Working of patents in India Compulsory licence and its implications; Enforcement of Patents against infringer.

Industrial Designs Registrations: Classification, Protection and Enforcement of Industrial Designs in Indian. Registration and protection of design in India and abroad.

Geographical Indications:Concept of Geographical Indications and GI registration in India; Global scenario of GI. Protection of Traditional Knowledge and development of balanced benefit sharing models; management of GI to enhance the economic returns from GIs. Enforcement of GI. GI registrations process in India Case studies.

Case Studies and Discussions related to IPR

Learning Outcomes

1. The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works during their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search.

2. This course provide further way for developing their idea or innovations.

3. To Pave the way for the students to catch up Intellectual Property(IP) as an career option a. R&D IP Counsel b. Government Jobs – Patent Examiner c. Private Jobs d. Patent agent and Trademark agent e. Entrepreneur

Assessment Tools: Written examinations, Case study discussions, Viva examinations.

REFERENCE BOOKS

Text book

1. Rimmer, M. (2008). *Intellectual property and biotechnology: biological inventions*. Edward Elgar Publishing.
2. Singh, H. B., Jha, A., &Keswani, C. (Eds.). (2016). *Intellectual property issues in biotechnology*. CABI.
3. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
4. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

E-resources:

1. Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. 2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

Reference Journal: 1. Journal of Intellectual Property Rights (JIPR): NISCAIR http://nopr.niscair.res.in/handle/123456789/45 (Case Studies)

Useful Websites:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

MMB301

Immunology

Course Objectives:

- To impart through knowledge of Immunology.
- To train the students to pursue further education.
- To be familiar with Immunological tools.

Course learning Outcomes:

Upon successful completion of the course, students are expected to be able to:

- Demonstrate an understanding of key concepts in immunology.
- Understand the overall organization of the immune system .
- Learn about immunization and their preparation and its importance.
- Begin to appreciate the significance of maintaining a state of immune tolerance sufficient to prevent the emergence of autoimmunity.
- To make them understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies

Unit I

Historical background, Innate and adaptive immunity; Cells and organs involved in immune system; Antigens and Antibodies-Properties and types; Haptens and Adjuvants. Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype). Genesis of antibody variability. Concept of tolerance, immunopotentiation and immunosuppression.

Unit II

Immunological principles of various reactions and techniques: Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA, western blotting, immunofluorescence, RIST, RAST, MLR, flow cytometry and fluorescence, and immunoelectron microscopy; Hybridoma technology, monoclonal antibodies and abzymes; Antibody engineering.

Unit III

Organization of Major histocompatibility complex (mice and humans). Structure and cellular distribution of HLA antigens, antigen processing and presentation, cytosolic and endocytic pathways. Complement system: Components of the complement activation , classical, alternative and lectin pathways; Complement activation

Unit IV

Types and mechanism of hypersensitive reactions; Autoimmunity - theories, mechanism and diseases with their diagnosis; tumor immunology - tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors - detection of tumor markers – α foetal proteins, carcinoembryonic antigen etc

Unit V

Immunodeficiency disorders: Animal models of primary immunodeficiency (nude mouse and SCID mouse). Specific impaired functions in lymphoid lineage (SCID, DiGeorge syndrome), myeloid lineage (CGD and Chediak, Higashi Syndrome).

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Demonstrate an understanding of key concepts in immunology.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.
II	Understand the overall organization of the immune system .	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Learn about immunization and their preparation and its importance.	Presentation/Video.	Quiz,Assignment, seminar.

IV	Begin to appreciate the significance of maintaining a state of immune tolerance sufficient to prevent the emergence of autoimmunity.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	To make them understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings :

1. Clark, W.R., "The Experimental Foundations of Modern Immunology (1991): John Wiley and Sons. Inc.

2. Roitt, I.M: Essential Immunology (1995): Blackwell Scientific Publications, Oxford.

3. Roth, J.A. (1985): Virulence Mechanism of Bacterial Pathogens. American Society for Microbiology, Washington D.C.

4. Stiehm F. (1980), "Immunological Disorders in Infants and Children" (1980): W.B. Saunders & Co., Philadelphia.

5. Stites, D.P. Stobo, J.D. feudenberg, H.H., Wells J.V.:Basic and Clinical Immunology, (1984): Lange Medical Publications., Los Altos., Clifomia.
6. Todd, I.R. (1990): Lecture Notes in Immunology, Blackwell Scientific Publications Ltd., Oxford.

MMB302

Molecular Microbiology

Unit I

History of molecular biology; Nucleic acids as hereditary material; Structure of nucleic acid; Secondary and tertiary structure of nucleic acids; Types of RNA - rRNA, tRNA and mRNA; structure of ribosomes; Nucleases; Restriction and modification; Nucleic acid sequencing; DNA replication and DNA polymerases of *E.coli*.

