CURRICULUM AND SYLLABUS of

M.Sc. Microbiology

(2019 ONWARDS)

Department of Microbiology

School of Life Sciences
**About the course**

The Department of Microbiology is committed to excellence in education, research and extension. This Department is being strengthened with various research units and periodical update / modernization of the curricula. The Department of Microbiology at the Pondicherry University, School of Life Sciences, brings together a variety of researchers as faculty of this programme who are specialized in their domains and united by the common goal of understanding the “Microbes”.

Microbes are playing important role in the bioprocess of all living things and maintain homeostasis of the universe. Without microbes, one cannot imagine such a biologically balanced and diverse universe; rather our earth would have placed as a barren planet. As the microbial activities are so diverse, the microbiology programme is a multidisciplinary subject, which will have the roots of life science, environmental science, and engineering. Traditional microbiology is considered to be an important area of study in biology since it has enormous potential and vast scope in fermentation, bioremediation and biomedical technology. But the recent developments from human microbiome project, metagenomics and microbial genome projects has expanded its scope and potential in the next generation drug design, molecular pathogenesis, phylogeography, production of smart biomolecules, etc. Modern Microbiology has expanded its roots in genome technology, nanobiotechnology, green energy (biofuel) technology, bioelectronics etc. Considering recent innovations and rapid growth of microbiological approaches and applications in human and environmental sustainability, the M.Sc. Microbiology curricula is designed to enlighten the students in basics of Microbiology to recent developments. The first semester curricula would cover basic concepts including biomolecules and metabolism, cell and molecular biology and techniques in microbiology. In the second semester, the students will study core microbiology including Microbiome biology, mycology, virology etc, subsequently they will study applied and modern microbiology including environmental, food, agriculture, aquatic microbiology, microbial genomics and metagenomics. A unique feature of the curricula includes both theory and practical course for each papers and dissertation work in the fourth semester.
**Entrance Examination**

M.Sc. Microbiology programme: The selection of student is based on All India entrance examination. The question paper will consist of objective types of questions of multiple choices. The questions will be of testing the basic knowledge of the students in cell and molecular biology, biochemistry, genetic engineering, and general and applied Microbiology.

**Teaching and Learning Methods**

Lectures, tutorials and seminars form the main methods of course delivery enhanced by individual and group project work, laboratory work, computing workshops and industrial visits.

**Assessment Methods**

Assessment will be through Choice Based Credit System (CBCS) through session by continuous assessment (class tests, assignments, seminars, laboratory works and project work and report) and end semester examinations. A thesis written for the project/dissertation will be evaluated by an expert followed by viva-voce.

Minimum credit requirement = 72; All teaching, learning and evaluations will follow Choice Based Credit System (CBCS) as per the Pondicherry University guideline’s.

**EVALUATION**

**Breakup of Internal/ External End Semester Exams:**

All subjects in a PG programme shall carry an Internal Assessment component to the extent of 40 marks and End Semester for 60 marks.

**Break up of Internal Assessment Marks**

Each teacher shall organize a continuous assessment of each of the courses assigned to him/her. The internal assessment marks shall be given as per the following breakup:

- Internal Assessment Tests / Term Papers / Quizzes (two) \(2 \times 15 = 30\)
- Seminars/ Assignments/ Case Demos/ Presentations/ Write ups/ Viva, etc. \(1 \times 10 = 10\)

Internal Total \(40\)
**Internal Assessments**

A schedule of Internal Assessment tests shall be prepared at the very beginning of the semester. Internal Assessment marks shall be displayed within a week from the date of conduct of examination and all corrected answer papers shall be given back to students with comments, if any. It is mandatory for all students to participate in all the Internal Assessment tests and in various course-work related activities for award of the above marks.

**End-semester examinations**

An End Semester examination shall be conducted for all courses offered in the department. The duration of the end semester examination shall be for 3 hours. A schedule of End Semester examinations be prepared and displayed by the department at least one-month ahead of the conduct of the examination. Each teacher shall prepare a model question paper, a Panel of External examiners and submit the same to the Head of the Department by 6th week of the Semester. The question paper should cover all the units of syllabus. Head of the Department shall coordinate the question paper setting.

**Letter Grades**

The department shall display the provisional grades within 15 days. If a student wishes to look at the evaluated answer scripts he/she can approach the concerned teacher within a week of declaration of the provisional results.

**Letter Grades Performances**

Performances of students in each paper are expressed in terms of marks as well as in Letter Grades. In case of fractions the marks shall be rounded off to nearest integer. The class interval for the purpose of awarding the grades can be arrived at by dividing the difference between the highest mark secured and the minimum pass mark by 6 as there are six passing grades. The formula is given below:

\[ K = \frac{X - 50}{6} \]

Where, \( K \) = class interval, \( X \) = the highest mark in the subject.

The grades may be awarded as given in the following table.
K should not be rounded off to less than two decimal places. The numbers given in Range of Marks column, (X-K), (X-2K), (X-3K), etc., can be rounded off to the nearest whole number. In courses where the number of students who have secured 50 marks and above is less than 10 then grading may be given based on the Table.

<table>
<thead>
<tr>
<th>Range of Marks in %</th>
<th>Letter Grade</th>
<th>Points for Calculation of GPA/ CGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>X to (X-K)</td>
<td>A+</td>
<td>10</td>
</tr>
<tr>
<td>(X-K-1) to (X-2K)</td>
<td>A</td>
<td>9</td>
</tr>
<tr>
<td>(X-2K-1) to (X-3K)</td>
<td>A-</td>
<td>8</td>
</tr>
<tr>
<td>(X-3K-1) to (X-4K)</td>
<td>B+</td>
<td>7</td>
</tr>
<tr>
<td>(X-4K-1) to (X-5K)</td>
<td>B</td>
<td>6</td>
</tr>
<tr>
<td>(X-5K-1) to (X-6K)</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>Below 50</td>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>

The GPA and CGPA will be calculated as weighted average of points secured by the student in all the papers registered by him/her. The weights are the number of credits for each paper. For example, a student getting in A grade in 4 credit course, A- grade in 2 credit course, A+ grade in a 3 credit course and F grade in a 3 credit course will have a GPA as (9x4 + 8x2 +10x3 + 0x3)/(4+2+3+3)=36+16+30+0)/12=82/12 = 6.83 out of 10.0; GPA = 6.83. The CGPA shall also be calculated in similar lines taking all subjects taken by the students in all semesters. Students with a CGPA of 9.0 and above and did not fail in any of the courses taken by him/her shall be awarded Distinction.

A CGPA of 6.0 and above shall be placed in First class.

Student who has secured less than 50% marks in any paper gets F Grade and he is treated as failed in that paper.
M.Sc. Microbiology, Department of Microbiology, School of Life Sciences

Programme objectives

1. The M.Sc. microbiology course is a multidisciplinary subject, which develop skills and knowledge base of students. M.Sc. Microbiology students able to apply their knowledge in microbial identification, diagnosis of infectious diseases and microbial processes expanded its roots across the disciplines particularly in genome technology, nanobiotechnology, green energy (biofuel) technology, bioelectronics and synthetic biology.
2. Classify microbes using molecular phylogenetics and modern taxonomy.
3. Scope and application in fermentation, bioremediation and biomedical technology.
4. Implications in the recent developments from human microbiome project, metagenomics and microbial genome projects has expanded its scope and potential in the next generation drug design, molecular pathogenesis, phylogeography, and production of smart biomolecules.

