Pondicherry University

Puducherry 605 014

Accredited with NAAC A+

CURRICULUM AND SYLLABUS OF

M.Sc. Microbiology

(2025 onwards)

Department of Microbiology

School of Life Sciences

About the Department

Vision: To emerge as world class department and excel in Microbiology through innovative, collaborative and inter-disciplinary research.

Mission

- To offer quality education and research in Microbiology.
- To encourage research and development skills among students in Microbiology.
- To reveal excellence in exploitation of microbial resources for human health and sustainable growth.

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 have 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 General Microbiology, Microbial Genetics, Microbial Biochemistry and Immunology. In the second semester, the students will study core microbiology including Microbiome biology, Virology, Cell and Molecular Biology, Techniques in Microbiology and Mycology, subsequently they will study applied and modern microbiology including Environmental, Food, Agriculture, Medical Microbiology, rDNA Technology, Microbial Genomics and Metagenomics. A unique feature of the curricula includes both theory and practical course for each paper and dissertation work in the fourth semester.

Course Structure and Syllabus

1. The Course Structure prescribes the minimum eligibility, Semester wise list of courses, including, Theory, Laboratory, Field work, Project work etc., and total credits for the MSc Microbiology.
2. Detailed syllabus for all courses offered by the Department is prepared in a specific number of units along with full details of Text Books, Reference books Books, Web based resources, Reference books of papers, e-Books, Published Reports, Monographs, etc. relevant to the course and made available to teachers and students.
3. Each course has a title and a unique course code. The course code consists of four alphabets representing the Department and three numerals. The first numeral stands for level of the course, the second numeral stands for odd or even semester and third numeral is the serial number of the course. The Course Structure and Syllabus are approved and recommended by the Programme Committee to Board of Studies (BOS) and School Board and then the Academic Council.

Courses

1. The courses offered under MSc Microbiology are designated as Hard Core and Soft Core courses.
2. A course designated as Hard Core course must invariably be completed by students to receive the degree.
3. In addition to Hard Core courses, students are required to earn a minimum number of credits from Soft Core courses to receive the degree.
4. A course offered by the Department may be treated as a Hard core or Soft Core course for students of other departments as per the requirement of the Programme.
5. Soft Core courses can be chosen from
   (a) a list of Soft-Core courses offered in the Department
   (b) any course offered by other Centre/Department/School under CBCS as Soft Core course, with the advice of Faculty Advisor.
6. While choosing a Soft-Core course students should keep in mind that the chosen course will:
   (a) support the discipline of study
   (b) provide an expanded scope
   (c) enable an exposure to some other discipline/domain
   (d) nurture the student's proficiency/skill.

Online Courses

1. Students may pursue online courses through SWAYAM platform, with the approval of Programme Committee of the Department, and these will be treated as Soft Core courses.
2. Though the host institute may award more credits to an online course, the maximum number of credits assigned to an online course shall not exceed 3 credits, and the minimum shall be 2 credits. Course code for online courses and the number of credits assigned to each course will be approved by the Programme Committee of the Department, and these will be uploaded in the SAMARTH portal.

3. A student will be permitted to pursue online courses up to a maximum of 12 credits in 2-year PG Programmes. However, during one semester a student will not be permitted to register for more than 5 credits of online courses.
4. SWAYAM Counsellors of the Department that facilitates online courses through the SWAYAM platform, shall obtain marks from the host institution. Grades will be awarded by the Programme Committee of the Department.
5. Attendance will not be applicable for SWAYAM courses and therefore hall ticket will not reflect these courses.
6. Students will be permitted to drop online course within the time limit prescribed in the Academic Calendar.

Number of Credits

1. **Minimum credit requirement is 72**
2. A candidate who has passed in all the HardCore courses and Project Work (if any) and accumulated not less than the minimum number of Credits prescribed shall be eligible to receive the Degree.
3. The normal duration of the Programme is 4 semesters.

Contact Hours

1. One credit shall mean one period of teaching for theory or two periods for laboratory /practical course per week in a semester having about 15 weeks of teaching.
2. One teaching period shall be for 60 minutes duration including 10 minutes for discussion/movement.
3. Field training course conducted by faculty members will carry one credit for every one week of such training.
4. Internship/Training for one month in an institution/ company/ organization approved by the Programme Committee will carry 2 credits.
5. One Tutorial hour per week may be conducted in addition to regular contact hours for both Hard core and Soft core theory Courses.

Registration

1. Each student, on admission shall be assigned to a Faculty Advisor.
2. With the advice and consent of the Faculty Advisor the student shall register for a set of courses in each Semester.
3. The student has to seek the consent of each teacher offering the courses for registration.
4. No student shall be permitted to register for courses exceeding 30 credits per semester. However, registration for repeat courses is allowed in excess of this limit.
5. A student, to retain status, should register for at least 12 credits in a semester while registering within normal duration of 2-year PG Programmes.
6. Students shall have to register for the courses within first week of a semester.
7. The maximum number of students to be registered in each course shall depend upon the physical facilities available.

8. Registration for Hard Core course offered by the Department is also open to students of other departments provided they meet the Pre-Requisites.
9. The information on list of courses offered by every Department/Centre shall be made available in the SAMARTH portal.
10. The Reference books for registration shall be given to the students of the department for whom the course is a Hard core course.
11. The registration for Soft Core course shall be on first come first served basis, provided the student fulfills Pre-Requisites for that course, if any. The number of students to be registered shall be based on the class room and laboratory capacity. Every effort will be made by the Department to accommodate as many students as possible.
12. No soft core course shall be offered unless a minimum of 5 students are registered
13. After registration, the students shall be permitted to drop courses within the time limit prescribed in the Academic Calendar.

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. To support students with varying learning needs, remedial coaching is provided for slow learners to help them improve academically, while fast learners are motivated to explore research opportunities and engage in skill-based initiatives to enhance their knowledge and expertise.

Assessment Methods

Assessment will be through Choice Based Credit System (CBCS) through session by continuous assessment (class tests, open book test, quiz, discussion, 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.

All teaching, learning and evaluations will follow Choice Based Credit System (CBCS) as per the Pondicherry University guidelines.

EVALUATION

Breakup of Internal/ External End Semester Exams:
All subjects in a PG programme carry

Internal Assessment Mark	End Semester Mark
40	**60**

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: **(Table 1)**

Table 1: Breakup of Internal Assessment Marks

Break up of Internal Assessment	Marks Distribution
Internal Assessment Tests / Term Papers / Quizzes (two)	2 x 15 = 30
Seminars/ Assignments/ Case Demos/ Presentations/ Write ups/ Viva, etc	1x 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

1) 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.
2) A schedule of End Semester examinations be prepared and displayed by the department at least one- month ahead of the conduct of the examination.
3) No student who has less than 70% attendance in any course shall be permitted to attend the end-semester examination and he/she shall be given FA grade– failure due to lack of attendance. He/she shall be required to repeat that course.
4) 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.

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

The 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:

$K = (X-50)/6$

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

The grades may be awarded as given in the **Table 2**.

Table 2

Sl No.	Range of Marks in %	Letter Grade	Points for Calculation of SGPA
1	X to (X-K)+1	O	10
2	(X-K) to (X-2K)+1	A+	9
3	(X-2K) to (X-3K)+1	A	8
4	(X-3K) to (X-4K)+1	B+	7
5	(X-4K) to (X-5K)+1	B	6
6	(X-5K) to 50	C	5
7	Below 50	F	
8	Failure due to lack of attendance	FA	

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 3**.

Table 3

SI No.	Range of Marks in %	Letter Grade	Points for Calculation of SGPA
1	81-100	O	10
2	71-80	A+	9
3	66-70	A	8
4	61-65	B+	7
5	56-60	B	6
6	50-55	C	5
7	Below 50	F	
8	Failure due to lack of attendance	FA	

Semester Grade Point Average (SGPA) 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, if a student gets A grade in 4 credit course, B+ grade in a 2 credit course, A+ grade in a 3 credit course and F grade in a 3 credit course during a semester, SGPA will be calculated as (8x4 + 7x2 + 9x3 + 0x3)/ (4+2+3) = (32+14+27+0)/9

= 73/9 = 8.11 out of 10.0; SGPA =8.11. Hence, the credits earned by the student in the semester will be 9, and SGPA will be 8.11. Cumulative Grade Point Average (CGPA) shall be calculated as weighted average of SGPA and credits earned by the student in consecutive 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. The students can apply microbiological techniques in inter-disciplinary subjects like nanotechnology, Biotechnology, bioelectronics and allied biosciences.
3. Microbiology students can understand implications of global projects like Human Microbiome Project, Million Microbial Genomes Project and Earth Microbiome Project.
4. The programme helps the students to initiate startup companies and be an entrepreneur in biological industries.

CURRICULUM AND SYLLABI FOR M.Sc. MICROBIOLOGY- COURSE STRUCTURE (2025-26 onwards)

SEMESTER - I

SI. No	Course Name	Course Code	Type of Course	Credits
Theory Courses				
1	General Microbiology	MICB - 411	HC	3
2	Microbial Genetics	MICB - 412	HC	3
3	Microbial Biochemistry	MICB - 413	HC	3
4	Immunology	MICB - 414	HC	3
Practical Courses				
1	General Microbiology Lab	MICB - 415	HC	1
2	Microbial Genetics Lab	MICB - 416	HC	1
3	Microbial Biochemistry Lab	MICB - 417	HC	1
4	Immunology Lab	MICB - 418	HC	1

SEMESTER - II

SI. No	Course Name	Course Code	Type of Course	Credits
Theory Courses				
1	Mycology	MICB - 421	HC	3
2	Virology	MICB - 422	HC	3
3	Techniques in Microbiology	MICB - 423	HC	3
4	Cell and Molecular Biology	MICB - 424	HC	3
5	Microbiome Biology	MICB - 425	HC	3
Practical Courses				
1	Mycology Lab	MICB - 426	HC	1
2	Virology Lab	MICB - 427	HC	1
3	Instrumentation Techniques Lab	MICB - 428	HC	1
4	Cell and Molecular Biology Lab	MICB - 429	HC	1

SEMESTER - III

SI. No	Course Name	Course Code	Type of Course	Credits
Theory Courses				
1	Medical Microbiology	MICB - 511	HC	3
2	Food Microbiology	MICB - 512	HC	3
3	Applied & Industrial Microbiology	MICB - 513	HC	3
4	rDNA Technology	MICB - 514	HC	3
5	Microbial Genomics	MICB - 515	HC	3
Practical Courses				
1	Medical Microbiology Lab	MICB - 516	HC	1
2	Food Microbiology Lab	MICB - 517	HC	1
3	Applied & Industrial Microbiology Lab	MICB - 518	HC	1
4	Microbial Genomics Lab	MICB - 519	HC	1

SEMESTER - IV

SI. No	Course Name	Course Code	Type of Course	Credits
1	Project/ Dissertation	MICB - 521	HC	6

Total Number of Credits: 60

SOFT CORE COURSE STRUCTURE (2025-26 onwards)

SI. No	Course Name	Course Code	Type of Course	Credits
1	Summer Internship	MICB - 431	SC	3
2	Self-study Review	MICB - 432	SC	3
3	Cell Culture Technology	MICB - 433	SC	3
4	Quality Control in Microbiology	MICB - 434	SC	3
5	Research Methodology – Scientific Writing and Publication Ethics	MICB - 435	SC	3
6	Research Methodology – Biostatistics	MICB - 436	SC	3
7	Entrepreneurship and Microbial Industries	MICB - 437	SC	3
8	Public Health Microbiology	MICB - 441	SC	3
9	Biomolecules	MICB - 442	SC	3
10	Microbial Physiology	MICB - 443	SC	3
11	Biology of Parasitism	MICB - 444	SC	3
12	Microbial Technology	MICB - 445	SC	3
13	Marine Microbiology	MICB - 446	SC	3
14	Microbial Nanotechnology	MICB - 447	SC	3
15	Agricultural Microbiology	MICB - 531	SC	3
16	Fermentation Technology	MICB - 532	SC	3
17	Genome Technology	MICB - 533	SC	3
18	Drug Design and Discovery	MICB - 534	SC	3
19	Bioethics, Biosafety and IPR	MICB - 535	SC	3
20	Microfluidics for Microbiology	MICB - 536	SC	3
21	Mushroom Culture Technology	MICB - 537	SC	3

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 411	General Microbiology	48	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**

Introduction to Microbiology – Scope of microbiology - Ancient Microbiology - Refutation of a biogenesis: discovery of penicillin: discovery of vaccination: proposal of one gene one enzyme hypothesis - Major contribution of scientists– Leeuwenhoeck, Edward Jenner, Alexander - Flemming, Joseph Lister, Robert Koch, Louis Pasteur, Hargobind Khorana. Modern Microbiology - Landmark achievements in 20th century - **Microbial Taxonomy** - Definition and systematics, Nomenclatural rules and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach - Woese domain system. Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular taxonomy. Bergey's Classification of bacteria. Concepts of Microbiome, synthetic biology.