Unit II

Transcription; RNA polymerases; Types of promoters; Reverse transcriptase and RNA replicase; Genetic code; Translation; Gene regulation at transcriptional and translational level; Operon-positive and negative control; Attenuation; Molecular mechanism of mutation; Mechanism of DNA repair.

Unit III

Molecular organization of eukaryotic genome- Structure of genomes, Chromatin; Types of DNA polymerases, DNA replication;

Types of RNA polymerases- Transcription, Structure of primary transcript; Ribozyme, RNA processing and alternate splicing;

Structure of ribosomes and translation in eukaryotes; Development and differentiation; Molecular evolution.

Unit IV

Cell division cycle- Check points in cell cycle; apoptosis and its pathways; Oncogenes-Retroviruses, Tumor suppressor p53, Telomere shortening, Ras oncogenes; Oncoproteins and gene expression; Genetic instability and cancer.

Suggested readings:

1. Lewin, B. Gene X, Oxford University Press.

2. Brown, T.A. Genomes, John Wiley and Sons Inc.

3. Brown. T.A. Molecular Biology LabFax, Bios Scientific Ltd.Oxford.

4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. Molecular Biology of the Cell, Garland Publishing.

5. Watson, J.D, Weiner, A.M and. Hopkins, N.H Molecular Biology of the Gene Addison-Wesley Publishing.

6. Lodish, H., Berk, A., Zipursky, S., Matsudaira, P., Baltimore, D. and Darnell, J.E Molecular Cell Biology, W.H. Freeman and Company.

MMB303A

Industrial Microbiology

Course Objectives:

- To impart in-depth knowledge of Industrial Microbiology.
- To impart theoretical knowledge of role of microbes in industrial production of different biochemicals/bio-molecules.
- The theory syllabus covers area such as design of bioreactors, media formulations and factors affecting the industrial production of bio-chemicals along with approaches that can be used for enhanced production.
- Role of micro-organism in production of organic acids, alcohols, wine, vinegar, enzymes, vitamins, antibiotics, amino-acids and steroids.

Course Learning Outcomes:

- **COI:** Learning of different fermentation techniques, bioreactor design,inoculum development for industrial fermentations, Microbial growth and product formation kinetics, media formulation and sterilization, isolation, preservation and improvement of industrially important micro-organisms.
- **COII:**Understanding of industrial production and purification of organic acids, alcohols, wine and vinegar with help of different microbes.
- **COIII:** Understanding of industrial production and purification of antibiotics, enzymes, amino acids and¬ steroids.
- **COIV:** Understanding of different pathways followed in or by the microbes involved in production of these bio-chemicals. Method of manipulating these pathways to get desired yield.
- **COV:** Understanding of application of these bio-molecules in benefit of mankind.

Unit I

Introduction and scope of industrial microbiology; Biology of industrially important microbes (metabolic pathways and control mechanisms); Isolation and selection of industrially important microorganisms; Genetic improvement of microbes; Preservation and maintenance of microbial cultures.

Unit II

Microbial substrate- Media formulation, Optimization of media; Cell growth kinetics: Kinetics of substrate utilization, biomass production and product formation in batch, fed batch and continuous cultivations; Kinetics of death of microorganisms

Unit III

Types of fermentation processes; Solid state, Static and submerged fermentations; Design of laboratory bioreactor; Types of Bioreactor: Stirred tank reactor, bubble column reactor, Airlift reactor, Packed bed reactor, Fluidized bed reactors; Scale-up principles; Instrumentation and control of bioprocesses; Downstream process; Fermentation economics.

Unit IV

Types of microbial products; Production of Biomass: Baker's Yeast, Mushroom, Single cell proteins, Biopesticides and biofertilizers; Production of primary metabolites: Ethanol; organic acids; Amino acids; Vitamins; Bioplastics; Industrial enzymes. Production of secondary metabolites: Antibiotics (penicillin, cephalosporins, streptomycin, etc), Pigments, Microbial transformation, Production of metabolites of non-microbial origin eg Insulin, Interlukin, Cytokines etc using rDNA technology. Designer microbes using synthetic genome.

Unit V

Strain development strategies. Environmental factors and genetic factors for improvement. Immobilization methods: Absorption, covalent linkage, entrapment and cross linkage, types of carriers, advantage and disadvantages.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Learning of different fermentation techniques, bioreactor design,inoculum development for industrial fermentations, Microbial growth and product formation kinetics, media formulation and	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.

	sterilization, isolation, preservation and improvement of industrially important micro-organisms.		
II	Understanding of industrial production and purification of organic acids, alcohols, wine and¬ vinegar with help of different microbes.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Understanding of industrial production and purification of antibiotics, enzymes, amino acids and¬ steroids.	Presentation/Video.	Quiz,Assignment, seminar.
IV	Understanding of different pathways followed in or by the microbes involved in production of¬ these bio-chemicals. Method of manipulating these pathways to get desired yield.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Understanding of application of these bio-molecules in benefit of mankind¬	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested readings:

1. Stanbury P. F., A. Whitaker, S. J. Hall. Principles of Fermentation Technology Publisher: Butterworth-Heinemann
2. Shuler M.L. and F. Kargi: Bioprocess Engineering Basic Concepts by Publisher Prentice Hall.
3. Vogel H.C., C.L. Todaro, C.C. Todaro: Fermentation and Biochemical Engineering Handbook: Principles, Process
   Design, and Equipment by Publisher: Noyes Data Corporation/ Noyes Publications.
4. W. Crueger and A.Crueger: Biotechnology. A Textbook of Industrial Microbiology, Publisher : Sinauer Associates.
5. Prescott and Dunn's Industrial Microbiology.Publisher: Gerald Reed: Books.

6. Casida L. E. J. R: Industrial Microbiology by Publisher: New Age (1968)
7. Shukla P. and Pletschke, Brett I. (Eds.) (2013) Advances in Enzyme Biotechnology, Springer-Verlag Berlin Heidelberg. ISBN 978-81-322-1094-8 (ebook); ISBN 978-81-322-1093-1 (Softcover)

[URL: http://link.springer.com/book/10.1007%2F978-81-322-1094-8]

MMB303B

Food Microbiology

Course Objectives

- The course aims to provide instruction in the general principles of food microbiology.
- The course covers the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses,
- Understand food spoilage microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.

Course Learning Outcomes:

- Understand the principles of microorganisms during various food-processing and preservation steps.
- Comprehend the interactions between microorganisms and the food environment, and factors¬influencing their growth and survival.
- Understand the significance and activities of microorganisms in food.
- Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and¬methods for their isolation, detection and identification.
- Analyze the importance of microbiological quality control programme's in food production. Discuss the microbiology of different types of food commodities.
- Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food.

Unit I

Food and Microorganisms- Historical developments, Microorganisms important in food molds, yeast and bacteria- general characteristics, classification and importance; Factors affecting growth of microorganisms-Hydrogen ion conc., water activity, oxidation reduction potential, nutrient content, inhibitory substances and biological structure.

Unit II

Spoilage and preservation of foods- Microorganisms associated with plants, soil, animals, water and air; Spoilage and preservation of different foods-Vegetables, fruits, cereals, sugar and its products, milk and its products, meat and meat products, poultry, fish and sea foods. Food preservation techniques.

Unit III

Food fermentation- Production methods of bread, cheese, fermented vegetables and dairy products, vinegar, wine, oriental fermented foods on industrial scale, microbes as a single cell protein (quron and pruteen), Mushrooms: nutritive values of mushrooms, Edible and poisonous Mushrooms.

Unit IV

Food borne infections and intoxications-Bacterial and nonbacterial infection with examples of infective and toxic types, *Brucella*, *Bacillus*, *Clostridium*, *Escherichia, Salmonella*, *Shigella, Staphylococcus* , *Vibrio*, *Yersinia*, fungi (*Aspergillus*, *Penicillium*) viruses (*Hepatitis*, *Poliomylitis*) and nematodes and emerging food-borne pathogens; Foodborne outbreaks, laboratory testing procedures and preventive measures, food sanitation in manufacture and retail trade.

Unit V

Contamination and spoilage-cereals, sugar products, vegetables, fruits, meat and meat products, fish and sea food, poultry and canned food, detection of spoilage and characterization, methods of food preservation. Food poisoning and foodborne infections; Bacterial toxins and mycotoxins in food; Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI, NABL.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Understand the principles of microorganisms during various food-processing and preservation steps.	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.
II	Comprehend the interactions between microorganisms and the food environment, and factors¬influencing their growth and survival.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test.
III	Understand the significance and activities of microorganisms in food.	Presentation/Video.	Quiz,Assignment, seminar.

IV	Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and¬methods for their isolation, detection and identification.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Analyze the importance of microbiological quality control programme's in food production. Discuss the microbiology of different types of food commodities.	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings

1. Adams, M. R. and Moss, M. O. (2005) Food Microbiology (Second edition).Royal Society of Chemistry Publication, Cambridge.
2. Jay, J.M. (2008) Modern Food Microbiology (Sixth Edition).Aspen Publishers, Inc.Gaithersburg, Maryland.
3. Ray, B. (2005) Fundamental food microbiology (Third edition). CRC Press, New York, Washington D.C.
4. Frazier, W. C. and Westhoff, D. C. (2007) Food Microbiology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
5. George J Banwart. 1989. Basic Food Microbiology. AVI publication.
6. Peppler HJ & Perlman D.1979. Microbial Technology. 2nd Ed. Academic Press.