Programme outcomes

1. Students can apply their knowledge (Microbiological approaches and applications) in human and environmental sustainability.
2. Techniques and approaches in the exploration of uncultured microbial majority and Microbiome Biology.
3. The students able to apply microbiological techniques in inter-disciplinary subjects include nanotechnology, Biotechnology, bioelectronics and allied biosciences
4. Microbiology students can understand implications of global projects include Human Microbiome Project and Earth Microbiology Project.
## CURRICULUM AND SYLLABI FOR M.Sc. MICROBIOLOGY - COURSE STRUCTURE
(2019-20 onwards)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE NAME</th>
<th>COURSE CODE</th>
<th>TYPE OF COURSE</th>
<th>NUMBER OF CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I Semester- Theory Courses</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>General Microbiology</td>
<td>MICB-411</td>
<td>HC</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Microbial Genetics</td>
<td>MICB-412</td>
<td>HC</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Biochemistry</td>
<td>MICB-413</td>
<td>HC</td>
<td>3</td>
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<td>4</td>
<td>Immunology</td>
<td>MICB-414</td>
<td>HC</td>
<td>3</td>
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<tr>
<td></td>
<td>I Semester- Lab Courses</td>
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<tr>
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<td>MICB-415</td>
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<tr>
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<td>Microbial Genetics Lab</td>
<td>MICB-416</td>
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<td>3</td>
<td>Biochemistry Lab</td>
<td>MICB-417</td>
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<td>4</td>
<td>Immunology Lab</td>
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<tr>
<td></td>
<td>II Semester- Theory Courses</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Mycology</td>
<td>MICB-421</td>
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<tr>
<td>2</td>
<td>Virology</td>
<td>MICB-422</td>
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<td>3</td>
<td>Techniques in Microbiology</td>
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<td>Cell and Molecular Biology</td>
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<td>Microbiome Biology</td>
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<td>HC</td>
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<td>II Semester- Lab Courses</td>
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<td>Mycology Lab</td>
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<td>Virology Lab</td>
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<td>Instrumentation Techniques Lab</td>
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<td>4</td>
<td>Molecular Biology Lab</td>
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<td></td>
<td>III Semester- Theory Courses</td>
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<td>Medical Microbiology</td>
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<td>3</td>
<td>Applied &amp; Industrial Microbiology</td>
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<td>HC</td>
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<td>4</td>
<td>rDNA Technology</td>
<td>MICB-514</td>
<td>HC</td>
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<td>5</td>
<td>Microbial genomics</td>
<td>MICB-515</td>
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<td>III Semester- Lab Courses</td>
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<tr>
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<td>Food Microbiology Lab</td>
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<td>3</td>
<td>Applied &amp; Industrial Microbiology Lab</td>
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<td>4</td>
<td>Microbial genomics Lab</td>
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<td>IV Semester</td>
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<td>1</td>
<td>Project/ Dissertation</td>
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Total Number of credits: 60
### SOFT CORE-COURSE - COURSE STRUCTURE (2019-20 onwards)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE NAME</th>
<th>COURSE CODE</th>
<th>TYPE OF COURSE</th>
<th>NUMBER CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Industrial visit and Reporting</td>
<td>MICB-431</td>
<td>SC</td>
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<tr>
<td>2</td>
<td>Self-study Review</td>
<td>MICB-432</td>
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<td>3</td>
<td>Research Methodology – Scientific writing and publication ethics</td>
<td>MICB-433</td>
<td>SC</td>
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<tr>
<td>4</td>
<td>Research Methodology – Biostatistics</td>
<td>MICB-434</td>
<td>SC</td>
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<tr>
<td>5</td>
<td>Entrepreneurship and Microbial Industries</td>
<td>MICB-435</td>
<td>SC</td>
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<td>6</td>
<td>Public Health Microbiology</td>
<td>MICB-436</td>
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<tr>
<td>7</td>
<td>Biomolecules</td>
<td>MICB-437</td>
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<td>8</td>
<td>Microbial Physiology</td>
<td>MICB-438</td>
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<td>Microbial Technology</td>
<td>MICB-541</td>
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<td>10</td>
<td>Marine Microbiology</td>
<td>MICB-542</td>
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<td>11</td>
<td>Microbial Nanotechnology</td>
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<td>12</td>
<td>Agricultural Microbiology</td>
<td>MICB-544</td>
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<td>13</td>
<td>Fermentation Technology</td>
<td>MICB-545</td>
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<tr>
<td>14</td>
<td>Genome Technology</td>
<td>MICB-546</td>
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<td>15</td>
<td>Drug Design and Discovery</td>
<td>MICB-547</td>
<td>SC</td>
<td>3</td>
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<tr>
<td>16</td>
<td>Bioethics, Biosafety and IPR</td>
<td>MICB-548</td>
<td>SC</td>
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</table>
GENERAL MICROBIOLOGY

Course Code: MICB-411
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objectives: This course aims to introduce the history and development of Microbiology.

Pre-Requisite: Bachelor degree in Life Sciences

Unit 1 10 h


Unit 2 10 h


Unit 3 8 h

Unit-4


Unit 5

**Cultivation and control of microbes**: Types of growth media (natural, synthetic, complex, enriched, selective - definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Automation in Microbiology. Anaerobic (thioglycolate, anaerobic chamber, Robertson’s media, microaerophilic), liquid shake culture of aerobic bacteria Control of microbes - Sterilisation, disinfection, antiseptic, tyndallisation, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical methods.

**Recommended Text Books**:


**Suggested Readings**:


**Course Outcome**: The contents of this course will help students understand history, biology of microorganisms, growth and control of microbes. A unit is exclusively focused on archaea which is one of the domains of Carl Woese’s classification. Thus the beginners are rightly exposed to foundation of Microbiology which would lead them towards progressive advancement of the subject.
MICROBIAL GENETICS

Course Code: MICB-412
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objectives: The aim of the course is to provide a basic knowledge about the use of microbes in genetic studies.

Pre-Requisite: Bachelor degree in Life Sciences

Unit- 1  8 h


Unit- 2  8 h

Microbial Genetics: Branches of Genetics, Microbes as tools for genetic studies, Basic and Applied Research, Genetic maps, Genes at the molecular level.

Unit- 3  10 h

Viral Genetics- General characteristics of viral genome, T₄ virulent Phage- Structure- life cycle. Lambda temperate phage- Structure - Lytic and lysogenic cycle, Lysogenic repression. Genetic mapping of viruses, Recombination in viruses; Genetics of Bacteriophage.

Unit- 4  12 h


Unit- 5  10 h

Fungal Genetics- Features and consequences of heterothallism, homothallism, mating types, Vegetative incompatibility, Polyploidy and aneuploidy. Neurospora- Tetrad analysis and linkage detection - 2 point and 3 point crosses – Induction of Mutations - Mitotic
recombination in *Neurospora*, Gene conversion. Yeast plasmids, Mating type genetics of yeast.

**Recommended Text Books:**


**Suggested Reading:**


**Course Outcome:** Microbial Genetics is an important tool in dissecting the genetic structure of an organism. The basic principles presented in this paper is of major importance in constructing new organisms for practical applications leading to research in Genetic recombination and genetic engineering.
MICROTIAL BIOCHEMISTRY

Course Code: MICB 413
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objective: It is an interdisciplinary course designed to introduce the essential fundamentals of biochemistry. This course focuses on the concepts of biochemistry and important microbial macromolecules and their metabolism.

Pre-Requisite: Bachelor degree in Life Sciences

Unit- 1 10h
Chemistry of Life and Special Microbial Molecules:

Structure of Special Microbial Molecules: Bacteriorhodopsin, biphytanyl chains and lipids in archael cell membranes and other important adaptations in extremophiles: thermophiles and halophiles.

Unit- 2 10h
Bioenergetics: Laws of thermodynamics, concepts of entropy, enthalpy, free energy, spontaneous reactions and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions, Nernst equation under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions. ATP and other different groups of high energy phosphate compounds. Calculations of ΔG, ΔH. ATP : Energy currency of the cell.

Unit- 3 10h

Unit- 4
8 h
Macromolecules II- Carbohydrates and their Metabolic pathways and Fermentations:

Unit- 5
10 h
Macromolecules III- Lipids and Metabolism

Recommended Text Books:
4. 

Suggested Reading:

Course Outcome: On completion of the course a student will be well versed with the knowledge of bioenergetics, energy calculations at physiological conditions and central metabolic pathways in bacteria and eukaryotes.
Course Code: MICB- 414  
Total Number of Lecture hours: 40  
Total Number of Credits: 03

Course Objective: This course attempts to teach host defense system, essential concepts of immune system, host-microbial interaction, immune-diagnosis and emerging advancement of immunology.

Pre-Requisite: Bachelor degree in Life Sciences

Unit- 1

Basics of Immunology: Historic perspective, Discovery of humoral and cellular immunity, Types of Immunity (Innate & Acquired immunity), Innate immunity components-physical, physiological defenses; – complement, acute phase proteins. Acquired immunity: (specific) natural, artificial, active and passive immunity. Inflammatory response, Hematopoiesis, Cells (T cell, B cell, macrophages, neutrophils, Natural killer cells, mast cells, basophils, and eosinophils etc) & organs of Immune system (Thymus, Bone marrow, lymph node, spleen, MALT, GALT, BALT).