Unit - 2 **10 h**

Biology of Microorganisms: Differences between prokaryotic and eukaryotic cell. Biology of bacteria - cell structure, size, shape, arrangement membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis, endospore - biology of fungi, structure, physiology and classification – biology of yeast – reproduction - virus (bacteriophages) structure, life cycle (lytic and lysogenic) – biology of algae – Mycoplasma – prions.

Unit - 3 **8 h**

Microbial nutrition: Microbial nutrient requirements – macro-nutrients, micro-elements – growth factors - sources of nutrients – nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph - Nutritional patterns of pathogens – Saprophytes - Auxotroph.

Unit - 4 **10 h**

Extremophiles: Diversity of microorganisms of Arctic, Antarctic and hydrothermal vents – Archaeal biology - Acidophile , Alkaliphile, Anaerobe, Cryptoendolith, Halophile, Hyperthermophile, Hypolith, Lithoautotroph, Metal-tolerant microbes, Oligotroph, Osmophile, Piezophile, Polyextremophile, Psychrophile/Cryophile, Radioresistant (*Deinococcus radiodurans*), Thermophile, Thermoacidophile, Xerophile – mechanism of extremophiles, Microbes in Space.

Unit - 5 **10 h**

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.

Text books:

1. Tortora, G. J., Funke, B. R., Case, C. L., Bair, W. B., Weber, D. (2020). Microbiology: An Introduction (13th Edition).. United Kingdom: Pearson.
2. Madigan, M. T., Aiyer, J., Buckley, D. H., Sattley, W. M., Stahl, D. A. (2021). Brock Biology of Microorganisms, Global Edition (16th Edition). United Kingdom: Pearson Education.
3. Willey, J. M., Sandman, K. M., Wood, D. H. (2023). Prescott's Microbiology (12th Edition). United States: McGraw-Hill Education.
4. Foster, J. W., Aliabadi, Z., Slonczewski, J. (2021). Microbiology: The Human Experience (2nd edition). United Kingdom: W. W. Norton.

Reference books:

1. Black, J. G., Black, L. J. (2018). Microbiology: Principles and Explorations (9th edition). United Kingdom: Wiley.
2. C K Jayaram Paniker, R. A. (2020). Ananthanarayan and Paniker's Textbook of Microbiology (11th edition). Orient Blackswan Pvt Limited.

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 412	**Microbial Genetics**	**48**	**03**

Course Objectives: *The main aim of the course is to provide a basic knowledge about the use of microbes in genetic studies and is curated for upper-level undergraduates.*

Pre-Requisite: Bachelor degree in Life Sciences

Unit - 1 **8 h**

History and Development- Definition and scope of Genetics. Premendelian genetic concepts – Preformationism, Epigenesis, Inheritance of acquired characters, traits, Germplasm theory. Hereditary and Environment, Genotype and Phenotype.

Unit - 2 **8 h**

Microbial Genetics - Branches of Genetics, Microbes as tools for genetic studies, Microbes as models in genetic studies- *Escherichia coli, Aspergillus nidulans, Neurospora crassa* and *Saccharomyces cerevisiae*, Genetic maps, Genes at the molecular level.

Unit - 3 **10 h**

Viral Genetics- General characteristics of viral genome, Lytic and lysogenic cycle, Structure of virulent phage (T4) and temperate phage (Lambda phage), Genetic map of the Lambda phage Site-specific recombination in Lambda phage, Lysogenic repression. Genetic mapping of viruses, Recombination in viruses.

Unit - 4 **12 h**

Bacterial Genetics- Organization of genetic material in bacteria, Recombination in bacteria, Gene transfer mechanisms- Transformation: Definition, Natural competence in *Bacillus subtilis, Haemophilus influenzae* and *Streptococcus pneumoniae*, Induction of Artificial competence. Conjugation- Nature of the donor strains, Hfr and F^+ plasmids, Properties of the F plasmid, Interrupted Mating Technique and Transduction- Generalized and Specialised/ Restricted transducion. Transfection and forced competence, Drug resistance in bacteria.

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. Recombination in *Neurospora*, Gene conversion. Yeast plasmids, Mating type genetics of yeast.

Text books:

1. Henkin T.M. and Peters J.E. (2020). Snyder and Champness Molecular Genetics of Bacteria. 5th edition, ASM Press, Washington, D.C. ISBN: 978-1-555-81975-0
2. Baumberg. S. (2002). Prokaryotic gene expression. Oxford University Press, UK.
3. Hartl D. L. (2020). Essential Genetics- A genomics perspective, 7th edition, Jones and

Barlett Publishers, Boston.

3. Dale J. W. and Park S. F. (2010). Molecular Genetics of Bacteria, 5th Edition, Wiley Blackwell Publishers, Boston.
4. Trun N. and Trempy J. (2003). Fundamental Bacterial Genetics. 1st Edition, Wiley-Blackwell Publishers.
5. Maloy S. R., Cronan J.E., Freifelder D. (1994). Microbial Genetics. Jones and Barlett Publishers, Boston.

Reference books:

1. Birge E.A. (2006). Bacterial and Bacteriophage genetics, 5th Edition, Springer Nature.
2. Streips U.N. and Yasbin R. E. (2002). Modern Microbial Genetics. Second Edition Wiley-Liss, Inc.

Course Outcome: *The students will learn about various terminologies used in microbial genetics and the methods of microbial genetic recombination, with emphasis on bacteria, fungi and viruses. The knowledge obtained through this course will serve in the design of applications into the fields of pharmaceuticals, food, agriculture and industry.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 413	**Microbial Biochemistry**	**48**	**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 **10 h**

Chemistry of Life and Special Microbial Molecules: Introduction to Biomolecules of Life – Small and Macro- molecules – Types of bonds associated with biomolecules. Water - a biological solvent and its role in biological processes. pH and pH indicator dyes, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, range of buffer, important biological buffers. Bioenergetics – energy flow – high energy compounds.

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

Unit - 2 **10 h**

Macromolecules I- Proteins and Nucleic Acids: Proteins: Structural features of amino acids, classification of amino acids based on polarity and charge, peptide linkage: partial double bond nature, determination of primary structure of polypeptide (N-terminal, C- terminal determination, method of sequencing of peptides), Sequence determination of the peptide based on chemical and enzymatic reactions. structural classification of proteins, primary, secondary, tertiary, quaternary structures of proteins. Ramchandran plot.

Nature of Nucleic Acids: Structure of purines, pyrimidines, nucleosides and nucleotides. Capping of RNA. Hyperchromic effect and Tm. Chargaff's rule, Secondary structure of DNA - Watson and Crick model. Secondary structure of tRNA - cloverleaf model - *de novo* biosynthesis of purines and pyrimidines.

Unit - 3 **10 h**

Macromolecules II- Carbohydrates and their Metabolic pathways and Fermentations: Carbohydrates: Monosaccharides, oligosaccharides and polysaccharides, concepts of epimer, isomer, anomer, Glycolytic pathway, Pentose phosphate pathway (HMP), Entner- Doudoroff pathway, **Fermentation**- Lactic acid fermentation, LDH- Alcoholic fermentation ADH - Catabolism of Glycogen.

Unit- 4 **10 h**

Macromolecules III- Lipids and Metabolism Lipids: Saturated and unsaturated fatty acids - nomenclature, short hand notations, Fatty acid oxidation: β oxidation, α-oxidation - Tricarboxylic acid cycle, Electron transport chain,. Substrate level and oxidative

phosphorylation, inhibitors and un-couplers of electron transport chain and function of ATP synthase, Shuttle systems. Biosynthesis of saturated fatty acids - structure of yeast fatty acid synthase, triacylglycerols and phospholipids.

Unit - 5 **8 h**

Microbial products: Primary and secondary metabolites – antibiotics, bacteriocin, anti-inflammatory agents, anticancer agents, immunosuppressive compounds, and anti-biofilm molecules. Biologics from Microbes – microbial enzymes, neutraceutical molecules. Probiotic and synbiotics.

Text books:

1. Nelson DL, Cox MM, and Hoskins AA. (2021) Lehninger‘s Principle of Biochemistry. 8th edition. W. H. Freeman and company, U.S.A.
2. Heilman D, Woski S, Voet D, Voet J.G and Pratt CW. (2024) Fundamentals of Biochemistry 6th Edition. John Wiley and Sons.
3. Berg JM, Gatto GJ, Hines JK, Tymoczko JL, and Stryer L. (2023) Biochemistry 10th Edition. W.H. Freeman,U.S.A.
4. Kothari V, Ray S, and Kumar P. (2024) Microbial Products for Health and Nutrition. Springer Nature.

Reference books:

1. Segel, IH. (1975) Biochemical Calculations: How to solve mathematical problems in general biochemistry. Second Edn. John Wiley & Sons U.S.A.
2. Wood WB, Wilson JH, Benbow RM, and Hood LE. (1981) Biochemistry: A problems approach. Second Edn. Benjamin / Cummings publishing group, U.S.A.

Course Outcome*: On completion of the course a student will be well versed with the knowledge of biochemistry of macromolecules associated with microbes and higher organisms, and also be familiar with metabolic changes and the associated products. Students will be prepared to take other relevant subjects.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 414	**Immunology**	**48**	**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 **10 h**

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 **8 h**

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 **10 h**

T Cell & B cell Biology: MHC restriction-antigen presentation (Organization & 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 **10 h**

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

Unit - 5 **10 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.

Text books:

1. Kuby Immunology- 8th edition. (2018). Publisher W. H. Freeman & Company.

Reference books:

1. Roitt's Essential Immunology.13th edition (2017). Blackwell Science.

2. Janways Immunobiology. 10th edition. (2022). Publisher-Garland Science.
3. William E. Paul. Fundamental Immunology. 7th Edition. Lippincott Williams and Wilkins. (2012). Publisher: Philadelphia.
4. Abul. K Abbas. Cellular and Molecular Immunology. 10th edition. (2021). Elsevier.

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.*

Course Code	Course Name	Total Number of Credits
MICB - 415	General Microbiology Lab	01

1. Laboratory Biosafety and Good Laboratory Practices in Microbiology
2. Principles and methods of sterilization.
3. Direct microscopic observations of bacterial shape – cocci, rods, chains, fungal spores, mycelium, yeast budding.
4. Preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar.
5. Pure culture technique: Streak plate, spread plate and pour plate methods.
6. Measurement of size of microbes – micrometry.
7. Motility determination – Hanging drop method.
8. Enumeration of bacterial / yeast cells-viable count (Plate count) Total count (Haemocytometer count).
9. Isolation and purification of cyanobacteria, actinomycetes, fungi and protozoans.
10. Staining methods: Simple, Negative, acid fast, Gram staining , spore, Capsule, Metachromatic granular staining, Lactophenol cotton blue staining - Fungal slide culture.

Methodology books:

1. Smith, H., Brown, A. E. (2021). Benson's Microbiological Applications Laboratory Manual. United States: McGraw-Hill Education.
2. Cappuccino, J. G., Sherman, N. (2014). Microbiology: A Laboratory Manual. United Kingdom: Pearson.
3. Aneja, K. (2023). Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnology (6^{th} Edition). India: New Age International (P) Limited.

Course Code	Course Name	Total Number of Credits
MICB - 416	**Microbial Genetics Lab**	**01**

1. Bacterial Growth Curve Analysis
2. Isolation of Auxotrophic Mutants (UV/chemical mutagenesis)
3. Replica Plating Technique
4. Bacterial Conjugation
5. Bacterial Transformation (Plasmid uptake)
6. Bacterial Transduction using bacteriophages
7. Primer designing for targeted Genes
8. Agarose Gel Electrophoresis of Plasmids
9. Polymerase Chain Reaction (PCR) of a target gene
10. Tetrad Analysis in Neurospora
11. Pedigree Analysis

Methodology books:

1. Maloy, S. R., Cronan, J. E., & Freifelder, D. (2004) Microbial Genetics.
2. Willey, Sherwood & Woolverton. Prescott's Microbiology.
3. Sambrook & Russell. Molecular Cloning: A Laboratory Manual.

Course Code	Course Name	Total Number of Credits
MICB - 417	**Microbial Biochemistry Lab**	**01**

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
5. Quantitative estimation of protein by Biuret method.
6. Quantitative estimation of protein by Lowry's method.
7. Determination of Iodine value.
8. Estimation of carbohydrates by anthrone method.
9. Estimation of amino acids by ninhydrin method.
10. Estimation of DNA

Methodology book:

1. Joshi A. Rashmi. 2002. A Textbook of Practical Biochemistry, B. Jain**.**
2. S.P. Singh, 2025, Practical Manual of Biochemistry 8th edition. CBS publishers.