MMB304A

Biochemical and Biophysical Techniques

Course Objectives:

To introduce the student to the variety of biophysical and biochemical techniques currently available to probe the structure and function of the biological macromolecules, make them aware of the physical principles behind each technique and the instrumentation involved, make them familiar with various methods of analyzing the output data, and to build a strong foundation in

Course Learning Outcomes:

Upon successful completion of the course, the student will:

COI: Be familiar with the output of fluorescence and confocal microscopy .

COII: Be able to carry out the analysis of the data from CD and Fluorescence experiments to monitor the stability of the protein under different environmental conditions

COIII: Be able to design a multi-step purification protocol for a target protein.

COIV: Be able to perform chromatographic methods of separation.

COV: Be able to understand and correctly interpret the migration of protein molecule on PAGE under native and SDS conditions

Unit I

Basics of microscopy: image formation, magnification, resolution, Biological applications and instrumentation of various kinds of microscopy: Optical Microscopy, Fluorescence, Confocal and Electron, Differential centrifugation and purification by density gradient centrifugation.

Unit II

Spectrophotometry: Various theories exploring the concept of light: Corpuscular theory, Wave theory, Electromagnetic theory, Planck's concept and modern theory, Basic concepts, principles and biological applications of different types of spectroscopy: absorption spectroscopy, fluorescence spectroscopy, phosphorescence, Infrared and Raman spectroscopy, Optical Rotatory Dispersion (ORD), Circular Dichroism (CD).

Unit III

Isolation and purification of microbial protein, Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method,

Polyacrylamide gel electrophoresis (PAGE), native and SDS, PAGE, 2D,PAGE, capillary electrophoresis, IEF.

Unit IV

Chromatographic methods of separation, Principles and applications of Paper, Thin layer chromatography, Gas, Liquid chromatography, HPLC and FPLC; PCR & its types

Unit V

Antisense and RNAi technology, Protein and DNA sequencing techniques, Maxam–Gilbert sequencing, Chain termination methods, Next generation sequencing technologies, Pyrosequencing. Genomic and cDNA library preparation, RFLP, RAPD and AFLP techniques. Autoradiography, applications of radioactive tracers in biology, FACS.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Be familiar with the output of fluorescence and confocal microscopy .	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz.
II	Be able to carry out the analysis of the data from CD and Fluorescence experiments to monitor the stability of the protein under different environmental conditions	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test, Group discussion
III	Be able to design a multi-step purification protocol for a target protein.	Presentation/Video.	Quiz,Assignment, seminar, Group discussion
IV	Be able to perform chromatographic methods of separation.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

V	Be able to understand and correctly interpret the migration of protein molecule on PAGE under native and SDS conditions	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.

Suggested Readings:

1. Clark JM. 1977. Experimental Biochemistry. 2nd Ed. WH Freeman. Sawhney SK & Singh R. 2000. Introductory Practical Biochemistry. 2nd Ed. Narosa.
2. Willard M, Merritt LL & Dean JA.1981. Instrumental Methods of Analysis. 4th Ed. Van Nostrand.
3. William BL & Wilson K. 1975. Principles and Techniques of Practical Biochemistry. Edward Arnold.
4. Wilson K, Walker J & Walker JM. 2005. Principles and Techniques of Practical Biochemistry. Cambridge Univ. Press.
5. Kolowick NP & Kaplan NP. Methods in Enzymology. Academic Press (Series).
6. Plummer DT. 1998. An Introduction to Practical Biochemistry. 3rd Ed. Tata McGraw Hill.
7. Rickwood D. (Ed.). 1984. Practical Approaches in Biochemistry. 2nd Ed. IRL Press, Washington DC.
8. Wilson K & Goulding KH. 1992. A Biologist's Guide to Principles and Techniques of Practical Biochemistry. 3rd Ed. Cambridge Univ. Press.
9. Wilson K & Walker J. 2000. Principles and Techniques of Practical Biochemistry. 5th Ed. Cambridge Univ. Press. 30

MMB304B

Downstream processing

Unit I

Role and importance of downstream processing in biotechnological processes. An overview of bioseparation; Problems and requirements of bioproduct purification; Characteristics of biological mixtures; Downstream process economics.

UNIT-II

Physico-chemical basis of bio-separation processes. Removal of particulate matter; biomass; and insolubles: flocculation and sedimentation; centrifugation and filtration methods; Cell disruption methods; Enrichment Operations: precipitation methods (with salts; organic solvents; and polymers; extractive separations; aqueous two - phase extraction; supercritical extraction); adsorption method.

Unit III

Membrane separations: Membrane based separation theory; Types of membranes; Types of membrane processes (Dialysis; Ultrafiltration; microfiltration and Reverse Osmosis). Chromatographic separations: Paper; TLC; Adsorption; Ion exchange; Gel filtration; affinity chromatographic separation processes; GC; HPLC; FPLC; Electrophoretic separation.