Unit- 2

Antigens and Antibodies: Immunogenicity versus Antigenicity, Nature of antigens; Antibody-structure and functions-subtypes; structural basis of Antibody diversity; Theories of Antibody formation., Genetic basis of antibody diversity-somatic hyper mutation recombination, class switching and clonal selection, Recent advances in the production of monoclonal antibodies and their applications, Antibody engineering.

Unit- 3

T Cell & B cell Biology: MHC restriction-antigen presentation (Organisation & inheritance of MHC, MHC molecules & genes), Role of Antigen presenting cells (APCs),Antigen processing & presentation pathways, T cells subsets, T cell maturation, activation and differentiation, B cells subsets, B cell generation, activation and differentiation

Unit- 4

Immunity in Health & Diseases: Infection-Immunity& signal transduction pathways (antibacterial, antiviral and anti fungal immune responses), Immune system Disorders (Hypersensitivity Type-I to TypeIV), Immunodeficiency diseases (Primary and secondary immunodeficiencies), Auto immune diseases (organ specific and systemic), Prevention & therapy (Vaccine, cell therapy, cytokine and antibody therapy).
Unit- 5 8 h

**Immunotechniques and Immunodiagnosis:** Immune cell culture, ELISA, Immunoprecipitation & Immuno Blotting, CHIP assay, Nanopro Immunoassay, Flowcytometry, Immunofluorescence, Antibody Array, cytokine RT-PCR array, whole animal imaging.

**Recommended Text Books:**

**Suggested Reading:**

**Course Outcome:** Through this course students will acquire knowledge from basics to recent advancement in Immunology. This course will be helpful for students to choose their career in Immunology research and biopharmaceutical industries.
GENERAL MICROBIOLOGY LAB

Course Code: MICB-415  Total Number of Credits: 01

1. Principles and methods of sterilization.
2. Direct microscopic observations of bacterial shape – cocci, rods, chains, fungal spores, mycelium, yeast budding.
3. Preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar.
4. Pure culture technique: Streak plate, spread plate and pour plate methods.
7. Enumeration of bacterial / yeast cells-viable count (Plate count) Total count (Haemocytometer count).
8. Isolation and purification of cyanobacteria, actinomycetes, fungi and protozoans.

MICROBIAL GENETICS LAB

Course Code: MICB-416                         Total Number of Credits: 01

1. Transformation methods
2. Conjugation
3. Transduction
4. Karyotyping
5. Probability and Pedigree Analysis
6. RFLP
7. Replica plate technique
8. Ames test
9. Gradient plate technique – spontaneous mutations

Methodology book: Surajit Das and Hirak Nandan Dash, 2015, Microbial Biotechnology-A Laboratory Manual for Bacterial Systems, Springer India
1. Preparation of standard buffers and determination of pH of a solution.
2. Qualitative tests for Carbohydrates- Tests for sugars: Fructose, lactose, maltose, glucose and starch.
3. Qualitative tests for amino acids.
4. Quantitative estimation of glucose by DNS method
7. Determination of Iodine value.
10. Estimation of DNA

**Methodology book:**

IMMUNOLOGY LAB

Course Code: MICB-418                            Total Number of Credits: 01

1. Handling of laboratory animals (Demonstration using softwares & Videos)
2. Detection of antigen pattern by Ouchterlony Double Immunodiffusion
3. Quantification of antigen by Radial Immunodiffusion.
4. Quantification of cells by Hemocytometer
5. Widal test
6. Quantification of antigen by Immunoelectrophoresis
7. Quantification of antigen/antibody concentration by ELISA
8. Flow cytometry (demonstration)
9. Blood grouping
10. VDRL test

Methodology book:

MYCOLOGY

Course Code: MICB-421
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objectives: The aim of this course is to provide knowledge about the basic and applied aspects of fungi in agriculture, food production and industry.

Pre-requisite: Bachelor’s degree in Life Sciences

Unit-1 10 h


Unit-2 10 h


Unit-3 8 h


Unit-4 10 h

Endophytic fungi - symbiotic and opportunistic associations, co evolution and loss of reproductive structures, Secondary metabolite production, toxins – importance, toxicity to herbivores and insects. Use of endophytic fungi as biocontrol agents against plant diseases, insect herbivores. Mycorrhizal associations – endo and ecto mycorrhiza.

Unit- 5 10 h

Significance of fungi in human and livestock health - symbiotic fungi, toxigenic fungi and mycotoxins, pathogenic fungi; Significance of yeasts and fungi in agricultural production – symbiotic fungi, fungi in improving plant productivity, toxigenic fungi and mycotoxins, plant pathogenic fungi, fungi in biocontrol; Significance of fungi in
biotechnology and industrial production; Fungal metabolites and their economic significance – mycotoxins, medicinal uses of fungi (antibiotics), food additives, alcohol, vinegar, enzymes, biopesticides. Fungi as food – mushrooms, Mushroom poisoning.

**Recommended Text Books:**


**Suggested Reading:**


**Course Outcome:** This paper deals with recognizing fungi as model systems in biological sciences, applications of modern research techniques, agricultural and industrial concerns, and increased awareness of various ecological and phylogenetic issues by understanding their distribution, occurrence, structure, and classification. All have helped to an explosion of knowledge relating to fungi with a traditional base.
VIROLOGY

Course Code: MICB-422
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objectives: Virology syllabus is structured from basic virology to the advanced techniques in virology. This paper provides an insight into the history, ultra structure and diagnosis of virus.

Pre-requisite: Bachelor’s degree in Life Sciences

Unit-1


Unit-2


Unit-3


Unit-5 9 h


Recommended Text Books:


Suggested Reading:


Course Outcome: This course imparts the knowledge on various groups of virus and their detail study. The main features of this syllabus apart from the recent advances in the virology like antivirals & their mode of action, Antisense RNA, siRNA, ribozymes and in silico approaches for drug designing. Emerging virus and challenges also included in the course structure for better understanding of the upto date developments in the field of virology.
TECHNIQUES IN MICROBIOLOGY

Course code: MICB-423
Total number of Lecture hours: 48
Total number of Credits: 03

Course Objective: This course aims to introduce various techniques and instrumentation methods required for the study of microorganisms.

Pre-requisite: Bachelor’s degree in Life Sciences

Unit- 1 10 h
Microscopy - Magnification, resolving power, Principles and applications, simple, compound, dark, bright field, phase-contrast and fluorescent microscopes. Confocal laser scanning microscopy.
Electron microscopy: SEM and TEM, Mechanism of image formation and contrast generation in SEM, Sample preparation methods for TEM

Unit- 2 10 h
Spectroscopy - Electromagnetic spectrum, Beer Lambert’s Law. UV/VIS Spectrophotometry, single beam, dual beam, Infrared spectroscopy, FTIR, Atomic absorption spectroscopy, Electron Spin Resonance Spectroscopy techniques, Spin label and H and C NMR spectroscopy. Mass spectroscopy Fluorescent spectroscopy, Quenching, principle, instrumentation and application of MALDI-ToF.

Unit- 3 8 h
Centrifugation Techniques: Principles, Swedberg unit, sedimentation coefficient, factors affecting sedimentation rate, clearing factor, rotors, their types and maintenance, determination of molecular weight by centrifugation, types of centrifuges, density gradient centrifugation, ultracentrifuges.
Other techniques: Flow cytometry. Next-generation sequencing methods: Illumina (Solexa) sequencing, 454 Pyrosequencing, SMRT, SOLiD, Oxford Nanopore.

Unit- 4 10 h
Chromatography - Introduction and types of chromatography, paper, thin layer, gas (LC-MS, GC-MS), Rf value, Qualitative and preparative techniques, Gel permeation, ion-exchange, HP-TLC, HPLC, FPLC and affinity chromatography and instrumentation. Applications of Chromatographic techniques in Microbiology.
Unit- 5

10 h

**Electrophoresis and Blotting techniques** – factors affecting gel electrophoresis, PAGE (native and SDS), discontinuous, Agarose gel electrophoresis, Pulse Field Gel Electrophoresis, Blotting techniques- Southern blot, Western blot and Northern blotting.


