CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY
KANPUR

Four Year Undergraduate Programme (FYUP)

MICROBIOLOGY

Syllabus of

4 YEAR B.Sc. (HONOURS)

4 YEAR B.Sc. (HONOURS WITH RESEARCH)

AND

4+1 YEAR (B.Sc. HONOURS/ B.Sc. HONOURS WITH RESEARCH + M.Sc.) IN MICROBIOLOGY

SESSION 2025-2026 ONWARDS

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Prof. Neelam Pathak (Online)
Prof. Ram Narain (Online)
Prof. B.N. Mishra (Online)

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR
STRUCTURE OF SYLLABUS FOR THE
Program: Four Year Undergraduate Programme (FYUP) for Microbiology

Syllabus Developed By			
Name of BoS convenor/BoS member	**Designation**	**Department**	**College/University**
Prof. S. K. Awasthi	Dean, Faculty of Life Sciences	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Prof. Varsha Gupta	Director, School of Life Sciences and Biotechnology	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Prof. Neelam Pathak	External Expert	Department of Biochemistry	R.M.L. Awadh University, Ayodhya
Prof. Ram Naraian	External Expert	Department of Biotechnology	V.B.S. Purvanchal University, Jaunpur
Prof. B. N. Mishra	External Expert	Department of Biotechnology	Instt. of Engineering and Technology, Lucknow
Prof. Rolee Sharma	Professor	Department of Life Sciences, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Shilpa D. Kaistha	Associate Professor	Department of Biotechnology, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Manishi Tripathi	Assistant Professor	Department of Microbiology, School of Life Sciences and Biotechnology	CSJM University, Kanpur
Dr. Ekta Khare	Assistant Professor	Department of Microbiology, School of Life Sciences and Biotechnology	CSJM University, Kanpur

Proposed Year wise Structure of Four Year Undergraduate Program (FYUP) & One Year M.Sc. in Microbiology

(BOS Year 2025)

Year	Semester	Course Code	Paper Title	Theory /Practical	Credits
1	I	B0S0101T	General Microbiology	Theory	4
		B0S0102P	Experiments in Basic Microbiology	Practical	2
	II	B0S0201T	Agriculture and Environmental Microbiology	Theory	4
		B0S0202P	Experiments in Agriculture and Environmental Microbiology	Practical	2
2	III	B0S0301T	Basic Biochemistry and Microbial Physiology	Theory	4
		B0S0302P	Experiments in Basic Biochemistry and Microbial Physiology	Practical	2
	IV	B0S0401T	Molecular Biology and Microbial Genetics	Theory	4
		B0S0402P	Experiments in Molecular Biology and Microbial Genetics	Practical	2
		B0S0403R	Research Project/ Dissertation/ Internship/ Field or Survey work	Project	3
3	V	B080501T	Medical Microbiology	Theory	4
		B080502T	Immunology	Theory	4
		B080503P	Experiments in Medical Microbiology & Immunology	Practical	2
	VI	B080601T	Food Microbiology	Theory	4
		B080602T	Industrial Microbiology	Theory	4
		B080603P	Experiments in Food & Industrial Microbiology	Practical	2
Bachelor of Science (Honours) in Microbiology					
4	VII	B080701T	Principles of Microbiology	Theory	4
		B080702T	Biochemistry	Theory	4
		B080703T	Analytical Techniques and Biostatistics	Theory	4
		B080704T	Cellular Microbiology	Theory	4
		B080705P	Practical	Practical	4

	VIII	**B080801T**	Bacterial Metabolism and Physiology	Theory	4
		B080802T	Principles of Molecular Biology	Theory	4
		B080803T	Recombinant DNA Technology	Theory	4
		B080804T	Virology	Theory	4
		B080805P	Practical	Practical	4
OR					
Bachelor of Science (Honours with Research) in Microbiology					
4	VII	**B080701T**	Principles of Microbiology	Theory	4
		B080702T	Biochemistry	Theory	4
		B080703T	Analytical Techniques and Biostatistics	Theory	4
		B080704T	Cellular Microbiology	Theory	4
		B080705R	Dissertation/ Internship/ Field or Survey Work (Progressive)	Project	4
	VIII	**B080801T**	Bacterial Metabolism and Physiology	Theory	4
		B080802T	Principles of Molecular Biology	Theory	4
		B080803T	Recombinant DNA Technology	Theory	4
		B080804T	Virology	Theory	4
		B080805R	Dissertation/ Internship/ Field or Survey Work (Submitted)	Project	4
Master of Science Microbiology (1 Year)					
5	IX	**B080901T**	Microbial Genetics	Theory (any three elective to be chosen)	4
		B080902T	Cellular and Molecular Immunology		
		B080903T	Agro-environmental Microbiology		4
		B080904T	Microbial Genomics, Proteomics and Bioinformatics		4
		B080905T	Infectious Disease Microbiology		
		B080906T	Applied Food Microbiology		
		B080907P	Practical	Practical	4