Course Code	Course Name	Total Number of Credits
MICB - 418	Immunology Lab	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:

1. Robert Burns. 2005. Immunochemcial protocol. 3 rd Edition. Springer.
2. Johh. E. Coligan et al. 2002. Current protocol in Immunology. Loose leaf.
3. Teresa S. Hawley, Robert G. Hawley. 2016. Flow Cytometry Protocols. Springer Protocols. Humana Press.
4. John R. Cowther. 2008. The ELISA Guidebook. Humana Press.
5. Bhushan P Hatwar. 2014. Animal Handling Techniques & Protocol Development Strategies. Jaypee Brothers Medical Publishers.

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 421	**Mycology**	**48**	**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**

Development of Mycology as a branch of microbial science. General characteristics of fungi -Terminologies, Structure and organization of fungi – The fungal body and cells, Colony, communication and signaling. Cell differentiation and reproduction. Reproduction in fungi - Vegetative, asexual and sexual reproduction.

Unit - 2 **10 h**

Taxonomy- Criteria used for fungal classification. Traditional, Chemotaxonomy and phylogenetic classification and their significance. Myxomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and imperfect fungi. Ecology (Fungal Lifestyle)- the way they make their living, Distribution of yeasts and fungi.

Unit - 3 **8 h**

Nutrition and metabolism in fungi – nutritional requirement of fungi, saprophytic, parasitic, obligatory and facultative. Culture media for fungi, Natural substrates of fungi. Biotrophic semi-biotrophic and necrotrophic mode nutrient acquisition and growth. Fungal- plant interactions: symbiotic and antagonistic interactions.

Unit - 4 **10 h**

Endophytic fungi – Definitions and Occurrence, Secondary metabolite production and its importance, toxicity to herbivores and insects. Mycorrhizal associations- Vesicular Arbuscular Mycorrhizal (VAM) fungi, Industrial and pharmaceutical importance of endophytic fungi.

Unit - 5 **10 h**

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

Text books:

1. Agrios G. N. (2024). Plant Pathology, 6th Edition, Academic Press Inc.
2. Alexopoulos C. J. and Mims C. W. and Blackwell M. (2010). Introductory Mycology, John Wiley and Sons Inc (Wiley Student Edition). ISBN: 9788126511082, 9788126511082
3. Carlile M. J., Watkinson S. C. and Gooday G.W. (2001). The Fungi, 2nd Editon, Academic Press.
4. Carrey T. (2022). Mycology: A Comprehensive approach, International Edition, States

Academic Press
5. Webster J. and Weber R. W. S. (2007). Introduction to Fungi, 3rd Edition, Cambridge University Press.
6. Sharma P. D. (2005). Fungi and Allied Organisms. Alpha Science International Publishers.
7. Manoharachary C. (2016). Mycology and Microbiology: A textbook for UG and PG courses. Scientific Publishers.

Reference books:

1. Bennett J. W. and Klich M. (2003). Mycotoxins. Clin. Microbiol. Rev. 16:497-516.
2. Ainsworth G.C. (2009). Introduction to the History of Mycology, 2nd Edition, Cambridge University Press

Course Outcome: *This paper deals with recognizing fungi as model systems in biological sciences and how one could focus on exploring different ways to use fungi for human welfare. Classification systems will help students to understand how mycological studies have evolved over the decades to our current understanding of fungi. It also emphasizes basic learning about fungi, coupled with modern, genetic and molecular concepts. This course will ignite interest amongst students about mycology and add to the understanding of these intriguing organisms across multiple arenas of agriculture, food, and pharmaceuticals for human and animal welfare.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 422	Virology	48	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 **10 h**

Concept and scope of virology: Foundations of virology: Virus prehistory, discovery of viruses. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and enzymes. Classification and nomenclature of viruses, ICTV; Trends in virology; Evolutionary importance of viruses. Epidemiology of Virus infection. Principles of diagnosis in virology.

Unit - 2 **10 h**

Diagnostic virology: Biological activity of viruses, Physical, chemical and structural components of viruses, Visualization and enumeration of virus particles, Detection of viruses: physical, biological, immunological and molecular methods. Cultivation of viruses in embryonated eggs, laboratory animals and cell cultures. Serological methods – haemaglutination and HAI, complement fixation, immunofluorescence methods, ELISA and RIA: Physical, chemical and molecular methods- protein, radioactive tracers, electron microscopy, nucleic acid - PCR based assays, flowcytometry and immunohistochemistry. Infectivity assays for phages and plant viruses. Characterization of viral product expressed in the infected cells. Isolation and purification of viruses.

Unit - 3 **10 h**

Study of virus: Morphology, ultra structure, chemical composition and replication of: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV-TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – HBV. Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite virus, Virusoids, Viroids and Prions. Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Oncogenesis: oncogenic viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways.

Unit - 4 **9 h**

Applied virology: General aspects of plant and animal viral diseases. Introduction to viral vaccines, preparation of vaccines, new vaccine technology; antiviral drugs, Monoclonal Antibodies, antiviral gene therapy, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. Modern approaches of virus control: Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing. T-phages, Cyanophages, Baculovirus. Silver lining: viruses as therapeutic agents, Virotherapy, viruses for gene delivery and Targeted Drug

Delivery, viruses to destroy other viruses, phage display. Importance of studying modern virology.

Unit - 5 **9 h**

Emerging virus and challenges: Mechanism of host cell damage- Host cell 'shut off', apoptosis, necrosis, alteration of signaling pathways. Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases. Prospectus using medical technology to eliminate specific viral and other infectious diseases (Ebola, Nepha, Hendra, SARS etc).

Text books:

1. Knipe, D. M. (2014). Fields Virology (6th edition). United States: Wolters Kluwer Health.
2. Hewlett, M. J., Camerini, D., Bloom, D. C. (2021). Basic Virology (4th edition). United Kingdom: Wiley.
3. Carter, J. B., Saunders, V. A. (2013). Virology: Principles and Applications (2nd edition). United Kingdom: Wiley.
4. Black, J. G., Black, L. J. (2018). Microbiology: Principles and Explorations (10th edition). United Kingdom: Wiley.
5. Dimmock, N. J., Easton, A. J., Leppard, K. N. (2016). Introduction to Modern Virology (7th edition). United Kingdom: Wiley.

Reference books:

1. Flint, J., Racaniello, V. R., Rall, G. F., Hatziioannou, T., Skalka, A. M. (2020). Principles of Virology, Volume 1: Molecular Biology (5th edition). United Kingdom: Wiley.

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 423	Techniques in Microbiology	48	03

Course Objective: *This course aims to introduce various techniques and instrumentation methods required for the study of microorganisms. This paper provides understanding on techniques and methods of microscopy, spectroscopy, chromatography, radioactivity, centrifugation and electrophoresis.*

Pre-requisite: Bachelor's degree in Life Sciences

Unit - 1 **10 h**

Microscopy- Magnification, resolving power, Principles and applications of simple, compound, dark, bright field, phase-contrast and fluorescent microscopes. Confocal laser scanning microscopy.

Electron microscopy: SEM- topographical contrast, composition contrast, Mechanism of image formation and contrast generation in SEM, Sample preparation methods for TEM; freeze fracture, positive, negative staining.

Unit - 2 **10 h**

Spectroscopy - Electromagnetic spectrum, Beer Lambert's Law. UV/VIS Spectrophotometry, single beam, dual beam, troubleshooting, Infrared spectroscopy, FTIR, Electron Spin Resonance Spectroscopy techniques and Spin label, H and C NMR spectroscopy; chemical shift, coupling constant, rules of interpretation of NMR spectra. Fluorescent spectroscopy, intrinsic, extrinsic fluorescence and Quenching, Mass spectroscopy sample preparation, ionization methods; ESI, CI, MALDI, principle, instrumentation and application of MALDI-ToF, and MALDI-ToF-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.

Next-generation sequencing methods: Sequencing by synthesis and sequencing by ligation; emulsion PCR, base call, Illumina (Solexa) sequencing, 454 Pyrosequencing, SMRT, ZMW and SOLiD.

Unit - 4 **10 h**

Chromatography - Introduction and types of chromatography, paper, thin layer, gas (GC-MS), Rf value, Qualitative and preparative techniques, low pressure liquid chromatography techniques: Gel permeation/size exclusion (SEC), ion- exchange, and affinity chromatography, (LC-MS). HP-TLC, HPLC sample preparation, detectors, guard column FPLC. Applications of Chromatographic techniques in Microbiology.

Unit - 5 **10 h**

Electrophoresis and Blotting techniques: factors affecting gel electrophoresis, types of

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

Radioactivity techniques - Nature and types of radiations. Alpha, beta and gamma. Units of measurement of radioactivity, units, half-life, decay constant. Detection and measurement of radioactivity by Geiger Muller counter, Liquid Scintillation counter. Safety measures in handling radioisotopes. Radio Immuno Assay (RIA).

Text books:

1. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 8th ed. Cambridge Univ. Press, 2018.
2. Alcomo, I.E Fundamentals of microbiology, 10th edition 2013.
3. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
4. Experimental Biochemistry : Robert L. Dryer and Gene F. Lata ; oxford University Press, 1989 Edited
5. Modern Experimental Biochemistry: Rodney Boyer, Third edition, Pearson Education
6. Bioanalytical Chemistry: Susan R. Mikkelsen, Eduardo Corto´n ; 2nd edition (2016) WILEY interscience
7. Radioisotopes in Biology; A Practical Approach. Edited by R. J. Slater. IRL Press
8. Biophysics: Vasantha Pattabhi and N.Gautham . Second Edition. Narosa Publishing House
9. Koboldt DC, Steinberg KM, Larson DE, Wilson RK, Mardis ER. The next-generation sequencing revolution and its impact on genomics. Cell. 2013. 155:27-38. doi: 10.1016/j.cell.2013.09.006.

Reference books:

1. Evans, J. N.S. (1995). Biomolecular NMR Spectroscopy. Oxford University Press, UK.
2. Wahid, P.A. (2001) An Introduction to Isotopes and Radiations: Allied Publishers Ltd., India
3. Rouessac, F and Rouessac, A. (2022) Chemical Analysis: Modern instrumentation methods and techniques third edition., John Wiley and Sons, U.S.A.
4. Simpson, R.J., Adams, P. D. and Golemis, E.A. (2009) Basic methods in Protein purification and analysis; Laboratory Manual. Cold Spring Harbor Laboratory Press, U.S.A.

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

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 424	**Cell and Molecular Biology**	**48**	**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 **10 h**

The dynamic cell: Molecules of life - the architecture of cells - Cell Theory, Emergence of modern cell biology, Structure of Prokaryotic and Eukaryotic cells, Cell wall, Membrane, Extracellular matrix, Cell organelles-organization and functions, Cytoskeleton: microfilaments-intermediate filaments-microtubules, cell cycle events.

Unit - 2 **10 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**

Gene mutations: Types of mutations. Suppression, Transposable Genetic Elements, Ames test. **DNA damage and repair mechanisms,** Global response to DNA damage, DNA repair and aging, Medicine and DNA repair modulation.

Unit - 4 **10 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.

Unit - 5 **10 h**

Translation: Genetic code (Characteristics, deciphering the code). Prokaryotic and eukaryotic translation, translational machinery, mechanism of initiation, elongation and termination. Post translational modification, Control of gene expression in eukaryotes (Activation & repression).

Text books:

1. Watson. JD. *Molecular Biology of the Gene*. 8th Edition. East West Press, 2024
2. Weaver. R. F. Molecular Biology (*WCB Cell & Molecular Biology*). 5th edition. Mc Graw Hill publication, 2011.
3. Alberts Bruce. *Molecular Biology of Cell*, 7th Ed. Garland Publications, 2024.
4. Russel Peter. *Essential Genetics*. 2nd Edn, Blackwell Science Pub.
5. Friefelder D. Molecular Biology, 2nd Edition. Narosa Publishing House, 1995.

Reference book:

1. Benjamin Lewin. Gene IX. Jones and Bartlett Publishers Inc, 2007

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

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 425	Microbiome Biology	48	03

Course Objective: *The microbiome represents the trillions of microbes (unseen microbial majority) associated with the 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 – redefinition Berg *et al*. 2020 – uncultured majority – Candidatus, Use of Candidatus status in taxonomy (e.g., Candidatus Pelagibacter), Concept of "microbial dark matter"– definition, Limitations of traditional culture-based methods, environmental genomics-microbiomes of oceans, and terrestrial ecosystems, Microbiome ecology, Microbiome evolution. Earth Microbiome project.