Unit IV

Final product polishing and Case studies: Products polishing: Crystallization and drying; Purification of cephalosporin; aspartic acid; Recombinant Streptokinase; Monoclonal antibodies; Tissue plasminogen activator; Taq polymerase; Insulin.

Suggested readings:

1. Chromatographic and Membrane Processes in Biotechnology by C.A. Costa and J.S. Cabral. Publisher: Kluwer Academic Publishers
2. Bioseparations: Downstream Processing for Biotechnology by P.A. Belter et al. Publisher: John Wiley and Sons Inc
3. Bioseparations by P.A. Belter, E.L. Cussler and W.S. Hu. Publisher: John Wiley and Sons Inc.

4. Biochemical Engineering Fundamentals by J.E. Bailey and D.F. Ollis. Publisher: McGraw-Hill.
5. Downstream Processing by J.P. Hamel, J.B. Hunter and S.K. Sikdar. Publisher: American Chemical Society.

MMB301P

Immunology-Lab

Immunology:

- Determine total leucocyte count (TLC) of a given blood sample.
- To perform differential leucocyte count (DLC) of the blood sample.
- Separation of serum from the blood sample,
- Identification of human blood groups
    - ABO and Rh factor,
- Immunodiffusion by Ouchterlony method,
- Immuno-electrophoresis with a given antigen,
- antibody system,
- Dot- ELISA;
- Demonstration of Western blotting.

MMB302P

Molecular Microbiology-Lab

Molecular Microbiology:

- To study agarose gel electrophoresis of genomic DNA,
- To study genomic DNA isolation from bacteria and fungi, DNA isolation from humus rich soil samples and diversity study using 16s rDNA primers,
- To study restriction profile of isolated DNA and plasmid samples,
- Isolation of plasmids from *E.coli DH5α* cells,
- Isolation of DNA fragments which carry promoter sequence,
- Synthesis and codon modification of bacterial hemoglobin gene,
- Agrobacterium mediated gene transformation studies in fungi,
- To prepare chemically competent cells of *E. coli* DH5α and determine their transformation efficiency,
- To amplify the laccase/phytase/xylanase gene by Polymerase Chain Reaction,

- To clone the laccase/cellulase/phytase/xylanase amplicon into the TA cloning vector pGEM-T.

MMB303A(P)

Industrial Microbiology-Lab

Industrial Microbiology:

- Isolation of industrially important microorganism from different sources using specific substrates;
- Design and Preparation of Media for Bioprocesses;
- Growth curve studies of bacteria/Yeasts in batch culture and calculation of maximum specific growth rate;
- To study the various methods of biomass measurement;
- Production of ethanol from sucrose by yeast;
- Determination of yield coefficient and Monod's constant and metabolic quotient of E.coli culture on glucose.;
- To study the design of fermenter and its working;
- Production of citric acid using sucrose and molasses;
- Production of extracellular enzymes ;
- Ethanol production using immobilized yeast culture.

MMB303B(P)

Food Microbiology-Lab

Food Microbiology:

- Isolation of Lactobacilli from curd or milk sample,
- Detection of number of bacteria in milk by SPC,
- Determination of quality of milk sample by methylene blue reductase test (MBRT), Microbiological examination of different food samples;
- Production of Sauerkraut by microorganisms,

- Determination of antibacterial activity of lactic acid bacteria using agar well diffusion method.
- Statutory, recommended and supplementary tests for microbiological analysis of various foods: Baby foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers and water.

MMB304A(P)

Biochemical & Biophysical Techniques -Lab

Biochemical & Biophysical Techniques:

- Determination of absorption maxima of some important chemicals from their absorption spectra,
- Estimation of biomolecule using spectrophotometer,
- Separation of carbohydrates and amino acids by paper chromatography,
- Separation of lipids by thin layer and column chromatography,
- Separation of proteins by ion exchange and gel filtration chromatography,
- Electrophoretic techniques to separate proteins and nucleic acids,
- Preparation of stock solutions and buffers;
- Standard curves of BSA;
- Estimation of protein, RNA and DNA;
- SDS-PAGE of proteins;
- Polymerase chain reaction;
- RAPD analysis;
- DNA restriction analysis.

MMB304B(P)

Downstream Processing-Lab

Downstream Processing: Separation of microbial biomass from culture medium, Isolation of cell bound and intracellular product, Cell lysis and different methods, Isolation and purification of a protein by salt and solvent precipitation, Study the application of dialysis in downstream processing of a product, Product recovery and purification by different chromatography techniques such as gel filtration, ion exchange and other chromatography, Determination of

molecular mass of a protein using SDS-PAGE and gel filtration chromatography, Ultrafiltration and its application in purification.