**Recommended Text Books:**


**Suggested Reading:**


**Course Outcome:** This course provides understating on techniques and methods of microscopy, spectroscopy, chromatography, radioactivity, centrifugation and electrophoresis.
CELL AND MOLECULAR BIOLOGY

Course code: MICB-424
Total number of Lecture hours: 40
Total number of Credits: 03

Course Objective: This course is designed to teach the students basics, molecular mechanism and latest advancement in cell and molecular biology.

Pre-Requisite: Bachelor degree in Life Sciences

Unit 1 8 h


Unit 2 8 h

DNA Replication: DNA structure, Chromatin Organization, Prokaryotic and Eukaryotic DNA replication, mechanisms of DNA replication, fidelity of replication, enzymes and accessory proteins involved in DNA replication.

Unit 3 8 h


Unit 4 8 h

Transcription: Prokaryotic Transcription (RNA Polymerase, holoenzyme and apoenzyme, sigma factors, details of initiation, elongation, termination), Eukaryotic Transcription (types of RNA polymerases, Promoter of RNA polymerase II, Enhancers, General and inducible transcription factors). Post-transcriptional modification: mRNA processing, Processing, Capping, Cleavage and polyadenylation, splicing of nuclear pre-mRNA, mRNA stability.

Recommended Text Books:

Suggested Reading:

Course Outcome: Through this course students will acquire knowledge from basics to recent development in cell biology, DNA replication, transcription and translation
MICROBIOME BIOLOGY

Course code: MICB-425  
Total number of Lecture hours: 40  
Total number of Credits: 03

Course Objective: The microbiome represents the trillions of microbes (unseen microbial majority) associated with animal and human gut, environment and various niches. From the human microbiome project, it was revealed that the gut microbiota plays a significant role in human disease biology and treatments.

Pre-requisite: Bachelor's degree in Life Sciences

Unit 1: 8 h

Microbiome – definition – uncultured majority – Candidatus, Status and phyla radiatus – definition, History of microbiome perspective, environmental genomics-microbiomes of oceans, lakhs and terrestrial ecosystems, Microbiome ecology, the fungal and viral microbiomes, Microbiome evolution. Earth Microbiome project.

Unit 2: 8 h


Unit 3: 8 h

Human microbiome: biodiversity and major genera of human-microbiome, human-microbiome system as a "holobiont" or "superorganism", microbiome distributions in healthy individuals; composition of specific body sites’ microbiome (nose, skin, oral, urogenital, etc.) - fecal transplants- designer probiotics, Symbiosis- Dysbiosis -Rebiosis, Dynamics microbiome changes from birth to death; pregnancy and the microbiome; personnel microbiome concepts.

Unit 4: 8 h

Microbiome and disease biology: gut-brain conversation, obesity and gut microbiome, infectious diseases and gut microbiome, non-infectious diseases and gut microbiome, phylogeography of epidemics, microbiome’s role in diseases such as Inflammatory bowel disease (IBD), colitis, obesity, diabetes; effects of diet on microbiome; interactions with the immune system and resistance to pathogens; Drug delivery using microbes engineered to
secrete peptides, Microbes as neuromodulators, Microbes as cancer therapeutics, impacts of antibiotics on the development of resistomes.

**Unit 5: 8 h**


**Text Books**


Rob DeSalle and Susan L. Perkins (2015). Welcome to the microbiome. getting to know the trillions of bacteria and other microbes in, on, and around you. Yale University Press.

**Suggested Readings**


**Course Outcome:** Understanding the microbiomes will pave the way for transforming microbiology to microbiome biology as to evolve techniques and approaches to exploit the benefits of microbiomes in general.
MYCOLOGY LAB

Course Code: MICB-426

1. Methods of isolation and identification of fungi by traditional methods.
2. Preparation of pure culture and preservation of culture.
3. Isolation and identification of endophytic fungi from plants.
4. Isolation and Observation of mycorrhiza.
5. Isolation and identification of fungi from seeds.
6. Study of soil fungi from varied geographical origins.
7. Isolation of antibacterial/ antimycotic compounds from fungi.
8. Staining and observation of plant pathogenic fungi.
9. Study of asexual reproduction in *Saccharomyces*.

**Methodology book:** Aneja K R (2001), Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International Ltd.
VIROLOGY LAB

Course Code: MICB-427  Total Number of Credits: 01

1. Isolation of bacteriophages from sewage
2. Estimation of virus yields - plaque assay
3. Routes of inoculations in embryonated eggs
4. Haemagglutination test
5. Hemagglutination inhibition assay
6. Biocontrol assay on insect larvae using NPV
7. ELISA test
8. Study of virus infected plant material.
9. One step growth curve of bacteriophage by Burst size determination

1. Kohler Illumination and handling of Microscope: stereo microscope
2. Observation of unstained sample using compound microscope
3. Preparation of sample for light microscopy, staining and sectioning, use of oil immersion lens
4. UV-Visible spectrophotometry: Absorption spectrum, Hyper/ hypo chromic effect.
5. Paper Chromatography of amino acids
6. Thin Layer Chromatography
7. High Performance Thin Layer Chromatography (HPTLC) (Demo)
8. Ion exchange chromatography.
9. SDS Gel electrophoresis.
10. Agarose Gel electrophoresis
11. Fourier Transform Infrared Spectroscopy (FTIR) (Demo)
12. Scanning Electron Microscope
13. High Performance Liquid Chromatography (HPLC)/ Flow cytometry (Demo)
14. Visit Central Instrumentation facility (CIF) of the university

MOLECULAR BIOLOGY LAB

Course Code: MICB-429
Total Number of Credits: 01

1. Cell Viability Assay
2. Observation of human cheek epithelial cells
3. Observation of mitochondria in human cheek epithelial cells
4. Cell cycle Analysis
5. Isolation of genomic DNA from bacteria
6. Isolation of plasmid from bacteria
7. Isolation of RNA from bacteria
8. Primer Designing
9. Amplification of gene of interest by Polymerase chain reaction

Methodology book:
MEDICAL MICROBIOLOGY

Course Code: MICB-511
Total Number of Lecture hours: 48
Total Number of Credits: 03

**Course Objective:** This course deals with importance of the microorganisms in human health. The basic concepts and medical terms will be explained along Students will study important diseases by body system with reference to the etiology, pathogenesis, treatment, diagnosis and prevention.

**Pre-Requisite:** Bachelor degree in Life Sciences

**Unit- 1**

6 h

Important developments in medical microbiology. Normal microbiota of human body and their significance, opportunistic infections: situations/ conditions that create opportunities for infection Nosocomial infections and their control. CDC Blood and body fluid guidelines. General concepts and guidelines for clinical specimen collection, transport, processing and handling. biosafety levels. Koch's postulates, Molecular Koch’s postulates

**Unit- 2**

12 h


**Unit-3**

10 h

**Diseases of skin:** Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of skin diseases caused by: *Staphylococcus aureus; Streptococcus pyogenes, Pseudomonas aeruginosa; Varicella Zoaster Virus, Measles Virus; Cutaneous Mycoses, Leishmania major/tropicana*. **Diseases of Gastrointestinal tract (GIT) system:** Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of GIT diseases caused by: *Salmonella typhi, Shigella dysenteriae, Escherichia coli: ETEC, EHEC, EPEC, EAEC; viral Hepatitis: Hepatitis A, Hepatitis B, Hepatitis C; Entamoeba histolytica*,

**Unit- 4**

10 h

**Diseases of Nervous System:** Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of *Clostridium tetani, Clostridium botulinum, Mycobacterium leprae, Rabies virus,*
Neisseria meningitidis Diseases of Reticuloendothelial System: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of Brucella, Plasmodium, Bacterial Septicemia

Unit-5 10h

Text Books:


Suggested Readings:


Course Outcome: Students will have clear understanding of microbial diseases, host-pathogen dynamics and challenges involved in keeping drug resistant microbes under control.
FOOD MICROBIOLOGY

Course Code: MICB- 512
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objective: The aim of this course is to highlight the importance of food and the risks associated with consumption of foods due to microbial contamination.