Unit - 2 **10 h**

Approaches in Microbiome analysis, Metagenomics (open and closed formats), Meta-transcriptomics, Pan-genomics, Epigenomics, Microfluidics technology to study the human microbiome, single cell genomics, and Advanced culturing techniques to study microbiomes. Metagenomics: – definition – principles – methods - whole genome shotgun cloning – metagenomic library production – high throughput screening - metagenomics of archeological samples – Sargasso sea project – microbial phylogeography.

Unit - 3 **10 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, lung, skin, oral and urogenital) - fecal transplants- designer probiotics, Symbiosis- Dysbiosis -Rebiosis, Dynamics microbiome changes from birth to death; pregnancy and the microbiome; personnel microbiome concepts.

Unit - 4 **10 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 signatures in IBD vs IBS, 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 **10 h**

Biofilm biology: Introduction to Biofilms - Definition and significance in natural and artificial environments - Cell–cell communication mechanisms (e.g., quorum sensing) - Composition and function of extracellular polymeric substances (EPS) - Stages of development - Common

biofilm environments: dental plaque, medical devices, industrial surfaces - Role of extracellular DNA (eDNA) in biofilm stability and gene exchange - Clinical relevance of biofilms formed by: Pseudomonas aeruginosa, Staphylococcus aureus, Candida spp. Biofilm-associated antibiotic resistance and persistent infections.

Text books:

1. Angela E. Douglas (2018). Fundamentals of Microbiome Science – How Microbes Shape Animal Biology, Princeton University Press.
2. 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.
3. Rodney Dietert (2016). The Human Superorganism: How the Microbiome Is Revolutionizing the Pursuit of a Healthy Life. Dutton Books.

Reference books:

1. Marchesi, J. R. (Ed.). (2014). The human microbiota and microbiome. CABI Publishing.
2. Berg, G., & Raaijmakers, J. M. (Eds.). (2018). The plant microbiome. Springer.
3. Rosario, K., & Breitbart, M. (2021). Environmental microbiomes. Elsevier.
4. Lloyd-Price, J., Abu-Ali, G., & Huttenhower, C. (2016). The human microbiome. Nature, 535(7610), 65–74. https://doi.org/10.1038/nature18846
5. Streit, W. R., & Schmitz, R. A. (Eds.). (2017). Metagenomics: Methods and protocols. Humana Press.
6. Thursby, E., & Juge, N. (2017). Introduction to the human gut microbiota. Biochemical Journal, 474(11), 1823–1836. https://doi.org/10.1042/BCJ20160510
7. Nielsen, H. B., Almeida, M., & Segata, N. (2014). Microbiome analysis: Methods and applications. Nature Reviews Microbiology, 12(11), 831–844. https://doi.org/10.1038/nrmicro3368
8. Martin, F., Uroz, S., & Frey-Klett, P. (Eds.). (2021). Functional metagenomics: Tools and applications. Springer.
9. Gilbert, J. A., Quinn, R. A., Debelius, J., Xu, Z. Z., Morton, J., Garg, N., ... & Knight, R. (2016). Microbiome-wide association studies: Pitfalls and perspectives. Nature Microbiology, 1, 16009. https://doi.org/10.1038/nmicrobiol.2016.9
10. Berg G, et al. Microbiome definition re-visited: old concepts and new challenges. Microbiome. 2020 Jun 30;8(1):103. doi: 10.1186/s40168-020-00875-0.

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.*

Course Code	Course Name	Total Number of Credits
MICB - 426	**Mycology Lab**	**01**

1. Cultural methods for isolation and identification of fungi.
2. Preparation, preservation and maintenance of pure fungal cultures.
3. Isolation and identification of endophytic fungi from plants.
4. Isolation and Observation of Vesicular Arbuscular Mycorrhizal (VAM) fungi
5. Isolation and identification of seed-borne fungi.
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:

1. Aneja K.R. (2022). Experiments in Microbiology, Plant pathology, Tissue Culture and Microbial Biotechnology, 6th Edition, New Age International Publishers.

Course Code	Course Name	Total Number of Credits
MICB - 427	**Virology Lab**	**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
10. Demonstration of identification of arthropod vectors of viral transmission.

Methodology book:

1. Burleson, F. G., Chambers, T. M., Wiedbrauk, D. L. (2014). Virology: A Laboratory Manual. United Kingdom: Academic Press.
2. Dijkstra, J., Jager, C. d. (2012). Practical Plant Virology: Protocols and Exercises. United States: Springer Berlin Heidelberg.

Course Code	Course Name	Total Number of Credits
MICB - 428	Instrumentation Techniques Lab	01

1. Kohler Illumination and handling of 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 of carbohydrates
7. High Performance Thin Layer Chromatography (HPTLC) (Demo)
8. Ion exchange chromatography.
9. Gel filtration chromatography.
10. Differential centrifugation
11. SDS Gel electrophoresis
12. Agarose gel electrophoresis
13. Fourier Transform Infrared Spectroscopy (FTIR) (Demo)
14. Scanning Electron Microscope
15. High Performance Liquid Chromatography (HPLC) (Demo)
16. Visit Central Instrumentation facility (CIF) of the university

Methodology book:

Prakash Singh Bisen and, Anjana Sharma , (2017). Introduction to Instrumentation Techniques in life Sciences. CRC Press.

Course Code	Course Name	Total Number of Credits
MICB - 429	**Cell and Molecular Biology Lab**	**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
10. Gene expression analysis by qRT-PCR

Methodology book:

1. Ralph Rapley (2008). Molecular Biomethods Handbook . Humana press
2. Ralph Rapley(2021) Molecular Biology and Biotechnology 7th edition, Publisher: Royal society of chemistry
3. Michael R. Green, Joseph Sambrook. (2013) Molecular Cloning - A Laboratory Manual 4th edition, Publisher: Cold Spring Harbor Laboratory Press
4. Roberto Biassoni, Alessandri Raso. (2014) Quantitative Real-Time PCR: Methods and Protocols, Publisher: Humana Press
5. Teresa S. Hawley, Robert G. Hawley. 2016. Flow Cytometry Protocols. Springer Protocols. Humana Press.
6. Fiona Macdonald, Roger L. Lundblad, (2021) Handbook of Biochemistry and Molecular Biology, Publisher: CRC Press
7. http://www.iscb.org.in/docs_pdf/ISCBProtocol.pdf

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 511	**Medical Microbiology**	**48**	**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 books 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**

Basic concepts in Microbiology: Concept of epidemic, endemic and pandemic, acute, chronic, morbidity, mortality, prevalence, incidence, Reservoirs, Carriers. Stages of Disease Progression. Modes of transmission; contact: horizontal, vertical, vector, vehicle transmission, portals of entry. Mechanisms of microbial resistance to host cellular and humoral defenses. Molecular basis of microbial pathogenicity. Pathogenicity Islands, bacterial toxins: Exotoxins, Endotoxins, Superantigens.

Antimicrobial Agents: Mechanisms of drug resistance, Multi-drug Resistance: Target modification, Antibiotic inactivation, Bypass pathway, Drug efflux.

Applications of Artificial intelligence in early warning systems for infectious disease surveillance

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*; Chicken pox, Shingles Varicella Zoaster Virus, Measles Virus; Cutaneous Mycoses, Cutaneous Leishmaniasis *Leishmania major/ tropicana*.

Diseases of Gastrointestinal tract (GIT) system: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of GIT diseases caused by: *Salmonella enterica*, *Shigella dysenteriae*, *Escherichia coli*: ETEC, EHEC, EPEC, EAEC; viral Hepatitis: Hepatitis A, Hepatitis B, Hepatitis C; Amoebic dysentery-*Entamoeba histolytica*.

Unit - 4 **10 h**

Diseases of Nervous System: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of Central Nervous System diseases caused by: *Clostridium tetani* (Tetanus), *Clostridium botulinum*, *Mycobacterium leprae*, Rabies virus, *Neisseria meningitidis*

Diseases of Reticuloendothelial System: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of *Brucella, Plasmodium falciparum, vivax, ovale* and *malariae.*

Unit - 5 **10 h**

Diseases of Respiratory System: Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of *Corynebacterium diphtheriae*, *Bordetella pertussis*, *Mycobacterium tuberculosis*, *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae, Chlamydia psitacci, Hemophilus influenza*, Common Cold Viruses, Influenza Virus A and B, *Pneumocystis carinii*

Diseases of Urogenital System: Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of HIV, *Neisseria gonorrheae*, *Chlamydia trachomatis*.

Text books:

1. Bauman, R.W. (2017).fifth Edition. Microbiology: with diseases by body system; Pearson Education, Inc., U.S.A.
2. Ryan K. J. and Ryan C.G. (2021) Sherris Medical Microbiology: an Introduction to infectious diseases. 8th edition. McGraw-Hill, U.S.A.

Reference books:

1. Nester E. W., Anderson D. G. and Nester M. T. 2024. Microbiology: A Human Perspective, McGraw-Hill, U.S.A.
2. Brooks, G.F., Carroll, K. C., Butel, J. S. and Morse, S. A. (2025) Jawetz, Melnick, & Adelberg's Medical Microbiology, 29th Edition. McGraw-Hill Companies, UK
3. Murray P.R., Pfaller M.A., Tenover F.C., and Yolken R.H. (2020). Medical Microbiology 9th Edn., ASM Press, U.S.A.
4. Brogden, K. A., Minion, C., Roth, J.A., Bolin, C.A. and Stanton, T. B. (2016) Virulence Mechanisms of Bacterial Pathogens 5th Edition. ASM Press, U.S.A.
5. Salyers, A. A. and Whitt, D.D. (2002) Bacterial Pathogenesis: A molecular Approach – 2nd Edn. ASM Press, U.S.A.
6. Villanueva-Miranda I, Xiao G, Xie Y. Artificial intelligence in early warning systems for infectious disease surveillance: a systematic review. Front Public Health. 2025. 13:1609615. doi: 10.3389/fpubh.2025.1609615.

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

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 512	Food Microbiology	48	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**

Scope of Food Microbiology- Definitions of food, classification of food groups, Importance and significance of microorganisms in food. Factors – Intrinsic and Extrinsic factors 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- Toxic effects in humans and animals, Mycotoxins- Aflatoxicosis, Ergotism. Food Borne Viral Pathogens- (Rotavirus, Hepatitis A Virus) Food Borne Animal Parasites- Protozoa – Amoebiasis and Cryptosporidiosis. Roundworm – Trichinosis, Anisakiasis.

Unit - 2 **10 h**

Detection of foodborne pathogens- Detection and enumeration of microorganisms and their products in food. *Culture dependent methods*- Sample collection, processing, analysis, surface testing, metabolic methods for enumeration and detection of food-borne bacteria, Direct microscopic observation, isolation methods; Animal and Cell Culture Models to study food-borne pathogen interaction; *Culture independent techniques*- Nucleic-acid based methods- Polymerase Chain Reaction (PCR); Immunological methods- Immunofluresecence, Immunomagnetic separation (IMS), Immunodiffusion, Immunoimmobilization, Molecular Typing and Differentiation of Food-borne Bacterial Pathogens. Biosensor based detection of food 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 Atmospheric Storage (MAS) and Modified Atmospheric Packaging (MAP), Radiation, other food protection methods and Microbial resistance.

Unit - 4 **10 h**

Microbiology of Food fermentations- Milk Fermentation, Fermented milk products- Yoghurt, Kefir and Cheese; Fermented plant products- Sauerkraut and fermented olives; Fermented animal foods- Meat and fishery products. Microbial cells as food- Algae in human diet, Single Cell Protein (SCP), Challenges and considerations of SCPs, Probiotics- Definitions and their advantages. Genetically modified foods.

Unit - 5 **6 h**

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.

Text books:

1. International (Rt) Ltd., New Delhi.
2. Frazier W.C. and Westhoff D.C. (1995). Food Microbiology, Tata McGraw Hill Publishing Ltd., New Delhi.
3. Jay J. M., Loessner M. J. and Golden D. A. (2005). Modern Food Microbiology, Seventh edition.
4. Verma L. K. and Joshi V. K. (2022). Post Harvest Technology of Fruits and Vegetables, Tata McGraw Hill Publication.
5. Doyle M. P. and Beuchat L. R. (2007). Food Microbiology- Fundamentals and Frontiers, ASM Press.
6. Bhunia A. K. (2018).Food-borne Microbial Pathogens - Mechanisms and Pathogenesis, Food Science text Series, Springer International, New York, USA.