Suggested readings:

1. Cappuccino J.G. and Sherman N., A Laboratory Manual, Addison-Wesley.

2. Work T.S. and Work R.H.E., Laboratory Techniques in Biochemistry and Molecular Biology. Elsevier Science

3. Becker J.M., Coldwell G.A. & Zachgo E.A., Biotechnology – a Laboratory Course, Academic Press.

4. Sambrook J., Fritsch T. & Maniatis T. 2001.

MMB401

Virology

Course Objectives:

The course will facilitate in understanding of molecular virology by examining common processes and principles in viruses to illustrate viral complexity, to understand viral reproduction. The course will teach the strategies by which viruses spread within a host, and are maintained within populations. It covers the molecular biology of viral reproduction and addresses the interplay between viruses and their host organisms

Course Learning Outcomes:

At the end of this course the students will be able to:

COI: Describe classification of viruses, Know concept of viroids, satellites and prions

COII: Learn different techniques in cultivation of viruses.

COIII: Understand details about bacterial viruses, animal and plant viruses.

COIV: Students are able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection.

COV: Students are able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses

Unit I

Brief outline on discovery of viruses, nomenclature and classification of viruses; Viral genome, their types and structures; virus related agents; Viral replication cycles: - Lytic cycle, - Lysogeny

Unit II

Viral cultivation, assay and diagnosis; primary & secondary cell cultures; Assay of viruses, physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy), Infectivity assay (plaque method, end point method) – Infectivity assay of plant viruses. Haemagglutination & HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmunoassays.

Unit III

Bacterial Viruses-Bacteriophage structural organization; life cycle: lytic and lysogenic cycle, application of bacteriophages; briefdetails on M13,Mu,T7,T4, Lamda and P1. Viruses of cyanabacteria, algae, fungi.

Unit IV

Plant Viruses- Structure and life cycle of plant viruses.

Propagation,purification,characterization,identification and symptoms of diseases caused by plant viruses like TMV, Cauliflower MosaicVirus ,Gemini virus and Potato Virus X, Transmission of plant viruses,Some common Viriod diseases:Papaya ring spot, rice tungro, Potato spindle tuber, coconut cadang cadang.

Unit V

AnimalViruses - Structure and lifecycle of animal viruses. Replicative strategies employed by DNA and RNA viruses. Epidemiology, pathogenicity, diagnosis, prevention and treatment of Picorna,Ortho myxo, Paramyxo, Rhabdo, Pox, Herpes, Adeno, Hepatitis, HIV and other Oncogenic viruses; Viral vaccines (conventional vaccines, genetic recombinant vaccines, newer generation vaccines including DNA Vaccines with examples) interferons, and antiviral drugs.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Describe classification of viruses, Know concept of viroids, satellites and prions	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz. Group discussion
II	Learn different techniques in cultivation of viruses.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test, Group discussion
III	Understand details about bacterial viruses, animal and plant viruses.	Presentation/Video.	Quiz,Assignment, seminar, Group discussion

IV	Students are able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Students are able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest. Group discussion

Suggested Readings

1. Morag C and Timbury M.C (1994) Medical virology-X Edition. ChurchillLivingstone, London.
2. Dimmock NJ, Primrose SB (1994). Introduction to Modern Virology, IVEdition, Blackwell Scientific Publications, Oxford
3. Conrat HF, Kimball PC and Levy JA (1994) Virology-Ill Edition PrenticeHall, Englewood cliff, New Jersey.
4. Mathews, RE.,(1992) Functionals of Plant virology, Academic press, SanDiego.
5. Topley and Wilson's (1995) Text Book on Principles of Bacteriology,
6. Virology and Immunology. Edward Arnold, London.

MMB402A

Environmental Microbiology

Course Objectives:

This course aims to provide the student with an understanding of the current views of microbial association in various environments; to evaluate the continuing roles played by microbes in the environment, and to consider the non-pathogenic roles of microbes in the human body

Course Learning Outcomes:

On the completion of the course students should be able to:

CO I : Understand on soil characteristics and biogeochemical cycling

CO II : Know the microbial analysis of drinking water and aeromicrobiology

CO III : Know on the different aspects of waste management and sewage Treatment systems

CO IV : Acquire knowledge on bioremediation and microbial leaching

COV : Know the biosafety and environmental monitoring regulations

Unit I :

Soil characteristics & Biogeochemical cycling Physio-chemical properties of soil - Rhizosphere and rhizoplane organisms. Mineralization and immobilization. Biogeochemical cycling: Carbon cycling, nitrogen cycling, phosphorus cycling and sulphur cycling. Ecological groups based on oxygen requirement, nutrition, temperature, habitat (soil, water & air).

Unit- II :

Microbial analysis of drinking water & Aeromicrobiology Microbial analysis of drinking water: Tests for coliforms (presumptive, confirmed and completed tests). Purification of water: Sedimentation, Filtration (slow and rapid sand filters) and Disinfection. Aeromicrobiology - Phylloplane microflora (morphological, physiological characters: nutrition, radiation, relative humidity and temperature) – Air Pollution – aerosol, droplet nuclei and infectious dust. Examination of air microflora.