Pre-Requisite: Bachelor degree in Life Sciences

Unit- 1  12 h

Historical Perspective and Scope of Microbiology in relation to food- Importance and significance of microorganisms in food. Factors – Intrinsic and Extrinsic parameters affecting the growth of microorganisms in food. Food borne diseases- Bacterial food borne diseases- (Staphylococcal intoxication, Botulism, Salmonellosis, Shigellosis, EPEC Diarrhoea, Clostridium perfringens gastroenteritis, Bacillus cereus gastroenteritis; Food-borne fungi- Mycotoxins- Aflatoxicosis, Deoxynivalenol, Mycotoxicosis, Ergotism. Food Borne Viral Pathogens- (Norwalk virus, Reovirus, Rotavirus, Adenovirus, Parvovirus, Hepatitis A Virus) Food Borne Animal Parasites- Protozoa – Giardiasis, Amebiasis, Toxoplasmosis, Cryptosporidiosis. Cysticercosis/ Taeniasis; Roundworm – Trichinosis, Anisakiasis.

Unit- 2  10 h

Detection of foodborne pathogens- Detection and Enumeration of micro organisms and their products in food- Culture dependent methods- Sample collection and processing, analysis, surface testing, Direct microscopic observation, enumeration and isolation methods; Animal and Cell Culture Models to study food-borne pathogen interaction; Culture independent techniques – Metagenomics, Biosensor based detection of food pathogens, Nucleic-acid based methods- PCR; Immunological methods to detect food-borne pathogens; Molecular Typing and Differentiation of Food-borne Bacterial Pathogens.

Unit- 3  10 h

Food spoilage and Food preservation- Organisms involved, characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat, poultry and sea foods, milk and milk products, packed and canned foods. Spoilage and defects of fermented foods. Food preservation- High temperature, Low temperature- Significance of psychrophilic microbes in cold-stored and frozen foods, Drying, Chemical, Modified atmosphere, Radiation, other food protection methods and Microbial Resistance.
Unit- 4  


Unit- 5  

Food safety and Quality Management Systems- General principles of food safety risk management, Recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality- Microbiological criteria of foods and their Significance. The HACCP and ISO systems for food safety.

Recommended Text Books:


Suggested Reading:

**Course Outcome:** The Food Microbiology paper would enable students to learn about the epidemiology of food-borne diseases and the pathogens. Also, the study would equip them to study various methods of pathogen detection available along with understanding the beneficial and harmful effects of microbes in the food industry. Food Safety standards are also highlighted.
Course Code: MICB-513
Total Number of Lecture hours: 48
Total Number of Credits: 03

**Course Objectives:** The syllabus of applied and industrial microbiology is oriented towards the industrial application of microorganisms and recent microbial products.

**Pre-Requisite:** Bachelor degree in Life Sciences

**Unit- 1**

**Basics of Industrial Microbiology:** Historical account of microbes in industrial microbiology; sources and characters of industrially important microbes; their isolation, purification and maintenance; Screening of useful strains; primary screening and secondary screening; Strain improvement through random mutation and genetic engineering; types of fermentation and fermenters. Microbial growth kinetics in batch, continuous and fed-batch fermentation process.

**Unit- 2**

**Microbial production of metabolites:** Microbial production of Primary and secondary metabolites. Metabolic engineering, Pathways involved in secondary metabolite production, Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives. Microbial transformations: steroids and alkaloids production. Large scale production of recombinant molecules interferon, human proteins- insulin, somatostatin, vaccines and anticancer agents.

**Unit- 3**

**Fermented Microbial products:** Microbiology and production of alcoholic beverages; Malt beverages, distilled beverages, wine and champagne; Pathways involved in primary metabolite production, Commercial production of organic acids like acetic, lactic, citric, and gluconic acids; Commercial production of important amino acids (glutamic acid, lysine and tryptophan), and vitamins (riboflavin and vitamin A).

**Unit- 4**

**Microbial enzymes:** Immobilization of microbial enzymes and whole cells and their applications in industries; Industrial enzymes production; Cellulases, Xylanases, Pectinases,
Amylases, Lipases and Proteases and their applications. Enzymes involved in microbial biocatalysis / transformations.

**Unit- 5**

9 h

**Biofuels & Biopolymers**: Biofuels (ethanol and methane) from organic residues; fuels from algae; Microbial fuel cells, Mushroom cultivation; other microbial products - Biopolymers and EPS, Bioplastics, Biosurfactants.

**Recommended Text Books:**


**Suggested Reading:**


**Course Outcome**: After studying this paper, students will know the applied and industrial aspects of microbiology such as screening of microorganisms, strain improvement, microbial metabolites, fermented microbial products, microbial enzymes, Biofuels using microbes and microbial production of Biopolymers. The recent applications of the microbes for the human welfare are well structured in this paper.
Course Code: MICB-514  
Total Number of Lecture hours: 40  
Total Number of Credits: 03

Course Objective: This course aims to teach gene cloning and strategies of rDNA technology. This course provides an insight into the vectors, techniques, legal and ethical issues in rDNA technology.

Pre-Requisite: Bachelor degree in Life Sciences

Unit-1  
Introduction- History of nucleic acid, role of genes inside the cell, genetic code, genetic elements that control gene expression. Enzymes in recombinant DNA technology- DNA polymerase, reverse transcriptase, restriction endonucleases, polynucleotide kinase, terminal deoxynucleotidyl transferase, DNase, Methylase, phosphatases, ligases RNase and their mode of action. Vectors in recombinant DNA technology Introduction to cloning vectors, biology and features of vectors, types of vector - plasmids, cosmids, phages, BAC and YAC and viruses

Unit- 2  
Nucleic acid amplification and hybridization Techniques - Polymerase chain reaction (PCR) and its applications, variations in PCR and applications, methods of nucleic acid detection, methods of nucleic acid hybridization, sequencing methods, probes and target sequences, Southern blotting, Northern blotting, in situ hybridization, nucleic acid mutagenesis in vivo and in vitro, CRISPR-Cas systems for editing and targeting genome.

Unit-3  
Construction of DNA library- Construction of genomic and cDNA libraries, Screening libraries with gene probes, colony hybridization, plaque hybridization, screening by gain of function, immunological screening.

Unit- 4  
Gene transfer techniques- Gene transfer techniques in microbes, animals and plants - transformation, electroporation, microprojectile system, liposome mediated gene transfer, DNA/calcium phosphate co-precipitate method, gene gun, transfection with phage vectors etc. Agrobacterium based gene transfer in plants - Ti plasmid: structure and functions, Ti plasmid based vectors.

Unit-5  
Applications and legal issues- Applications of recombinant DNA technology in Agriculture, Veterinary, Industry, Forensic science and Medicine. Gene mapping-restriction mapping,
RFLP, RAPD, AFLP. Engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies etc. Transgenic organisms from mice to rice, Human genetic engineering and Gene therapy- methods of gene therapy, gene therapy in treatment of diseases, Stem cell therapy, Future of stem cell therapy. Science and the constitution- ethical, legal and environmental issues

**Recommended Text Books:**

**Suggested Reading:**

**Course Outcome:** Through this course students will acquire knowledge from basics to recent advancement in rDNA technology.
MICROBIAL GENOMICS

Course Code: MICB-515
Total Number of Lecture hours: 40
Total Number of Credits: 03

Course objective: This course aims to understand advancement of Microorganisms using culture-independent approaches.

Prerequisite: Bachelor’s degree in Life Sciences

Unit- 1 8 h

Taxonomy and phylogeny: Basic concepts in systematics, taxonomy and phylogeny; Polypahsic taxonomy, molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees, Phylogenetic analysis algorithms such as maximum Parsimony, UPGMA, transformed distance, Bayesian algorithm, Neighbor-Joining.

Unit- 2 8 h

Whole genome library: Need of genome library, methodology, Enzymes used in genome library construction, Vectors for library construction, Genomic libraries in high-capacity vectors, cDNA cloning, Shotgun cloning, Whole genome shotgun sequencing: DNA sequencing theory pair end sequencing, Contributions of Craig Venter, Early history of genome sequencing, Hierarchical Shotgun sequencing, ePCR, Next-generation sequencing methods and full genome sequencing platforms.

Unit- 3 6 h


Unit- 4 8 h

Structural and functional genomics- definition, historical prospective and strategies. Genome Structure: genome sizes – microbial and organelle genome – genome physical mapping and sequencing – tools in genome analysis; Structural and functional annotations of
genes and genomes. Human Genome Map repositories. Evolutionary genomics – Comparative genomics.