Reference books:

1. Benwart G. J. (1987). Basic Food Microbiology, CBS Publishers & Distributors, New Delhi.
2. Nash C. (2019). Fundamentals of Food Microbiology. Callisto Reference books Publishers.
3. Garbutt J. (1997). Essentials of Food Microbiology, Armold – International Students edition, London.
4. Marriott N. G. and Gravani R. B. (2006). Principles of Food Sanitation, Food Science text Series, Springer International, New York, USA

Course Outcome: *The Food Microbiology paper would enable students to learn about the global burden 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	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 513	Applied & Industrial Microbiology	48	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 **10 h**

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. Quality Control Best Practices for Industrial Microbiology Labs (GLP, GMP).

Unit - 2 **10 h**

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 books 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 **10 h**

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 **9 h**

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.

Text books:

1. Okafor, N., Okeke, B. C. (2018). Modern Industrial Microbiology and Biotechnology (2nd edition). United Kingdom: CRC Press, Taylor & Francis Group.
2. Waites, M. J., Morgan, N. L., Rockey, J. S., Higton, G. (2013). Industrial Microbiology: An Introduction (1st edition, ebook). Germany: Wiley.

Reference books:

1. Crueger, W., Crueger, A. (2017). Crueger's Biotechnology: A Textbook of Industrial Microbiology (3rd edition). India: MedTech.
2. Reed, G. (. (2004). Prescott and Dunn's Industrial Microbiology(4th edition). India: CBS Publishers and Distributors.
3. Demain, A.L. (2010). Manual of Industrial Microbiology and Biotechnology. United Kingdom: ASM Press.
4. Stanbury, P. F., Whitaker, A., Hall, S. J. (2016). Principles of Fermentation Technology (3rd edition). Germany: Elsevier Science.
5. Richard H. Baltz, Julian E. Davies, and Arnold L. Demain (2010). Manual of Industrial Microbiology and Biotechnology (3rd edition). United Kingdom: ASM Press.

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	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 514	Recombinant DNA Technology	48	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 **10 h**

Introduction - History of nucleic acid & genetic engineering, **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 vectors - plasmids, cosmids, phages, BAC and YAC and viruses.

Unit - 2 **12 h**

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, CRISPR-Cas systems for editing and targeting genome.

Unit - 3 **6 h**

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 **10 h**

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, genegun, transfection with phage vectors etc. *Agrobacterium* based gene transfer in plants - Ti plasmid: structure and functions, Ti plasmid-based vectors.

Unit - 5 **10 h**

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.

Text books:

1. Sandy Primose (2006). Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers.
2. Brown T.A. (2020). Gene cloning and DNA analysis: an introduction, 8th edition, Wiley-Blackwell.

Reference books:

1. David E Newton. (2016). DNA technology: A Reference books Handbook ABC-CLIO, LLC
2. BeiquanMou and Ralph Scorza. (2011). Transgenic Horticultural Crops: Challenges and Oppurtunities. CRC press.
3. Thomas F. Budinger and Miriam D. Budinger. (2006). Ethics of Emerging Technologies: Scientific Facts and Moral Challenges. John Wiley and Sons Inc.
4. Pete Shanks. (2005). Human Genetic engineering. Avalon publishing groups.
5. Glick BR and Cheryl L. Patten (2022). Molecular Biotechnology, 6th Edition, ASM press.
6. Peter J Russels (1997). Genetics. 5th Ed. Benjamin-Cummings Publishing Co.
7. David Frifielder, Stanley R.Maloy. (1994). Molecular Biology and Microbial genetics. 2nd Edition, Jones and Brlett Publishers.

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

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 515	Microbial Genomics	48	03

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

Pre-Requisite: Bachelor's degree in Life Sciences

Unit - 1 **8 h**

Taxonomy and phylogeny: Basic concepts in systematics, taxonomy and phylogeny; Polyphasic 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 **10 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 **10 h**

Genome projects: An overview of genome projects: human, plant, animal and microbial genomes. Genomes of model organisms – *Haemophilus, E. coli, Saccharomyces cerevisiae, Streptomyces* (industrial strain), virus and cyanobacteria. Functional analysis of genomes - microarrays and transcriptomes, gene chips and gene expression analysis, methods in proteomics and metabolomics.

Unit - 4 **10 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 (artimisinin).

Text books:

1. Sandy B. Primrose, Richard Twyman (2008), Genomics : Applications in Human Biology. Wiley and Sons.
2. Diana Marco (2017). Metagenomics: Current Innovations and Future Trends. Book: 978-1-904455-87-5. Horizon Scientific Press.

Reference books:

1. Muhammad Jamal (2017). The CRISPR/Cas System: Emerging Technology and Application. Caister Academic Press.
2. Manuel Fuentes, Joshua LaBaer (2014). Proteomics: Targeted Technology, Innovations and Applications. Book: 978-1-908230-46-1. ebook: 978-1-908230-62-1. Caister Academic Press.
3. Patrick Arbuthnot and Marc S. Weinberg (2014). Applied RNAi: From Fundamental Research to Therapeutic Applications. Book: 978-1-908230-43-0. ebook: 978-1-908230-67. Caister Academic Press.
4. Jianping Xu (2014). Next-generation Sequencing: Current Technologies and Applications. Edited by: Published: 2014 Book: 978-1-908230-33-1. Ebook: 978-1-908230-95-9. Caister Academic Press.
5. S. B. Primrose (2002). Principles of Genome Analysis. A Guide to Mapping and Sequencing DNA from Different Organisms. Blackwell publishing.
6. Mount D (2004). Bioinformatics: Sequence and Genome Analysis by. Cold Spring Harbor Laboratory Press, New York.
7. Andreas D. Baxevanis, B. F. Francis Ouellette (2005). Bioinformatics- a practical guide to the analysis of Genes and Proteins. John Wiley & Sons, UK.
8. Tom Strachan and Andrew P Read (2011). Human Molecular Genetics, 4th edition, Garland Science.
9. Sudbery P and Sudbery I (2009). Human Molecular Genetics. Prentice Hall.
10. Guido Grandi (2004), Genomics, proteomics and Vaccines. Wiley and Sons.

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.*

Course Code	Course Name	Total Number of Credits
MICB - 516	Medical Microbiology Lab	01

1. Antimicrobial sensitivity profile of the pathogen by Kirby-Bauer disk diffusion method and determination of drug resistance/sensitivity according to CLSI guidelines
2. Dipstick Urine sample analysis for color, pH, microscopic analysis for RBCs, WBCs and crystals
3. Cutaneous mycoses of hair: microscopic observation of ectothrix and endothrix for *Trichophyton* and *Microsporum*
4. Bacterial endotoxin assay (Kinetic-Turbidimetric method)
5. Giemsa staining of malarial blood films (thick and thin smear)
6. Paired Sera test (demonstration)
7. Studying Infectious Disease Spread using SEIR model run using Netlogo
8. Cultural and differential diagnosis of respiratory tract bacterial pathogen (using avirulent strain of MTCC Culture of – *Streptococci/ Klebsiella pneumoniae.*
9. Cultural and differential diagnosis of gastrointestinal bacterial infection (using avirulent strain of MTCC Culture of) – *Salmonella / Shigella sps.*
10. Cultural and differential diagnosis of pus specimens (using avirulent strain of MTCC Culture) for *Staphylococcus aureus, Streptococcus pyogenes and Pseudomonas aeruginosa.*

Methodology book:

C.P. Prince Pages: 300 pages Publisher: Jaypee Brothers Medical Publishers 2008-12-01 Language: English ISBN-10: 8184486375 ISBN-13: 9788184486377

Course Code	Course Name	Total Number of Credits
MICB - 517	Food Microbiology Lab	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.

Methodology book:

1. Harley and Prescott (2004), Laboratory Exercises in Microbiology, 6th Edition McGraw Hill Higher Education.
2. Rigel N. and Izquierdo J. (2022) Laboratory Exercises in Microbiology, 12th Edition, Wiley Publishers, ISBN10:1264775660 and ISBN13: 9781264775668
3. Aneja K.R. (2022). Experiments in Microbiology, Plant pathology, Tissue Culture and Microbial Biotechnology, 6th Edition, New Age International Publishers.

Course Code	Course Name	Total Number of Credits
MICB - 518	Applied & Industrial Microbiology Lab	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
9. Demonstration: Reactor Studies: Batch, fed-batch, and continuous flow reactor analysis and residence time distribution.
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.
14. Isolation and characterization of plant growth promoting bacteria.

Methodology book:

Bull, Alan T. and Junker, Beth and Katz, Leonard and Lynd, Lee R. and Masurekar Prakash and Reeves, Christopher D. and Zhao,Huimin, eds. (2010). *Manual of Industrial Microbiology and Biotechnology, 3rd Edition.* ASM Press.

Course Code	Course Name	Total Number of Credits
MICB - 519	Microbial Genomics Lab	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.

Methodology book:

Maria S. Poptsova (2014). Genome Analysis: Current Procedures and Applications. Book: 978-1-908230-29-4. ebook: 978-1-908230-68-3. Caister Academic Press.

Course Code	Course Name	Total Number of Credits
MICB - 521	**Project/Dissertation**	**06**

Guide Allocation: The guide allocation will be based on student's area of research interest and their CGPA till the third semester.

Assessment	Mark Distribution	Evaluation
Internal	60	Evaluated by Concerned guide based on student's performance in the lab.
External	40	Evaluated by two external members (faculties from other department/school of Pondicherry University) nominated by Head of the Department.

Course Code	Course Name	Duration	Total Number of Credits
MICB - 431	**Summer Internship**	**6 – 8 weeks**	**03**

Pre-Requisite: Students can perform their summer internship in any recognized University/Research Institutes/Industries etc. Students must submit the internship approval letter from the host institute to the Head of the Department and internal guide prior to beginning of the internship.

Guide Allocation:

Internal Guide: Faculty advisor will be the default internal guide to monitor and ensure the student's completion of summer internship.

External Guide: Scientist/Faculties/Investigators of the internship host Institute.

Assessment	Mark Distribution	Evaluation
Internal	40	Evaluated by Internal guide based on the report submitted by the students.
External	60	Two external members (nominated by Head of the Department) will evaluate based on the presentation & report submitted by the students.

Course Code	Course Name	Duration	Total Number of Credits
MICB - 432	**Self-Study Review**	**12-16 weeks**	**03**

This self-study review course helps the students to prepare their dissertation work by focusing on the literature review, report writing, result analysis etc.

Guide Allocation: Dissertation guide will be the default guide for the self-study review

Assessment	Mark Distribution	Evaluation
Internal	40	Evaluated by Concerned guide based on student's performance in the lab
External	60	Evaluated by two external members (faculties from other department/school of Pondicherry University)

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 433	Cell Culture Technology	48	03

Course Objective: *This course is designed to teach the students about basics and diverse applications of cell culture technology.*

Pre-Requisite: Bachelor degree in Life Sciences

Unit - 1 **10 h**

Basics of cell culture: History of cell culture, Types of cell cultures: Primary cell culture, Secondary cell culture, Cell lines (finite and continuous), and cell strain, Adherent & suspension cells, Morphology of cells in culture, Organ culture, Tissue culture. Laboratory design for aseptic cell culture - Biosafety level, Cell culture hood, Aseptic work area, Standard operating procedures, Care and maintenance of laboratory area.

Unit - 2 **10 h**

Requirements and Reagents in Cell Culture: Basics equipments - Biosafety Cabinet, CO_2 Incubator, Centrifuge, Inverted Microscope, Water Bath, Refrigerator, -80° Freezer, Liquid Nitrogen Storage Tank. Expanded Equipment - Aspiration pump, pH meter, Roller racks, Confocal microscope, Flow cytometer, Bioreactors, Cell cube. Cell culture plastics and cell culture vessels - Culture Flasks, Tubes, Petri Dishes, Multiwell Plates, chamber slides, Centrifuge Tubes, Serological Pipettes, Cryovials. Media and reagents - Types of culture media: Basal media, Synthetic media, Serum and serum free media, Media recommendations for common cell lines. Growth supplements, Balanced salt solution, Enzymes used in cell culture, physiochemical parameters (pH, CO_2, Temperature).

Unit - 3 **8 h**

Maintenance and Expansion of Cell Lines: Establishment of primary cell culture, Subculturing of adherent and suspension cells, Growth curve kinetics, Cryopreservation and storage of cells, Cell revival (Thawing of frozen cells), Quantification of Cells and Determining Cell Viability, Biology and characterisation of cultured cells.

Unit - 4 **10 h**

Identification and Prevention of Contamination in cell culture: Sources of contamination, Types of Contamination – Bacteria, Yeast, Mold, Virus, Mycoplasma and Cross contamination. Detection of contamination (fluorescent staining, ELISA, PCR, immunostaining, autoradiography, or microbiological assays). Prevention of Contamination – Aseptic technique, Proper handling of sterile reagents and media.