Unit- III :

Waste management & Sewage Treatment Waste management - Utilization of solid and liquid waste pollutants for production of Single-Cell protein. Nature of sewage and its composition. Physical, chemical and biological properties of sewage (BOD, COD etc). Sewage systems and types. Sewage Treatment: Single Dwelling Unit, municipal sewage treatment - primary, secondary and tertiary treatments (Trickling filters, activated sludge process, Oxidation lagoons and Imhoff tank).

Unit- IV :

Bioremediation & Microbial leaching Polluted heterogeneous environment. Indicator organisms for pollution and abatement of pollution. Bioremediation – Types and uses - Microbes and Environmental clean up - Genetically Engineered microbes for Bioremediation. Microbial leaching: In situ & Ex situ methods -copper and uranium mining.

Unit- V :

Biosafety & Environmental monitoring Environmental regulations - Biohazards - Types of hazardous emission - Biosafety measures - Biomonitority of waste water toxics - Monitoring of Genetically Engineered Microbes in the Environment.

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Understand on soil characteristics and biogeochemical cycling	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz. Group discussion
II	Know the microbial analysis of drinking water and aeromicrobiology	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test, Group discussion
III	Know on the different aspects of waste management and sewage Treatment systems	Presentation/Video.	Quiz,Assignment, seminar, Group discussion
IV	Acquire knowledge on bioremediation and microbial leaching	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	Know the biosafety and environmental monitoring regulations	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest. Group discussion

Suggested Readings

Text Books

1. Raina M. Maier, Ian L. Pepper and Charles P. Gerba. 2000. Environmental Microbiology. Academic Press. New York.

2. Atlas, R.M. and Bartha, R. 1992. Microbial Ecology: Fundamentals and Applications.III Ed., Benjamin Cummings, Redwood City.CA.

3. Pelczar.M.J. and Reid 1986 " Microbiology". V Ed., Tata McGraw Hill Co., New Delhi.

References Books

1. Mara. D and Horan. N 2003. The Handbook of Water and Waste Water Microbiology. Academic. Press, California.

2. Clescri, L.S., Greenberk, A.E. and Eaton, A.D.1998. Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health Association.

3. Raina M. Maier, Ian L. Pepper and Charles P. Gerba. 2000. Environmental Microbiology. Academic Press. New York. pp: 394-399;491-538.

4. Patel, A.H. 1996. Industrial Microbiology, Macmillan India Ltd., New Delhi.

5. Subba Rao, N. S. 1995. Soil Microbiology. IV Ed. Oxford & IBH Publishing Co. Pvt. Ltd.New Delhi. pp: 11-49; 292-301.

6. Subba Rao, N.S. 1995. Biofertilizers in Agriculture and Forestory.3rd Ed., Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.

7. Salle, A.J. 1992. Fundamental Principles of Bacteriology, VII Ed., McGraw Hill Publishing Co. Ltd., New York. pp: 649-709;794-843.

8. Kumar, H.D. 1991. Biotechnology, II Ed., East – West Press Private Ltd., New Delhi.

9. Pelczar.M.J. and Reid 1986 " Microbiology". V Ed., Tata McGraw Hill Co., New Delhi.pp:593-617.

10. Brock, T.D, Smith, D.W. and Madigan M.T 1984, Biology of Microorganisms. IV Ed., Prentice Hall Int. Inc., London.

11. Campbell, R. 1983. Microbial Ecology, II Ed., Blackwell Scientific Publishers, London.

12. Alexander, M. 1971. Microbial ecology, John Wiley & Sons Inc., New York

MMB402B

Agriculture and Soil Microbiology

Course Objectives:

- To impart in-depth information on soil and agriculture
- To make the students understand the role of microbes in agriculture
- To give an overview on plant microbe interaction.
- To understand infection process and control measures
- To know the importance of biofertilizers and biopesticides
- To make the students to know about various techniques involved in biofertilizers and biopesticides production

Course Learning outcomes:

By the end of this course students will be able to

COI : Understand the role of microbes in the different cycles and their role in agriculture

COII: Understand biological nitrogen fixation in symbiotic and non symbiotic associations with plants.

COIII: To know the value, production, application and crop response of biofertilizers and biopesticides.

COIV: To have an indepth knowledge on biopesticides and their role in pest control.

COV: To know about plant pathogenic microorganism.

Unit – I

Development of soil microbiology; Distribution of microorganisms in soil; Quantitative and qualitative microflora of soils; general description of soil, types of soil, soil profile, Role of microorganisms in soil fertility; Influence of soil and environmental factors on microflora: moisture, pH, temperature, organic matter; Distribution of microorganisms in manure and composts; Influence of soil amendments on soil microflora.