Unit-5  10 h

Synthetic biology and bioengineering

Introduction to synthetic biology - Metabolomics and synthetic microbiology, predictive model building (metabolomes) - Secondary metabolism and synthetic biology - synthetic bacterium, Mycoplasma laboratorium, Repressilators, Biobrics, iGEM, Genome engineering, yeast cell factories (artemisinin).

Recommended Text Books:


Suggested Reading:

Course outcome: Microbial Genomics, and Bioinformatics are new dimensions of approaches in exploring the microbial world. Without these new dimensions, a Microbiology student could not apply his knowledge in research and development activities. Therefore, this course could enable the students to perform analysis and interpretation of microbial phylogeny.
MEDICAL MICROBIOLOGY LAB

Course Code: MICB-516 Total Number of Credits: 01

1. Study of normal micro-biota of mouth; isolation, identification and preservation of microorganisms
2. Study of normal micro-biota of skin; isolation identification and preservation of microorganisms
3. Identification and Biochemical tests of respiratory tract bacterial pathogen (using avirulent strain of MTCC Culture of – *Streptococci/ Klebsiella pneumoniae*).
4. Identification and Biochemical tests of gastrointestinal bacterial infection (using avirulent strain of MTCC Culture of) – *Salmonella / Shigella sps.*
5. Laboratory examination and identification and biochemical tests of pus specimens (using avirulent strain of MTCC Culture) for *Staphylococcus aureus, Streptococcus pyogenes and Pseudomonas aeruginosa.*
6. Laboratory examination and identification and biochemical tests of urine specimens (using avirulent strain of MTCC Culture) for *E.coli and Candida albicans.*
8. Visit to Clinical laboratory for one day orientation and demonstration on clinical specimen collection and processing.

FOOD MICROBIOLOGY LAB

Course Code: MICB-517  
Total Number of Credits: 01

1. Examination of microbial load in soft drinks, ice creams, packaged and canned foods.
2. Isolation and identification of food –borne pathogenic bacteria from contaminated foods, dairy products.
3. Isolation and identification of food spoilage fungi from foods (Eg: Cereals, Spices).
4. Production and estimation of lactic acid by Lactobacillus species
5. Detection of number of bacteria in milk by standard plate count (SPC).
6. Determination of quality of milk sample by methylene blue reductase test.
7. Bacteriological Examination of water quality.
8. Determination of water quality using Membrane Filter Technique.

APPLIED & INDUSTRIAL MICROBIOLOGY LAB

Course Code: MICB-518

Total Number of Credits: 01

1. Bioassay of nicotinic acid
2. Production of Ethanol by Yeast.
3. Isolation of amylase producing microorganisms from soil
4. Isolation of protease producing microorganisms from soil
5. Isolation of lipase producing microorganisms from soil
6. Production and extraction of thuricides.
7. Laboratory scale production of biofertilizers.
8. Production, quantification and extraction of Citric acid
10. Demonstration: Down-stream Processing Lab
11. Determination of the specific growth rate a bacterium in submerged fermentations.
12. Production of wine from grape juice.
13. Preparation of fermented food products-curd, cheese and alcohols.

MICROBIAL GENOMICS LAB

Course Code: MICB-519

Total Number of Credits: 01

1. Polymerase chain reaction-Gradient
2. Cloning of GFP protein
3. RT-PCR
4. 16S typing
5. Primary databases : Nucleic Acid & Protein : Genbank, EMBL, DDBJ
6. Multiple sequence alignment- Global and local alignment
7. Molecular Phylogenetic methods- Parsimony, Distance, Molecular Phylogeny, Bayesian - MEGA
8. Evaluation of Methods and Phylogenetic tree- Bootstrapping
9. Using Phylogenetic Trees to Study Speciation and Extinction, Gene duplication, Recombination
10. Comparative genomic analysis tools
11. Bioinformatic programs to protein mutations.

Project/Dissertation

Course Code: MICB-521
Total Number of Credits: 03
SELF-STUDY REVIEW

Course Code: MICB-432
Total Number of Lecture hours: 32
Total Number of Credits: 02

A self study review is a course aims to prepare Masters students for their dissertation works. This course is based on a literature review of scholarly reports available on a selected topic for dissertation work. The review shall consolidate the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic.

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Course Code: MICB-433  
Total Number of Lecture hours: 32  
Total Number of Credits: 02

Course objective: Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic (libguides.wits.ac.za).

Prerequisite: Masters students in Life Sciences

Unit-I  
8 h  

Unit-II  
8 h  

Unit-III  
8 h  

Unit-IV  
8 h  
Publication Ethics: Ethics of scientific exhibits (visuals, graphs, charts, etc) – copyright and power point presentations, Ethical issues related to publishing, Plagiarism and Self Plagiarism – Turnitin (demo), COPE guidelines.

Recommended book:

Suggested Readings


**Course outcome:** This course enables the students to apply their knowledge in publication ethics, impact factor and citation index and plagiarism which ultimately prepare the students become an innovative scientific researcher.
RESEARCH METHODOLOGY – BIOSTATISTICS

Course Code: MICB-434
Total Number of Lecture hours: 32
Total Number of Credits: 02

Course objective: Research methodology aims the students to learn specific procedures or techniques used to identify, select, process, and analyze information about a topic.

Prerequisite: Masters students in Life Sciences

Unit -I 6 h
Fundamentals of Biostatistics; sampling, Data collection and recording, Measures of Central Tendency - arithmetic mean, mode, median for ungrouped and grouped data.

Unit-II 4 h
Measures of Dispersion: variance, standard deviation and standard error.

Unit-III 7 h
Probability Rules and Theoretical Distributions: Basic probability rules, expectation, conditional probability; Probability distributions Bionomial, Poisson, Normal and Log-normal distributions; Fitting of probability distributions to environmental data

Unit -IV 7 h
Test of Significance: Null hypothesis and uses of t-test, F-test, X²-tests; Correlation and Regression: Bi-variate data and scatter diagram; Simple (linear) correlation and regression; Coefficient of correlation and regression and their properties.

Unit -V 6 h
Analysis of Variance: ANOVA - Computer applications in environmental modeling. Computer based modeling for population and population studies.

Recommended book:


Suggested Reading
Course outcome: In this course the students would learn data processing and validation methods in publications to prepare the students become an innovative scientific researcher.
ENTREPRENEURSHIP AND MICROBIAL INDUSTRIES

Course Code: MICB-435  
Total Number of Lecture hours: 40  
Total Number of Credits: 03  

Course objective: This soft course was designed for students from all the science discipline. The course focuses on basics of Entrepreneurship, organisation and bioscience based investment.

Pre-Requisite: Any MSc/ MSc integrated student can register for this course.

Unit-I 8 h  
Entrepreneurship- (Economical & social facts) – Entrepreneur- Identifying new opportunity – communicating ideas to business plan-Entrepreneurial exit strategy

Unit-II 8 h  
Entrepreneurial organization – Developing company – Firm development strategy - Firm development instruments – Legal and tax aspects of venture – lean start-up methodology

Unit-III 8 h  
Entrepreneur & company founder – starting own company – survival – steps to run the firm – public communication – pros/cons of being founder – current scenario of start-up industries

Unit-IV 8 h  
Bioscience based investment – business of science – scientific analyst – role of scientific analyst – decision to invest – marketing stocks – corporate financing

Unit-V 8 h  
Entrepreneurship in Biosciences – Developing project from idea to business plan – proof of concept – product development – biological products/drugs/device approval process- preclinical trials etc – intellectual property management and ways to protect new discoveries – Design and writing patent-commercialisation of Bio products

Text Books:

Suggested Reading:


Course outcome: After this course student will learn how to be an entrepreneur in biosciences.
PUBLIC HEALTH MICROBIOLOGY
Course Code: MICB-436
Total Number of Lecture hours: 40
Total Number of Credits: 03

Course Objective: This course aims to teach basics of public health, general concept of microbiology, causes, symptoms and prevention of infectious diseases.

Pre-Requisite: Any MSc/ MSc integrated student can register for this course

Unit-I 8 h

Introduction to Public health: Public health definition and approach. Public health Organizations and functions – (World health organization (WHO), Center for Disease control and Prevention (CDC), Occupational Safety and Health Administration (OSHA) and Public health organizations in India), Importance of public health Microbiology, Public health Diseases (Non communicable and communicable)

Unit-II 8 h

Air and water borne diseases: bacterial, Viral and Fungal diseases. Analysis of microbial load in air and water, air sanitation, water treatment, control of Air and water borne diseases

Unit-III 8 h

Food borne diseases: Food Hygiene, Food spoilage, Food poisoning and food borne infection. Types of food borne diseases (Typhoid, Cholera, Diarrhea, Food poisoning), control of food borne diseases.