		B080908R	Research project/ Dissertation/ Internship/ Field or Survey Work (Progressive)	Project	4
	X	**B081001T**	Microbial Technology	Theory (any three elective to be chosen)	4
		B081002T	Advanced Immunology & Immunotechniques		4
		B081003T	Entrepreneurial Microbiology		4
		B081004T	MOOC*		
		B081005P	Practical	Practical	4
		B081006R	Research project/ Dissertation/ Internship/ Field or Survey Work (Submitted)	Project	4

*Any course from MOOCS of the relevant discipline may be selected after approval from coordinator & Head / Director as 10th semester elective paper.

Subject prerequisite	
To study MICROBIOLOGY at undergraduate, a student must have Biology in Class 12.	
Programme Objectives (POs)	
1.	**Microbiology Knowledge** Graduates will acquire microbiology specific knowledge including molecular biology, immunology and rDNA technology coupled with handson skills and leadership skills to take up higher studies, set up small scale industries, and develop confidence to take up challenging tasks of research in the field of Microbiology.
2.	**Critical Thinking** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
3.	**Effective Communication** Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology
4.	**Team Work** Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.
5.	**Effective Citizenship** Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems. Students learn to integrate science with society for the overall development of the nation.
6.	**Environment and Sustainability** Understand the issues of environmental contexts and sustainable development.
7.	**Ethics** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
8.	**Lifelong learning** Graduates will carry on to learn and adapt in a world of constantly evolving technology.

Certificate Course in Microbial Techniques	
B. Sc. I Programme Specific Outcomes (PSOs)	
PSO1	Students will be able to acquire, articulate, retain, and apply specialized skills and knowledge relevant to microbiology.
PSO2	Students will be able to appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of habitats, understand their pathogenic as well beneficial significance to man and nature.
PSO3	Students will acquire and demonstrate proficiency in good laboratory practices in a microbiological laboratory and be able to explain the theoretical basis and practical skills of the tools/technologies commonly used to study this field.
PSO4	Students will gain fundamental knowledge about the various scopes on agricultural and environmental microbiology and their concepts.
PSO5	The certificate course will enable students to apply for technical positions in government and private labs/institutes.

Diploma in Microbial Technology	
B.Sc. II Programme based outcomes	
PSO 1	Students will develop familiarity and understanding of the microbiology concepts as relevant to various areas such as biochemistry, microbial physiology, molecular biology and genetics.
PSO 2	Students will exhibit reasonable abilities in the utilization of instruments, advances and techniques common to microbiology, and apply the logical strategy and theory testing in the plan and execution of examinations.
PSO3	Students will be adequately capable to utilize microbiology information and abilities to analyze problems involving microorganisms, articulate these with peers and undertake remedial measures.
PSO4	Students will be able to describe how microorganisms obtain energy, metabolism, reproduction, survival, and interactions with their environment, hosts, and host populations.
PSO5	Students will be able to work in a variety of fields, including biological and medical science in higher education institutions, public health, environmental organizations, and the food, dairy, pharmaceutical, and biotechnology industries.

Degree in Bachelor of Science	
B.Sc III Programme Specific Outcomes (PSOs)	
PSO1	Students of B.Sc. Microbiology Programme will learn to use scientific logic as they investigate a broad variety of contemporary subjects covering different areas of basic microbiology such as Bacteriology, Virology, Biochemistry, Microbial Physiology, Immunology, Cell Biology, Molecular Biology, Genetics, Immunology, and Microbial Genetics, as well as becoming aware of the importance of environmental microbiology.