Unit – II

Microorganisms in soil processes: biogeochemical cycles, Nitrogen fixation: symbiotic, non symbiotic, associative symbiotic and endophytic organisms, process of nitrogen fixation, Molecular biology of Nitrogen fixation; Microbial transformation of phosphorus, iron, sulphur and micronutrients in soil; phosphorus solubilization by phosphobacteria; sulphur; iron bacteria and their importance.

Unit – III

Interrelationships between plants and microorganisms -Rhizosphere concept - quantitative and qualitative studies – R : S ratio - Rhizoplane -spermosphere - phyllosphere microorganisms - their importance in plant growth. PGPR (plant growth promoting rhizobacteria), siderophores and antimicrobials, microbial interactions.

Unit –IV

Biofertilizer: Mass cultivation of microbial inoculants; green manuring; Microbial products and plant health; Microbial

Pesticides: development and their significance; Source Organisms: Bacteria-*Bacillus thuringiensis*, Bt based commercial products, other Bacilli producing pesticides.

Unit-V

Plant pathogenic microorganisms Algal, fungal, bacterial, viral, mycoplasma, Nematode diseases and symptoms. Mode of entry of pathogens and factors affecting disease incidence - Plant disease resistance and various control measures. Phenolic compounds. Interaction of plant pathogens with host. Definition and History of Biopesticides – Viral (NPV, CPV & GV), bacterial (Bacillus thuringiensis, B.popillae & Pseudomonas sp.), Fungal (Entomophthora musca, Beaveria sp., Metarrhizium sp. & Verticillium sp.),Protozoan (Mattesia sp., Nosema sp., Octospora muscaedomesticae & Lambornella sp.)

FACILITATING THE ACHIEVEMENT OF COURSE LEARNING OUTCOME

UNIT NO.	COURSE LEARNING OUTCOME	TEACHING AND LEARNING ACTIVITY	ASSESSMENT TASK
I	Understand the role of microbes in the different cycles and their role in agriculture	Discussion &Presentation/Lecture.	Evaluation of Students on the basis ofPresentation,Assignment Evaluation,Quiz. Group discussion
II	Understand biological nitrogen fixation in symbiotic and non symbiotic associations with plants.	Application Based learning/Video , Lecture.	Evaluation of Students on the basis of Application-Based Activity,Evaluation,Assignment,Class test, Group discussion
III	To know the value, production, application and crop response of biofertilizers and biopesticides.	Presentation/Video.	Quiz,Assignment, seminar, Group discussion

IV	To have an indepth knowledge on biopesticides and their role in pest control.	Presentation/Video/ ResearchStudy	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest.
V	To know about plant pathogenic microorganism.	Lecturing / ResearchStudy/video	Evaluation of Studentsbased on ResearchStudy Presentation,Assignment Evaluation,Classtest. Group discussion

Suggested readings:

1. Subba Rao, N.S. (1999). Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Alexander, M. (1985). Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi.
3. Rangaswami. G. 1979. Recent advances in biological nitrogen fixation.Oxford and IBH. New Delhi.
4. Subba Rao, N.S. (1995) .Soil Micro organisms and plant growth, Oxford and IBH publishing Co. Pvt. Ltd.

Environmental Microbiology Lab

MMB402A-P

- Bacterial examination of water by multiple tube fermentation test.
- . Counting of MPN number.
- . Isolation and screening of cellulose degrading organism.
- . Determination of biological oxygen demand of water.
- . Effect of cleaning and sweeping of floors on the microbial population of labs.
- . Isolation of air microorganism.
- Screening for amylase producing organisms
- Isolation of rhizobia from root nodule.
- Analysis of water for pH, turbidity, color, total dissolved solids.
- . Identification and estimation of nitrate, arsenic, iron and alkanity in water.
- . Microscopic studies of fresh water algae and protozoan.
- . To check the pollution levels by collection of particulate settled on leaves at various places in the city.

Agriculture and Soil Microbiology Lab

MMB402B-P

- Isolation and characterization of microorganisms from soil
- Isolation and characterization of microorganisms from Water
- Isolation and characterization of microorganisms from air samples
- Isolation of halophiles/acidophiles/methanogens
- Isolation of Rhizobia from root nodule using Yeast Extract Agar Medium (YEMA)

MMB403P

Dissertation in Microbiology

Course Outcomes

On completion of the course, students will acquire

CO1: In-depth knowledge of the current research and development work in microbiology

CO2: The ability to plan and carry out tasks in given framework of thesis

CO3: The capability to clearly present and discuss the planned work/task both in written and spoken English.

CO4: Capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.

Note:

The Dissertation will be based upon research and actual bench work. It will be carried out IVth Semester, but review of literature etc. will be initiated in the IIIrd Semester in order to give maximum time for working of students. The dissertation will be submitted at the end of semester and will be evaluated by external and internal examiners. The dissertation topics and date of submission will be decided by Departmental committee.