Unit - 5 **10 h**

Application of cell culture: Cell Culture Models for Human Health and Disease, Drug Development and screening, large scale production of biopharmaceuticals (proteins, enzymes, hormones, monoclonal antibodies, Vaccines), Construction & Maintenance of genome library, cell culture therapy, Tissue Regeneration and Transplantation- 3D culture

system and Organoid technology.

Text books:

1. R Ian Freshney (2021) Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 8th Edition.
2. M Butler (2004) Animal Cell Culture and Technology, 2nd edition.

Reference books:

1. Gibco Cell Culture Basics Handbook.
2. Animal Cell Culture Guide – ATCC.
3. John R W Masters (2000) Animal cell culture: A practical approach, 3rd edition, Oxford University Press.
4. Muhammed Al-Bureai (2015) Animal cell culture, Springer.
5. Ralf Portner (2021) Cell culture engineering and technology, Springer.

Course Outcome: *Through this course, students will gain a fundamental understanding of cell culture and utilize this knowledge in research and practical applications.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 434	Quality Control in Microbiology	48	03

Course Objective: *To train the students about basic/microbiology laboratory rules, industry regulations, microbiological criteria, Good Laboratory Practices (GLPs), and operation of laboratory equipment as per Standard Operating Procedures (SOP).*

Pre-Requisite: Bachelor degree in Life Sciences

Unit - 1 **10 h**

Basic concepts of Microbiological Quality Control: Overview of Biological/ Life Sciences concept, regulatory, accreditation and certification bodies, Norms in good manufacturing practices (GMP) and good documentation practices (GDP), organizational structure, employment prospects and opportunities, role and responsibilities of a quality control microbiologist

Unit - 2 **10 h**

Good Laboratory Practices (GLP) Guidelines: Guidelines of Good Laboratory Practices (GLP), good microbiological practices, Biosafety cabinets- working, use of protective clothing, BSL1, BSL2 and BSL3. Critical quality attributes (CQA), critical process parameters (CPP) and critical process controls (CPC), Quality management system for quality control in microbiology/ life sciences

Unit - 3 **8 h**

Health, Safety and Workplace Cleanliness: Personal Protection Equipments (PPEs), Concepts of safety, hazards/ accidents (hazardous material, fire, etc.) in a laboratory, safety signs and signals, Preparation and Interpretation of Material Safety Data sheets (MSDS), Disposal of bio-hazardous waste.

Unit - 4 **10 h**

Sample Preparation, Preservation and Storage: Specimens-Types, Handling, Labelling and Storage of incoming samples, Standards and guidelines for sample handling in Life Science industries, Guidelines- for sample weighing and storage. Good storage practices (GSP), Sample handling, Identification and Report of non-conformities (NCs) during sampling handling, storage and preservation

Unit - 5 **10 h**

Tests and Analysis of Specimens: Tests and analysis of physical, chemical and microbiological specimens- Maintenance of laboratory equipments, preparation of reagents, stock solutions, media and other miscellaneous laboratory requirements, documentation and reporting to laboratory supervisors. Experiments and data reporting to meet quality standards.

Text books:

1. Micheal, JL and Burton, EP (2011) A Photographic Atlas for the Microbiology Laboratory, 4th Edition, Morton Publishing Company.
2. Baird, RM, Hodges, NA and Denyer, SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Reference books:

1. Roesti, D and Goverde, M (2020) Pharmaceutical Microbiological Quality Assurance and Control: A practical guide for non-sterile manufacturing, John Wiley and Sons.

Course Outcome: *The students will be able to define legal and regulatory framework in the life science industry and equip themselves with laboratory rules, industry regulations and standards. They will also gain knowledge on good laboratory practices (GLPs) and learn the significance of standard operating procedures (SOPs) in handling, storage, preservation, experimentation, analyses and documentation.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 435	Research Methodology – Scientific Writing & Publication Ethics	48	03

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).*

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **12 h**

Academic Document Preparation - Books - types and varieties, Chapter in an edited volume, Book reports, Conference papers, Dissertation, Research Article, Research Paper, Technical reports, Thesis, Data announcements, poster presentations.

Unit - 2 **12 h**

Impact of Research: Impact Factor, calculation methods, various citation index methods, H- index, i10-index, STR, Web of Science, Scopus index, Source Normalized Impact per Paper, Citescore, 5-Year Impact factor, SCImago Journal Rank (SJR). Clarivate analytics.

Unit - 3 **12 h**

Art of Scientific Writing: Interpretation of Data and Paper Writing - Layout of a Research Paper, Writing a Research Report: Format and style. Review of literature and its implications, Major findings, Conclusions and outcomes. Reference books formats, Leading Science Journals, Impact factor of Journals.

Unit - 4 **12 h**

Publication Ethics: Ethics of scientific exhibits (visuals, graphs, charts, etc) – copy right and power point presentations, Ethical issues related to publishing, Plagiarism and Self Plagiarism – Turnitin (demo), COPE guidelines.

Text books:

1. S. Melville, W. Goddard. (1996) Research Methodology: An Introduction for Science and Engineering Students. Juta & Co Ltd, Land.

Reference books:

1. Joseph E. Harmon, Alan G. Gross (2007), On Early English Scientific Writing. The scientific literature, ISBN 9780226316567. The University of Chicago Press.
2. Day, Robert; Sakaduski, Nancy (2011). Scientific English: A Guide for Scientists and Other Professionals, Third Edition. ABC-CLIO. ISBN 978-0-313-39173-6. Greenwood.
3. Wendy Laura Belcher (2019). Writing Your Journal Article in 12 Weeks: A Guide to Academic Publishing.

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 436	Research Methodology - Biostatistics	48	03

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

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **10 h**

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

Unit - 2 **8 h**

Measures of Dispersion: variance, standard deviation and standard error.

Unit - 3 **10 h**

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

Unit - 4 **10 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 - 5 **10 h**

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

Text books:

1. Zar, Jerrold H. (2009). Biostatistical Analysis. Prentice Hall, N.J.

Reference books:

1. Walpole, R. and R. Myres (2016). Statistics for Engineers and scientists, 9th edn. Mac Millan, N.Y.
2. Wayne, R. Ott (1995). Environmental Statistics and Data analysis. CRC Press.
3. Manly (2008) statistics for environmental science and management, chapman and Hall/CRC.

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*.

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 437	Entrepreneurship and Microbial Industries	48	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 - 1 **8 h**

Entrepreneurship- (Economical & social facts) – Entrepreneur- Identifying new opportunity – Business Model Canvas

Unit - 2 **10 h**

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

Unit - 3 **10 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 - 4 **10 h**

Bioscience based investment – business of science – scientific analyst – Strategies of Pitching – decision to invest – marketing stocks – corporate financing.

Types of Funding – Public Funding: Startup India Initiative, Startup India Seed Fund Scheme, Atal Innovation Mission. Private Funding: Angel Investors and Venture Capital. Funding Sources: MSME, DBT-BIRAC, NABARD, SFAC.

Unit - 5 **10 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, Entrepreneurial exit strategy

Text books:

1. Craig Shimasaki. (2020). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Elsevier.

Reference books:

1. Holger Palzelt (Editor), Thomas Brenner. (2008). Handbook of Bioentrepreneurship. Springer.

2. Khanka S.S. (2018). Entrepreneurial Development. Chand & company Ltd.
3. Cynthia Robbins-Roth. (2005). Alternative Careers in Science. Academic press.

Course outcome: After this course student will learn how to be an entrepreneur in biosciences

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 441	Public Health Microbiology	48	03

Course Objective: *The course offers a comprehensive introduction to public health discipline the science of public health is interdisciplinary in nature and integrate with life science, social and behavioral science statistical science.*

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

Unit - 1 **10 h**

Concept and Winslow's definition of public health. Core functions of public health. Six domains of public health: epidemiology, statistics, biomedical sciences, social and behavioural sciences, environmental sciences, health administration. Public health agencies and their roles: CDC, WHO, 'Healthy people 2030', Occupational safety and health act. Initiatives of India to eliminate microbial diseases of public health concern: RNTCP, NACO.

Unit - 2 **10 h**

Epidemiology: Mortality, morbidity, prevalence, incidence, epidemic, pandemic, outbreak. Case control study, cohort studies, randomized control trial. Measures of disease in population. Sources of global health data.

Unit - 3 **8 h**

Foodborne and waterborne disease outbreaks, general approach to outbreak investigation, foodborne disease surveillance system, Microbial indicators of food safety, indicators of water quality. Notifiable diseases, Food borne infections, toxico-infections and intoxications. FDA, USDA, FoodNet: active surveillance network, GRAS, FSSAI.

Unit - 4 **10 h**

Airborne microbial pathogens, Non-microbial health hazards in air: Criteria air pollutants, PM10, PM2.5, EPA, aeromicrobiological pathway.
Nosocomial infections, types, causes. CDC guidelines for health care workers for control of nosocomial infections.

Unit - 5 **10 h**

Prevention and control of microbial public health hazards: Antimicrobial vaccination programs; whom to vaccinate and when to vaccinate. Role of hygiene and sanitation in maintenance of health and prevention of microbial infections. Developing and prioritizing interventions, prevention of Antimicrobial resistance (AMR) using Theory Planned Behavior (TPB)-based education.

Text books:

1. Mary Jane Schneider. (2020). Introduction to Public Health. 6th edition.

2. Murray P.R., Rosenthal K.S., Pfaller M.A., (2025). Medical Microbiology, Mosby Elsevier. Tenth edition.
3. Oxford Textbook of Public Health, Ed. Roger Detels, James McEwen, Robert Beaglehole, and Heizo Tanaka. Oxford University Press (OUP), 4th Edition: 2002.
4. Public Health at the Crossroads – Achievements and Prospects. Robert Beaglehole and Ruth Bonita, 2nd Edition, Cambridge University Press.
5. Maxcy-Rosenau-Last Public Health & Preventive Medicine, 16th Edition, Ed. Robert Wallace, MD, et al.
6. Somerville Margaret, et al., Public Health and Epidemiology at a Glance, Second Edition, Wiley-Blackwell, 2016.
7. Griesceke J: Modern Infectious Disease Epidemiology 3rd edition 2017

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 442	Biomolecules	48	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 **10 h**

Carbohydrates: Definition – classification - Structures and Properties of Simple Sugars - The Variety of Monosaccharides - conformation. Concept of epimer, isomer, enantiomer. Disaccharides scientific nomenclature, Polysaccharides - Conformations of Polysaccharide Chains. Homopolysaccharides - Heteropolysaccharides. Unbranched and Branched, Polysaccharides of Bacterial surfaces

Unit - 2 **10 h**

Lipids and Sterols: 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 **10 h**

Proteins: The building blocks of proteins: amino acids, peptides, polypeptides - Amino acids: Classification of amino acids – molecular mass, properties of amino acids, Ramchandran Plot. Three-dimensional structure of protein. Classification - Fibrous and globular proteins. Structural organization of proteins- Primary structure, Secondary structure- α-Helix, β- pleats and β – turn. Hierarchy of structural organization.

Unit - 4 **10 h**

Nucleic Acids: Structure and Chemistry of Nucleotides - Names and Abbreviations. Acid–Base Chemistry and Tautomerism. Absorption of Ultraviolet Light. Base Pairs - Double Helices - The B Form of DNA. Other Double-Helical Forms of DNA - Ribonucleic Acids (RNA) - types - RNA Loops and Turns.

Unit - 5 **8 h**

Vitamins and Bioelements: 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

Text books:

1. Nelson D. L. and Cox, M. (2021) M. Lehninger's Principle of Biochemistry. 8th edition. W. H. Freeman and company, U.S.A.
2. Metzler, D. E. (2003) Biochemistry: the chemical reactions of living cells. Second edition. Academic Press, U.S.A.

Reference books:

1. Frieden, E. (1984) Biochemistry of the essential ultra-trace elements. Plenium press U.S.A.
2. Simmonds, R. J. (1992) Chemistry of Biomolecules: An Introduction. Royal society of Chemistry, UK
3. Berg J. M., Tymoczko J. L.and Stryer L. (2023) Biochemistry. 10th edition. W.H. Freeman, U.S.A.
4. White D. (2011) Physiology and Biochemistry of Prokaryotes. 4th edition. Oxford University Press, New York, U.S.A.

Course Outcome: *Students will study the fundamental concepts of these biomolecules, their structures, types and biological importance*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 443	Microbial Physiology	48	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 *E. coli* aspartate carbamoyl transferase.

Unit - 5 **10 h**

Adaptive and Developmental Changes: Myxobacterial Developmental Cycle: Life Cycle of Myxobacteria, Aggregation and Fruiting Body Formation, Intercellular signaling in myxobacteria - *Caulobacter* Differentiation: Life Cycle of *Caulobacter crescentus*, The Stalk, the Holdfast, and the Flagellum: Structure. Genetics, and Regulation, Regulation and Checkpoints of the Cell Cycle of *C. crescentus* - Oxidative stress, Heat shock response, Response to changes in osmotic pressure, Chemotaxis.