PSO2	Students will learn about various biotechnological applications of microorganisms as well as industrially relevant substances developed by microorganisms. They'll learn about the special role microbes play in genetic modification technologies.
PSO3	Students will learn and develop good laboratory practices in a microbiological laboratory, as well as be able to explain the theoretical foundations and practical skills of the tools and technologies widely used in this area. Students can gain proficiency in the quantitative skills needed to analyze biological problems.
PSO4	Students will learn about experimental methods, hypothesis creation and testing, and experiment design and execution. Students can develop their critical thinking skills as well as their ability to read and interpret scientific literature. Via successful presentation of experimental findings as well as workshops, students can acquire good oral and written communication skills.
PSO5	The Degree courses will enable students to go for higher studies in Microbiology and Allied subjects leading to Post Graduation and Ph.D. degrees.

Degree in Bachelor of Science in Microbiology (Honors/ Hon)	
B.Sc. IV Programme Specific Outcomes	
PSO1	Students will learn about experimental methods, hypothesis creation and testing, and experiment design and execution.
PSO2	He/she will be able to design and execute experiments related to Principles of Microbiology, Biochemistry, Molecular Biology, Microbial Physiology, and develop research aptitude through exposure to recent advances in microbial sciences and bioinformatics.
PSO3	The student will become able to utilize Analytical techniques, Virology and Recombinant DNA Technology to produce pharmaceutically important biomolecules as well as using practical hands-on training to become employed in diagnostic, industrial, pharmaceutical, food and research and development laboratories.
PSO4	After graduation the students may join industry, academia, and public health and play their role as microbiologists in a useful manner contributing their role in the development of the welfare society.

Degree in Bachelor of Science in Microbiology (Honors with Research)	
B.Sc. IV Programme Specific Outcomes	
PSO1	Students will learn about experimental methods, hypothesis creation and testing, and experiment design and execution. Students can develop their critical thinking skills as well as their ability to read and interpret scientific literature. Via successful presentation of experimental findings as well as workshops, students can acquire good oral and written communication skills
PSO2	He/she will be able to design and execute experiments related to Principles of Microbiology, Biochemistry, Molecular Biology, Microbial Physiology, RDT and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision.
PSO3	The student will become able to utilize Analytical techniques, Virology and Recombinant DNA Technology to produce pharmaceutically important biomolecules as well as using practical hands-on training to become employed in diagnostic, industrial, pharmaceutical, food and research and development laboratories.
PSO4	After graduation the students may join industry, academia, and public health and play their role as microbiologists in a useful manner contributing their role in the development of the welfare society.

Degree in Masters of Science in Microbiology	
M.Sc. Programme Specific Outcomes	
PSO1	The students will get knowledge and skill of entrepreneurship and start-up ventures by integrating applied microbiology knowledge with skill-based learning in microbial product development, quality control, and business planning.
PSO2	At the time of completion of the programme the student will have developed extensive knowledge in various areas of Microbiology. Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice.
PSO3	By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.
PSO4	The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Detailed Syllabus
of
B.Sc. First Year

Programme/Class: Certificate	Year: First	Semester: First
Subject: MICROBIOLOGY		
Course Code: B080101T	Course Title: General Microbiology	

Course Outcomes:

The student at the completion of the course will be able to:

- To understand the history, relevance of microbiology and classification of microbes.
- To learn and understand the microbial diversity in the living world.
- To understand the working of various microscopes and their applications.
- To gain knowledge of various (physical and chemical) methods of control of microorganisms and safety measures to be followed while handling microbes.
- To demonstrate and understanding of bacterial, fungal, cyanobacterial, algal, viral and rickettesial classification, culturing, reproduction and significance.
- To learn different methods of staining of microbes.
- To understand, learn and gain skill of isolation, culturing and maintenance of pure culture.
- To enable the students to get sufficient knowledge in principles and applications of bio-instruments.
- To help students gain knowledge about antibiotics and other chemotherapeutic agents.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	Min. Passing marks: as per rules

Total No. of Lectures-Tutorials-Practical(in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Introduction, history and scope of Microbiology** History, scope, branches of microbiology and relevance of microbiology; Contribution of Antony Van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Ivanowsky, Waksman, Subba Rao, Sambhunath De; Position of microorganisms in the living world. 5 kingdom classification of Whittaker and 3 kingdom classification, comparison of the 3 domain of microorganisms- bacteria, archaea, eukarya; Bergey's manual and introduction to classification of bacteria.	8
II	**Bacterial morphology** Ultrastructure of bacterial cell, cell wall, plasma membrane, capsule, flagella, nucleoid, and reserve material. Differences between archaebacterial and eubacterial cell. General features of Rickettsia, Chlamydia, Mollicutes, Actinomycetes and Cynobacteria. **The viruses** General properties and structure of animal viruses: Influenza, HIV; plant viruses: TMV; bacterial viruses: Lambda Phage and T4 bacteriophage. **Fungi** General characteristics, classification & reproduction of Saccharomyces, Aspergllus. **Protozoa** General characteristics, classification & reproduction of Entamoeba	10
III	**Techniques in microbiology I** Principles of microscopy, construction and application of-	6