Unit-IV 8 h


Unit-V 8 h

Prevention and treatment of infectious diseases: Good hygiene and practices, Vaccines – types of vaccine, Vaccine schedule (India and United states), Modern development in Vaccine production, Antimicrobial agents (Antibacterial, antifungal, antiprotozoal, antiviral and antiretroviral drugs).
**Text books**


**Suggested Reading:**


**Course Outcome:** *Through this course students will be gain knowledge on microbial disease, their cause and transmission. The outcome of course will be helpful for students to practise safe and healthy life style.*
BIOMOLECULES
Course Code: MICB-437
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objective: This course deals with important macromolecules in biological system viz. Carbohydrates, Proteins, Lipids, Nucleic Acids. It also deals with the major and minor bioelements like vitamins and metal ions. This syllabus will prepare students to study more advanced topics.

Pre-Requisite: Any MSc/ MSc integrated student can register for this course

Unit-1 CARBOHYDRATES 10 h

Unit-2 LIPIDS AND STEROLS 10 h
Lipid Composition of Microorganisms - Naming of fatty acids, degree of unsaturation, essential and non-essential fatty acids, common types of membrane lipids: Phospholipids, Cholesterol, Glycolipids, Archaeal Lipids, ganglioside, cerebroside, sphingomyelin, triacylglycerols, arachidonic acid, prostaglandins, - properties, amphipathic molecules, micelle formation, liposomes, lateral diffusion, transverse diffusion, membrane fluidity, hydropathy plot, artificial membranes, lipid raft.

Unit-3 PROTEINS 10 h

Unit-4 NUCLEIC ACIDS 10 h

Unit-5 VITAMINS AND BIOELEMENTS 8 h
Vitamins: Classification, sources and properties - coenzymes - Bioelements: Major and minor bioelements, Trace and ultra-trace elements, their sources and some of their functions in microorganisms.
Recommended Text Books:

Suggested Reading:

Course Outcome: Students will study the fundamental concepts of these biomolecules, their structures, types and biological importance
MICROBIAL PHYSIOLOGY
Course Code: MICB-438
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objective: Microorganisms have tremendous metabolic diversity hence it’s intriguing to learn how these small creatures deal with different environmental conditions and either adopt themselves to it or convert it to favorable conditions by involving different physiological processes. It will elaborate the anaerobic respiration by variety of groups of microbes and non-genetic regulation at metabolic pathways.

Pre-Requisite: Any MSc/ MSc integrated student can register for this course

Unit-1 10 h
METABOLIC DIVERSITY Heterotrophic metabolism on substrates other than glucose
Hydrolysis of polymers - Starch hydrolysis, Cellulose hydrolysis, Oxidation of aliphatic hydrocarbons - Amino acid utilization: Oxidative deamination, Transamination - Methanotrophy; Characteristics of methanotrophs, Dissimilation of methane by methanotrophs

Unit-2 10 h
PHOTOSYNTHESIS AND INORGANIC METABOLISM
Characteristics and Metabolism of Autotrophs, Photosynthetic Bacteria and Cyanobacteria
Autotrophic CO₂ Fixation and Mechanisms of Photosynthesis, Photosystem I and II in cyanobacteria - Nitrification: Nitrifying Bacteria, Ammonia oxidation, Nitrite oxidation, anaerobic nitrification - Sulfur bacteria and the oxidation of sulfur compounds

Unit-3 10 h
ANAEROBIC RESPIRATION
Denitrification: Biochemistry of denitrification, - Regulation of denitrification - Metal reduction: Fe(III) and Mn(IV) reduction, Metal reduction and the environment - Sulfidogenesis: Biochemistry of sulfidogenesis, Reduction of sulfate and sulfur, - sulphur reducing bacteria.

Unit-4 8 h
METABOLIC REGULATION:
Regulation through modulation of enzyme activity: fine regulation, Feedback inhibition
Enzyme activity modulation through structural changes, Phosphorylation Adenylylation, Acetylation, Other chemical modifications, Regulation through physical modification and
dissociation/association Allosteric regulation and Feedback control- Regulation of \textit{E. coli} aspartate carbamoyl transferase

**Unit-5**

**ADAPTIVE AND DEVELOPMENTAL CHANGES**


**Recommended Text Books:**

**Suggested Reading:**

**Course Outcome:** The contents of this course will help students how microbes can grow on substrates other than glucose, their inorganic metabolism and photosynthesis and how do they respond to the changes in environment.
MICROBIAL TECHNOLOGY

Course Code: MICB-541
Total Number of Lecture hours: 40
Total Number of Credits: 03

Course objective: This course aims to introduce the basic and applied Microbiology. The contents of this course will help students to understand importance of microorganisms.

Prerequisite: Masters students in Life Sciences

Unit-I


Unit-II

Industrial Process: Antimicrobials, Organic acids and enzymes- microbial production of pencillin, Tetracycline and peptide antibiotics; Acetic acid; Lactic acid; Gluconic acid. Microbial production and commercial applications of Amylases, Proteases, Lipases. Biotransformation of steroids.

Unit-III


Unit-IV

Unit-V  


**Recommended Text Books:**


**Suggested Readings**


**Course outcome:** The students became trained manpower in microbial production of beverages, Antimicrobials, Organic acids and enzymes, Microbiology of wastewater and solid waste treatment, Plant Growth Promoting Rhizobacteria and Renewable bioenergy using microorganisms.
MARINE MICROBIOLOGY

Course Code: MICB-542
Total Number of Lecture hours: 40
Total Number of Credits: 03

Course objective: This course aims the students to learn the world’s oceans and its unprecedented stresses due to human impacts such as increased nutrient runoff, over-fishing, and increased emissions of greenhouse gases that are causing pervasive changes in ocean chemistry and temperature. This paper is designed introduce the students to understand microbial processes and dynamics of marine environment.

Prerequisite: Masters students in Life Sciences

Unit-I


Unit-II

Dynamics of Marine Microbes - Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming - Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization - phosphorus cycle; Decomposition of organic matter; Bioleaching and biodeterioration of natural and synthetic materials

Unit-III

Marine Microbial products: Microbial interaction Microbes of Biotechnological importance; Primary and secondary metabolites - enzymes, antibiotics, organic acid, toxins, biosurfactants and pigments

Unit-IV

Unit-V


**Recommended Text Books:**


**Suggested Readings:**


**Course outcome:** *The basic knowledge and tools to predict how these changes will affect critical ocean ecosystems upon which society relies for many important functions.*
MICROBIAL NANOTECHNOLOGY

Course Code: MICB-543
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objectives: The aim of the course is to provide basic knowledge about Nanobiotechnology, implications and the various applications in biomedicine

Prerequisite: Masters students in Life Sciences

Unit-I

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanocomposite, nanotubes, nanowires and emergence of bionanotechnology. Characterization of nanoparticles – UV-Vis spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD.

Unit-II


Unit-III

Preparation of nanobiomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans; Alginites;Pectins; Chitin. Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles.

Unit-IV


**Recommended Text Books:**


**Course Outcome:** *Microbes play an important role in the synthesis of nanoparticles. This syllabus would enlighten the students to understand basic concepts and application of nanotechnology. The most important objectives that are frequently found in nanobiology involve applying nanotools to relevant medical/ biological problems and refining these applications. Developing new tools for the medical and biological fields is another primary objective in nanotechnology.*
AGRICULTURAL MICROBIOLOGY

Course Code: MICB-544
Total Number of Lecture hours: 48
Total Number of Credits: 03

**Course Objective:** This course designed to introduce the essential fundamentals of Agriculture Microbiology.

**Prerequisite:** Masters students in Life Science

**Unit-I**


**UNIT-II**


**UNIT-III**


**UNIT-IV**

agriculture (herbicide resistant, Bt, viral). Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.

**UNIT-V**  
Molecular plant microbe-interactions: Cell signalling, Quorum sensing, and Biofilm formation. Invasion of plant tissue- resistance mechanisms against attack by plant pathogens. Molecular detection of pathogens. Integrated pest management-concepts and components; host plant resistance-biological control of insect pests; Recycling of agricultural wastes - Microbiology and biochemistry of biogas, bioethanol and other value added products.