Text books:

1. Moat A.G., Foster J.W. and Spector M.P.(2002). Microbial Physiology (4th edition). John Wiley and Sons, U.S.A.
2. White, D., (2011) The Physiology and Biochemistry of Prokaryotes. 4th edition. Oxford University Press, UK

Reference books:

1. Gottschalk,G. (1985) Bacterial Metabolism, Second edition, Springer, U.S.A.
2. Caldwell, D.R. (1995) Microbial Physiology and Metabolism, Wm. C. Brown Publishers, U.S.A.
3. Perry, J.J., Staley, J.T. and Lory, S. (2002). Microbial Life. Sinauer Associates, Publishers, Sunderland, U.S.A.
4. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. (2006). Microbe. ASM Press, U.S.A.
5. Tortora, G.J., Funke, B.R. and Case C.L. 2018 Microbiology-An Introduction. Benjamin Cummings. San Francisco. U.S.A.
6. Alcomo, I.E. (2001). Fundamentals of Microbiology. Sixth Edition, Jones and Bartlett Publishers, U.S.A.

***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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 444	Biology of Parasitism	48	03

Course Objectives: *This course aims to make the students understand the modern parasitology approaches focused on the cellular and molecular mechanisms by which human parasites cause disease and the host response to infection on global human health. The course would also enable students to describe the molecular diagnostic methods and therapeutic approaches for parasitic diseases.*

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

Unit - 1 **8 h**

History of human parasitic diseases, Parasite identification, Insect vectors, Transmission of parasitic diseases (Animals, Blood, Food, Insects, Water), Public health importance and department resources, Elements of epidemiology,

Unit - 2 **10 h**

Principles of parasite-host interactions, Parasite-vector interactions, pathological changes associated with parasitic infections, targeting parasite enzymes, Human activity and parasite biogeography, Climate change and vector-borne disease.

Unit - 3 **10 h**

Pathogenesis of clinically important parasites**:** Plasmodium, Leishmania, Toxoplasma, Trypanosoma, enteric protozoa (Entamoeba, and Cryptosporidium), Schistosoma, Specialized organelles in protozoans.

Unit - 4 **10 h**

Mechanisms of nutrient uptake, virulence factors, drug resistance, parasite motility, host-to-host transmission by insect vectors and immune responses to infection.

Unit - 5 **10 h**

Diagnosis techniques of parasitic diseases, Drug susceptibility testing of parasites, therapeutic agents (chemo drugs, RNA-based drugs, vaccines) in clinical studies.

Reference books:

1. Peters W., Pasvol G. (2024) Atlas of tropical medicine and parasitology Elsevier Mosby, Sixth edition
2. Bogitsh B.J., Carter C.E., Oeltmann T.N. (2019) Human Parasitology. 5th edition. Academic Press
3. Julia Walochnik., Michael Duchêne. (2016) Molecular Parasitology, Protozoan Parasites and their Molecules. Springer
4. Heinz Mehlhorn., (2023) Human Parasites - Diagnosis, Treatment, Prevention. Springer.

5. Rohela Mahmud., Yvonne Ai Lian Lim., Amirah Amir (2017) Medical Parasitology. Springer.

Course Outcome*: Through this course, students will be able to describe the clinical aspects of parasite biology at the host-parasite interface and discuss their molecular diagnostic method and treatment strategies for clinically essential parasites.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 445	Microbial Technology	48	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.*

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **8 h**

Industrial Fermentation: – role of microorganisms in food and dairy industry. Fermented beverages-beer, wine and other alcoholic beverages. Microbial preparation of Tempeh, sauerkraut, Miso, yogurt. Probiotics. Biomass production – Baker's Yeats, Single cell protein. Mushroom cultivation.

Unit - 2 **10 h**

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 - 3 **10 h**

Microbiology of wastewater and solid waste treatment: - biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Trickling filter - Activated sludge and Anaerobic digestion process. Treatment of industrial effluents by microorganisms. Composting methods. Microbiology of degradation of xenobiotics – BHC, DDT and pesticides. Bioremediation of insecticides, pesticides and heavy metals.

Unit - 4 **10 h**

Plant Growth Promoting Rhizobacteria (PGPR). Biofertilizers- *Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter*, *Azorhizobium*, phosphobacteria - mycorrhizae - Blue Green Algae and Azolla. Biopesticides - *Bacillus thuringiensis*, NPV, *Beauveria bassiana*. Mass production of biofertilizers and biopesticides – integrated insect pest management.

Unit - 5 **10 h**

Green Energy: Renewable bioenergy using microorganisms – Methanogenesis, Methane production by anaerobic digestion of waste organic materials. Bioethanol and Biobutanol production by using microorganisms. Biohydrogen Generation, Microbial Fuel. Biodiesel from algae.

Text books:

1. Prescott's Microbiology, Joanne M. Willey , Linda M. Sherwood , Christopher J. Woolverton 12th Edition McGraw-Hill Publishers.
2. Wulf Cruger and Anneliese Cruger., Biotechnoloogy, (A text book of industrial

Microbiology), Panima Publishers, New Delhi, 2nd edition, 2003.

Reference books:

1. Prescott and Dunn, Industrial Microbiology, CBS Publishers, New Delhi, 4th Edition, 1987.
2. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc.,Tata MacGraw Hill, New Delhi.
3. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A. D. Russell Sixth edition. Blackwell scientific Publications.
4. Bioremediation by Baker K.H. And Herson D.S. 1994.. Mac Graw Hill Inc. N.Y.

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 446	Marine Microbiology	48	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.*

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **8 h**

Introduction to Microbial Oceanography – marine ecosystem: benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop - marine microbial communities - phytoplankton, protozoa, bacteria, fungi, and virus. Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association – Theory of hologenome (coral).

Unit - 2 **10 h**

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 - 3 **10 h**

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

Unit - 4 **10 h**

Microbes of extreme environments – mechanism of extremophiles – halophiles – halorhodopsin – deep sea microbes – microbes of hydrothermal vents - thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles – importance in biotechnology.

Unit - 5 **10 h**

Seafood microbiology - normal genera associated with fish, food spoilage, fish & human pathogens; zoonotics – Vibrio parahaemolyticus, Brief account on aquaculture pathogens - Vibriosis – fish and shrimp diseases – WSSV – MBV etc. Rapid diagnosis of contamination in seafoods and aquaculture products.

Text books:

1. M.T. Madigan and J.M. Martinko (2006) Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA.

2. Rheinhemer, G. (1991). Aquatic Microbiology, Johnwiley & Sons

Reference books:

1. Elay, A.R. (1996). Microbial food poisoning. Chapman and Hall, London, 191 pp.
2. Ford, T.E., (1993). Aquatic microbiology. An ecological approach. Blackwell scientificpublications,London, 518 pp.
3. Krichman, D.L. (2008). Microbial ecology of the oceans. Wiley – liss, New york,
4. Bhakuni, D.S. and Rawat, D.S. (2005). Bioactive marine natural products. Anamaya Publishers, New Delhi.
5. Joseph Selvin and A. S. Ninawe (2009). Shrimp Disease Management. ANE Publishers.

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 447	Microbial Nanotechnology	48	03

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

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **9 h**

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 - 2 **9 h**

Microbial nanotechnology –Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vechicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

Unit - 3 **9 h**

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

Unit - 4 **12 h**

Nanoscale applications in biology and medicine: Nanotechnologies for biology and medicine- Micro- and nano- fluidics - Scanning probe microscopy in biology and medicine - Self- assembly of biological molecules. Nanobiotics, Application of Nanoparticles in theranostics, Drug delivery – protein mediated and nanoparticle mediated. Hybridconjugates of gold nanoparticles – DNA oligomers – use of DNA molecules in nanomechanics and Computing.Nanoparticles as carrier for genetic material. Genetically Modified Organisms (GMO) and applications.

Unit - 5 **9 h**

Implications of nanotechnology: Health and safety implications from nanoparticles: Health issues – Environmental issues – Need for regulation – Societal implications: Possible military applications – Potential benefits and risks for developing countries – Intellectual property issues – Criticism of Nanotechnology – Studies on the implications of Nanotechnology.

Text books:

1. Pradeep T. (2012). Textbook of Nanoscience and Nanotechnology. McGraw Hill Education (India) Private Limited.

2. Murty B.S., Shankar P., Baldev Raj, Rath B. B., James Murday. (2013). Textbook of Nanoscience and Nanotechnology. Springer, Berlin, Heidelberg.
3. Risal Singh, Shipra Mital Gupta. (2016). Introduction to Nanotechnology: Understanding the Essentials, 1st edition. Oxford University Press.
4. Rakesh K. Tekade. (2019). Biomaterials and Bio-Nanotechnology, 1st edition. Academic Press.
5. David E. Reisner. (2011). Bionanotechnology II: Global Prospects. CRC Press.
6. Yubing Xie. (2017). The Nanobiotechnology Handbook, 1st edition. CRC Press.

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.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 531	Agricultural Microbiology	48	03

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

Pre-Requisite: Masters students in Life Science

Unit - 1 **10 h**

Soil Environment- Microorganisms, soil structure, soil profile, Physico-chemical conditions, Microbial composition, sampling techniques, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins). Bio-geo chemical cycles – Carbon cycle, Nitrogen cycle – Nitrogen fixation, nitrification, de-nitrification, sulphur, iron and phosphorus cycles. PGPR-Rhizosphere – Rhizosphere Microorganisms, Siderophores. PGPM-Plant growth promoting microorganisms. plant-microbe beneficial interactions. Mechanisms of plant growth promotion.

Unit - 2 **10 h**

Major plant disease symptoms caused by fungi, bacteria and viruses. Plant diseases – Principles, symptoms and control measures of the following diseases: Fungal – Tikka, red rot of sugarcane, *Fusarium wilts* (red gram and cotton), *Sclerotium rolfsii* and *Macrophomina phaseolina* (collar rot disease, charcoal rot). Bacterial – Blight of rice, citrus canker, *Xanthomonas* (black rot). Viral and mycoplasmal – Bud necrosis of groundnut, citrus mosaic, little leaf of brinjal, tomato leaf curl. Principles of plant disease control. Protection - Diseases of field, vegetable, orchard and plantation crops of India and their control; causes and classification of plant diseases; principles of plant disease control biological control of diseases.

Unit - 3 **10 h**

Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes – phosphate solubilization- *Rhizobium, Azotobacter, Azospirillum, Azolla; Anabaena* Symbiosis, blue green algae and Ecto- and Endomychorizae. Cultivation, mass production and inoculation of *Rhizobium, Azotobacter, Azospirillum, Azolla* and cyanobacteria, Carrier-based inoculants, methods of application, quality control, agronomic importance. Application methods for different biofertilizers – Vermicomposting.

Unit - 4 **9 h**

Biopesticides – Principles of biological control – antagonism, parasitism, *Bacillus thuringiensis, B. sphaericus, B. popilliae, Pseudomonas syringae*. Biocontrol- nematophagy - Microbial control of plant pathogens- Trichoderma. Useful genes from microorganisms for agriculture (herbicide resistant, Bt, viral). Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.

Unit - 5 **9 h**

Molecular plant microbe-interactions: Cell signaling, 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.

Text books:

1. Dirk J, Elas V, Trevors JT, Wellington, EMH (2021) Modern Soil Microbiology, Marcel Dekker INC, New York.
2. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
3. Bio-fertilizers in Agriculture and Forestry, 1995, by N.S. Subba Rao.
4. Microbes For Sustainable Agriculture by K.V.B.R. Tilak, K.K. Pal, Rinku Dey
5. Soil Microbiology and Plant Growth, 1995, by N.S. Subba Rao.
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
9. Plant-microbe interactions and biological control Volume 63 of Books in soils, plants, and the environment by Greg J. Boland, L. David Kuykendall.

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-interaction*.

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 532	Fermentation Technology	48	03

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

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **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 microorganisms; 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 - 2 **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 - 3 **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 - 4 **9 h**

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 technique

Unit - 5 **10 h**

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.

Text books:

1. Stanbury, P.F., Whitekar A. and S.J. Hall. (2016). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
2. McNeil B. and L. M. Harvey (1990). Fermentations - A practical approach. IRL Press.
3. Sven-Olof Enfors (2000). Bioprocess Technology: Fundamentals and Applications. Royal Institute of Technology
4. Creuger A. and Creuger W. (2000). Biotechnology- A textbook of Industrial Microbiology Oxford University Press
5. Vogel, H.C. and C.L. Todaro, (2005). Fermentation and Biochemical Engineering Handbook : Principles, Process Design and Equipment. 2nd Edition, Standard Publishers.