**Recommended Text Books:**

2. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.  
6. Plant Growth and Health Promoting Bacteria by Dinesh K. Maheshwari  
7. Plant-microbe interactions, Volume 1 by Gary Stacey and Noel T. Keen  
8. Biological control of crop diseases Volume 89 of Books in soils, plants, and the environment by S. S. Gnanamanickam  

**Course outcome:** This course focuses on the concepts of Agricultural Microbiology such as Soil Environment, Major plant diseases caused by fungi, bacteria and viruses, biopesticides & biofertilizers and plant microbe-interactions
FERMENTATION TECHNOLOGY

Course Code: MICB-545
Total Number of Lecture hours: 48
Total Number of Credits: 03

Course Objective: This course aims to introduce technological advancement of fermentation and bioprocess for industrial applications.

Prerequisite: Masters students in Life Sciences

Unit-I  10 h

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Microbial culture selection for fermentation processes - Fermentation Pathways for Industrial Products: Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by micro organisms; possibility of control of the reactions for the increased formation of useful metabolites. Strain Development - Various techniques of modifying the strains for increased production of industrial products.

Unit-II  10 h

Fermentation process: Growth of cultures in the fermenter Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentation - cell and enzyme immobilization.

Unit-III  9 h

Bioreactors: Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, sterilization of media - cooling and heating devices, probes for online monitoring, computer control of fermentation process-PID, measurement and control of process. Reactors for specialized applications: Continuous Stirred Tank Bioreactor, Airlift Bioreactor, Fluidized Bed Bioreactor, Packed Bed Bioreactor, Photobioreactor and Membrane Bioreactor.
Unit-IV

**Downstream Processing:** Introduction, removal of microbial cells and other solid matters, Filtration: Theory, Batch filters (plate and frame filters, pressure leaf filters), Continuous filters (rotary vacuum, Cross flow filtration); Centrifugation, Cell aggregation and flocculation, Types of centrifuges (basket centrifuges, tubular bowl centrifuge etc); Cell disruption: Physical mechanical methods and chemical methods - solvent extraction of product; evaporation chromatographic systems for separation and crystallization; drying techniques

Unit-V

**Bioprocess economics - Bioproduct regulation - General fermentation economics.** Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights, Secrets, Patenting of biological materials, international cooperation, obligations with patent applications, implication of patenting, current issues, hybridoma technology etc. Patenting of higher plants and animals, transgenic organisms and isolated genes, patenting of genes and DNA sequences.

**Recommended Text Books:**


**Suggested Reading:**

**Course Outcome:** Microorganisms are capable of growing on a wide range of substrates and can produce a remarkable spectrum of products. This course will enlighten the students on basics of fermentation, metabolic engineering, fermenter design and downstream processing. The economics and IPR of industrial products are introduced to understand commercialization of microbial products.
GENOME TECHNOLOGY

Course Code: MICB-546
Total Number of Lecture hours: 40
Total Number of Credits: 03

Course objective: The Genome Technology course aimed to transform advanced developments in genomic science to the students.

Prerequisite: Masters students in Life Sciences

Unit-I 8 h
An introduction to genetic technology - Enzymes used in genetic engineering- Restriction endonucleases, DNA polymerases, Reverse transcriptase, Ligases, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Klenow fragment, Terminal deoxynucleotidyl transferase, RNase. Vectors for cloning- Plasmids, Bacteriophage , Filamentous phage vectors, Cosmids, Phagemids, PACs, YACs. Ligation of DNA fragments with vectors - Homopolymer tailing, Ligation of cohesive termini, Blunt-end ligation, Linker molecules.

Unit-II 8 h
Introducing genes into bacterial systems- Natural gene transfer methods-Transformation, transduction, calcium chloride mediated transformation, Transfection with phage vectors. Introducing genes into eukaryotes- Gene transfer by viral transduction, Calcium phosphate mediated transformation; Liposome mediated transformation, Microinjection, Electroporation.

Unit-III 6 h
Producing genomic libraries, Genomic libraries in high-capacity vectors, cDNA cloning, Shotgun cloning, Cloning in E.coli, Identifying the recombinant DNA and its products- Genome Engineering, genome editing and CRISPR-CAS tools.

Unit-IV 9 h
Prokaryotic expression systems Gene expression based on bacteriophage T7 RNA polymerase, Eukaryotic expression systems- Fused genes, Unfused genes, Secreted proteins, Gene expression by transcription factors- Nfkb, PPAR, Antisense RNA technology- SiRNA, miRNA.
Unit-V

Techniques in genetic technology- Hybridization technique, Southern, Northern-Western blotting techniques, Site directed mutagenesis, Restriction mapping, DNA profiling in forensic science, Chromosome walking, Chromosome jumping, DNA sequencing, PCR. Basic concepts of Intellectual property rights.

Recommended Text Books:


Suggested Reading:


Course outcome: This course would develop the students became knowledgeable/skilled in new methods, technologies and instruments that enable rapid, low-cost determination of DNA sequence, SNP genotyping, functional genomics and synthetic biology.
Course Code: MICB-547
Total Number of Lecture hours: 48
Total Number of Credits: 03

**Course Objectives:** Drug Design and Discovery course introduce the basic principles of modern drug design, discovery and development. The course deals with the different source of drug with specific focus on microbial source, drug development and manufacturing process.

**Prerequisite:** Masters students in Life Sciences

Unit-I

**Introduction**- History of drug design, Current approaches and philosophies in drug design, Molecular mechanisms of diseases and drug action with examples. Pharmaceutical products, Pharmaceuticals of microbial origin (macrolides, ansamycins, Peptide and other antibiotics) animal origin (sex hormones androgens, Oestrogens, Progesterone and progestogens etc), plant origin (Alkaloids Atropine and scopolamine Morphine and cocaine Additional plant alkaloids)

Unit-II

**Sources of Drugs**- Microbial drugs, Plants as a source of drugs, E. coli as a source of recombinant therapeutic proteins. Expression of recombinant proteins in yeasts, animal cell culture systems. Additional production systems: Fungal production systems, Transgenic animals, Transgenic plants and Insect cell-based systems. Rational drug design and Combinatorial approaches to drug discovery, Antibody Drug Conjugates.

Unit-III


**Drug manufacturing process**- Guides to good manufacturing practice, Production of final product - Cell banking systems, Upstream processing, Microbial cell fermentation, Mammalian cell culture systems, Downstream processing, Final product formulation, Freeze-drying, Labelling and packing.
Unit-IV  
10 h


Unit-V  
9 h


Recommended Text Books:


Reference Books:


Course Outcome: The course will imparts knowledge on detection, selection, and validation of new antibacterial targets, vaccines and the use of gene technology in pharmaceutical industry.
BIOSAFETY, BIOETHICS & IPR

Course Code: MICB-548
Total Number of Lecture hours: 40
Total Number of Credits: 03

Course Objective: This soft course teaches student about biosafety, bioethics and IPR, which are highly essential and must to learn for science students.

Pre-Requisite: Any MSc/ MSc integrated student can register for this course.

Unit-I 8 h
Introduction to Biosafety: Biological laboratory, Biosafety, Need for biosafety, Good laboratory practices (GLP) - Fundamental points and resources of GLP, Standard operating procedures (SOPs), Implementation of GLP.

Unit-II 8 h
Biosafety levels: Types of biosafety levels (Biosafety level I, II, III, IV), Requirements of Biosafety levels, Operational guidelines for biosafety levels. Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals

Unit-III 8 h
Biosafety facilities: Animal Biosafety facilities (ABSL), Plant Biosafety facilities (PBSL), Aquatic organism Biosafety facilities (AQBSL), Operational guidelines for ABSL, PBSL, AQBSL.

Unit-IV 8 h
Bioethics: Introduction to Ethics, Ethical issues in Biosciences, Ethical committee, Guidelines for research that involve animals, Human, Microorganism, Genetic engineering, Gene therapy, organ transplantation & Stem cells.

Unit-V 8 h

Reference Books:

Suggested Reading:


Course Outcome: Through this course students will acquire knowledge on good laboratory practise, safety guidelines and ethics to be followed in science. This course will be helpful for student to perform best in bioscience laboratory.