Reference books:

1. Biely, J.E. and Ollis D.F (1986). Bio Chemical Engineering Fundamentals Megraw Hills.
2. Moo-Young M (2011). Comprehensive Biotechnology, Elsevier.
3. Brian Currell, R. C. Van Dam Mieras (1997). Biotechnological Innovations in Chemical Synthesis. BIOTOL. Publishers / Butterworth.
4. Christoph Wittmann, James C. Liao, Sang Yup Lee, Jens Nielsen, Gregory (2017). Industrial Biotechnology: Microorganisms. Wiley-VCH.

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*.

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB-533	Genome Technology	48	03

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

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **10 h**

Genome Organization: Genome size, complexity and organization of Eubacteria, Archaebacteria, and viruses. Genomic organization of eukaryotes like algae, fungi, plants and mammals.

Unit - 2 **10 h**

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, and PCR.

Unit - 3 **10 h**

Genome Editing: Genome editing in animals, and plants - Cre-LoxP system, and Ti plasmid vectors. Genome editing in human and non-human primates - Zinc finger nucleases, phage recombinase, sleeping beauty transposon, Talen, and CRISPR-Cas systems.

Unit - 4 **8 h**

Gene Expression Analysis: Chromatin immunoprecipitation (ChIP) assay, RNA sequencing, single cell RNA sequencing, and other types of genome sequencing.

Unit - 5 **10 h**

Prokaryotic expression systems Gene expression based on bacteriophage T7 RNA polymerase, Eukaryotic expression systems- Fused genes, Unfused genes, and Secreted proteins.

Text books:

1. Sandy B. Primrose, Richard Twyman (2008), Genomics: Applications in Human Biology. Wiley and Sons.
2. Mount D (2004). Bioinformatics: Sequence and Genome Analysis by. Cold Spring Harbor Laboratory Press, New York.

Reference books:

1. Diana Marco (2014). Metagenomics of the Microbial Nitrogen Cycle: Theory, Methods and Applications Book: 978-1-908230-48-5. ebook: 978-1-908230-60-7, Caister Academic Press.
2. Pilar Francino, M (2012). Horizontal Gene Transfer in Book: 978-1-908230-10-2. ebook:

978-1-908230-72-0, Caister Academic Press.
3. Muhammad Jamal (2017). The CRISPR/Cas System: Emerging Technology and Application. Caister Academic Press.
4. Manuel Fuentes, Joshua LaBaer (2014). Proteomics: Targeted Technology, Innovations and Applications. Book: 978-1-908230-46-1. ebook: 978-1-908230-62-1. Caister Academic Press.
5. Patrick Arbuthnot and Marc S. Weinberg (2014). Applied RNAi: From Fundamental Research to Therapeutic Applications. Book: 978-1-908230-43-0. ebook: 978-1- 908230-67. Caister Academic Press.
6. Jianping Xu (2014). Next-generation Sequencing: Current Technologies and Applications. Edited by: Published: 2014 Book: 978-1-908230-33-1. Ebook: 978-1- 908230-95-9. Caister Academic Press.
7. Maria S. Poptsova (2014). Genome Analysis: Current Procedures and Applications. Book: 978-1-908230-29-4. ebook: 978-1-908230-68-3. Caister Academic Press.
8. Diana Marco (2011). Metagenomics: Current Innovations and Future Trends. Book: 978-1-904455-87-5. Horizon Scientific Press.
9. S. B. Primrose (2002). Principles of Genome Analysis. A Guide to Mapping and Sequencing DNA from Different Organisms. Blackwell publishing.

Course outcome: *This course would make the students knowledgeable/skilled in new methods, and technologies involved in genome characterization, editing, and development for genetic improvement and over-production of commercial important bio-compounds.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB-534	**Drug Design & Discovery**	**48**	**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.*

Pre-Requisite: Masters students in Life Sciences

Unit - 1 **9 h**

Introduction- History of drug design, Current approaches and philosophies in drug design, Molecular mechanisms of diseases and drug action with examples. Pharmaceutical products. Target Identification and Validation, Lead Discovery and Optimization, Preclinical Studies and Clinical trials, Intellectual property, Role of regulatory bodies. Receptors as targets of drug design; *in vitro* ADME and *in vivo* Pharmacokinetics

Unit - 2 **10 h**

Sources of Drugs- 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). *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 - 3 **10 h**

Drug development process- Impact of genomics and related technologies upon drug discovery: Gene chips, Proteomics, Structural genomics and Pharmacogenetics, Model systems in the development of drugs, Drug - Development, Optimisation, and Validation Nanoscaffolds for Drug Delivery.

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 - 4 **10 h**

Vaccines and adjuvant- Traditional vaccine preparations, attenuated, dead or inactivated bacteria, Attenuated and inactivated viral vaccines, Toxoids, antigen-based and other vaccine preparations. Impact of genetic engineering on vaccine technology. Peptide vaccines Vaccine vectors. Development of an AIDS vaccine, Difficulties associated with vaccine development, AIDS vaccines in clinical trials, Cancer vaccines, Recombinant veterinary vaccines. Adjuvant technology: Adjuvant mode of action, Mineral-based adjuvants, Oil-based emulsion adjuvants Bacteria/bacterial products as adjuvants, Biosimilars.

Unit - 5 **9 h**

Nucleic acid as drugs- Gene therapy: Basic approach to gene therapy, Vectors used in gene therapy -Retroviral vectors, Additional viral-based vectors, Manufacture of viral vectors, non-viral vectors. Gene therapy and genetic disease, cancer, Gene therapy and AIDS. Gene- based vaccines, Biologics and Biosimilars.

Text books:

1. Kristian Stromgaar, Povl Krogsgaard-Larsen and Ulf Madsen (2017). Textbook of Drug Design and Discovery, Fifth Edition, CRC press, 2017.
2. Thomas J. Dougherty and Steven J. Projan. Microbial Genomics and Drug Discovery, Taylor and Francis, 2003.

Reference books:

1. Merz Jr, Kenneth M., Dagmar Ringe, and Charles H. Reynolds, eds. Drug design: structure-and ligand-based approaches. Cambridge University Press, 2010.
2. Klebe, Gerhard. Drug design: from structure and mode-of-action to rational design concepts. Springer Nature, 2025.
3. Walsh, Gary. Biopharmaceuticals: biochemistry and biotechnology. John Wiley & Sons, 2013.

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*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 535	Biosafety, Bioethics & IPR	48	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 - 1 **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 - 2 **10 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 - 3 **10 h**

Biosafety Facilities: Animal Biosafety facilities (ABSL), Plant Biosafety facilities (PBSL), Aquatic organism Biosafety facilities (AQBSL), Operational guidelines for ABSL, PBSL, AQBSL.

Unit - 4 **10 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 - 5 **10 h**

IPR: Intellectual Property (IP), types of IP, (Patents, Trademarks, Copyright & Related Rights, Industrial Design), importance of IPR, legal protection of bioscience discoveries (patentable and non patentable). Procedure for filing Indian, International and US patent.

Text books:

1. Lewis Vaughn. Bioethics: Principles, Issues and Cases, 6th Edition. Oxford University Press
2. Deepa Goel, Shomini Parashar. (2013). IPR, Biosafety and Bioethics.Pearson.

Reference books:

1. Handbook Good Laboratory Practices, World Health Organization, Second edition.
2. Regulations and guidelines on biosafety of recombinant DNA research and biocontainment, DBT, Government of India, 2017.

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*.

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 536	Microfluidics for Microbiology	48	03

Course Objective: *This soft course was designed for students from all the science discipline. This course teaches about microfluidics and its importance in future research*

Pre-Requisite: Bachelor degree in Life Sciences

Unit - 1 **8 h**

Basics of Microfluidics: Introduction to Microfluidics, History and Milestone of Microfluidics. Principle of Microfluidics, Lab-on-chip model, Advantages and disadvantages of Microfluidics.

Unit - 2 **10 h**

Microfluidics Components: Types of Materials- Polymers, silicone-glass devices, hydrogel, wood, liquid-liquid interfaces, PTFE. Microfabrication, Operational units: pumps, valves, flow sensors, types of biosensors & its application, micromixers, droplet generators, microparticle separator, microreactors-design.

Unit - 3 **10 h**

Microfluidics in Microbial Culture: Biofilm research, pathogen detection and antibiotics susceptibility, diagnosis of viral infection, toxin detection in food samples.

Unit - 4 **10 h**

Microfluidics in Microbial Research: Microfluidics model-organ on chip microbiome studies (lung, gut, skin, bone, heart, kidney and brain), Nucleic acid analysis, Cytometry & cell sorting, detection of biomarker, Microfluidics in Antimicrobial Resistance (AMR).

Unit - 5 **10 h**

Prospectives of Microfluidics: Droplet microfluidics, Microfluidics & Artificial Intelligence, Human-on-chip. Personalized Drug delivery, precision medicine, 3D Cell Culture.

Text books:

1. Introduction to Microfluidics 2nd edition (2023), Patrick Tabeling. Publisher-Oxford press
2. Fundamentals and Applications of Microfluidics 3rd edition (2019), Nam-Trung Nguyen and Steven T. Wereley. Artech House Publishers
3. Microfluidic Methods for Molecular Biology (2016), Chang Lu, Scott S. Verbridge. Publisher-Springer International Publishing

Reference books:

1. https://www.sciencedirect.com/science/article/pii/S1359644624000618

2. https://www.nature.com/articles/s41467-022-30384-7
3. https://www.elveflow.com/microfluidic-reviews/a-general-overview-of-microfluidics/#:~:text=Microfluidics%20is%20both%20the%20science,fluids%20flow%20or%20are%20confined.
4. https://www.nature.com/articles/nature05058

Course Outcome: *Through this course students will get exposure to emerging field of research such as lab-on-chip, organ-on-chip models.*

Course Code	Course Name	Total Number of Lecture hours	Total Number of Credits
MICB - 537	Mushroom Culture Technology	48	03

Course Objective*: It is a Skill-based course framed to educate students all relevant details required to be a master in mushroom technology. This course covers almost all aspects pertaining to mushroom maintenance, cultivation and value addition.*

Pre-Requisite: Bachelor degree in Life Sciences

Unit - 1 **8 h**

Biology of Mushroom: Mushrooms: Typical structure of a mushroom and a brief account of life cycle; History and Scope of Mushroom - Taxonomical rank of Mushrooms - Classification of mushrooms: based on natural habitat, taxonomic position -Vegetative characters of edible and poisonous mushrooms- Morphological features of edible mushrooms

Unit - 2 **10 h**

Biochemistry of Mushrooms: Nutraceutical value of edible mushrooms and their activities- Therapeutic aspects: antitumor, antioxidant, antidiabetic activity, Mushroom active compounds against cardiovascular diseases (CVDs) and neurodegenerative diseases (NDs)- Medicinal mushrooms in South India and their therapeutic value- Poisonous mushrooms: harmful effects.

Unit - 3 **10 h**

Edible Mushrooms: Button Mushroom (*Agaricus bisporous*), Oyster mushroom (*Pleurotus sajorcaju*), paddy straw mushroom (*Volvariella volvacea*), Milky Mushroom (*Calocybe indica*) - Other medical and economically important mushroom: Shiitake Mushroom (*Lentinula edodes*), Kabul Dhingri (*King Oyster*) Mushroom.

Unit - 4 **10 h**

Cultivation of Mushrooms: Structure and construction of mushroom house - Compost and composting- Methods of composting: long and short method of composting - Spawn and spawning - Preparation of spawn substrate - Casing- Different types of casing mixtures, commonly used materials- Cropping- Problems in cultivation.

Unit - 5 **10 h**

Value Additions and Marketing: Shelf life of mushrooms - Preservation of mushrooms; freezing, dry freezing, drying, and canning- Value added products / recipes - Quality assurance- Packing and packaging- Market opportunities - Economics of different types of mushrooms- Management of spent substrates and waste disposal of various mushrooms.

Text books:

1. Pandey, RK. and Ghosh, SK. (1996) A handbook of Mushroom Cultivation. Emkey Publication.
2. Pathak, VN and Yadav, N. (1998) Mushroom Production and Processing Technology.

Agrobios, Jodhpur.
3. Nita Bhal. (2000) Handbook on Mushrooms (Vol. I and II). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
4. Rattan, SS. and Upadhyay, RC. (2006) Mushroom Production Technology: Recent Advances, Daya Publishing House, Delhi, India

Course Outcome: *On completion of the course a student will be knowledgeable and be prepared to start a firm concentrating on mushroom cultivation, product development and marketing. This course also empowers students to deal with all compliance issues associated quality of mushroom and related products.*