	Compound Microscope (monocular and binocular), Bright field Microscopy, Dark field Microscopy ,Phase Contrast Microscopy, Fluorescence Microscopy, Electron Microscopy- TEM and SEM	
IV	**Techniques in microbiology II** Principles, construction and application of centrifuge; bacteriological Incubator & Incubator Shaker; Laminar flow; Colourimeter & Spectrophotometer (UV-Vis)	6
V	**Sterilization techniques and control of microorganisms** Definitions of terms- sterilization and disinfection; Sterilization by Physical methods- Use of moist heat- heat under pressure, autoclave, boiling, pasteurization, fractional sterilization, tyndallization; Use of dry heat- hot air oven, incineration; Filtration- Seitz filter, membrane filter, HEPA filter; Radiation- Ionizing and non- ionizing; Chemical methods- Alcohols, aldehydes, phenols, halogens, metallic salts, ethylene oxide.	7
VI	**Isolation, cultivation and preservation of microorganisms** Culture media and its types; Methods for enumeration & isolation of microorganisms using pour plate, spread plate technique, and streak plate; Isolation of anaerobic microorganisms; Maintenance and preservation of pure culture	8
VII	**Stains and staining techniques** Staining techniques, principles, procedures and applications of Simple staining, negative staining; Differential staining- Gram's staining, acid fast staining, Leishman's staining, Giemsa's staining, Ziehl Neelsen staining; Structural staining- cell wall, capsule, endospore and flagella staining.	7
VIII	**Biostatistics** Introduction to biostatistics – definition statistical methods, Measure of central tendency – Mean, median, mode, standard deviation; Collection of data, sampling and sampling design, classification and tabulation, Histogram.	8

Suggested Readings:

1. Alexopoulas C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
3. Atlas R.M., Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson Harold J., Microbiological Applications, WCB Mcgraw-Hill, New York.
5. Bold H.C. and Wynne M.J., Introduction to Algae, Prentice Hall of India Private Limited, New Delhi.
6. Baveja C.P., Textbook of microbiology APC 6th edition.
7. Dubey R.C.. and Maheshwari D.K., Textbook of microbiology, S Chand Publications.
8. Pelczar M.J., Chan E.C.S and Kreig N.R., Microbiology, Mcgraw-Hill Book Company, New York.
9. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB Mcgraw- Hill, New York.
10. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.

11. Sharma P.D., Microbiology, Rastogi Publications.
12. Tortora G.J., Funke B.R. and Case C.L., Microbiology: An introduction, 9th edition, Pearson Education.
13. Suggestive digital platforms web links-
    - https:/www.classcentral.com/tag/microbiology
    - https://cmp.berkeey.edu/bacteria/bacteria.html
    - https://www.livescience.com/53272-what-is-a-virus.html
    - https://www.slideshare.net/sardar1109/algae-notes-1
    - https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy
    - https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
    - https://microbenotes.com/laminar-flow-hood
    - https://physics.fe.uni-lj.si/students/predavanja/MicroscopyKulkarni.pdf

Programme/Class: Certificate	**Year:** First	**Semester:** First
Subject: MICROBIOLOGY		
Course Code: B080102P	**Course Title:** Experiments in Basic Microbiology	

Course Outcomes:

The student at the completion of the course will be able to:

- To understand the instruments, microbial techniques and good lab practices for working in a microbiology laboratory.
- Practical skills in the laboratory experiments in microbiology.
- Develop skills for identifying microbes and using them for industrial, agricultural and environmental purpose.
- To prepare slides and stain to see the microbial cell.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing marks:** as per rules

Total No. of Lectures-Tutorials-Practical(in hours per week): **L-T-P:** 0-0-2

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1.	• Good labroratory practice in Microbiology and safety measures. • Cleaning and sterilization of glassware and equipments. • Study of aseptic technique- preparation of cotton plug, wrapping of glassware, transfer of media and Inoculum.	12
2.	• Study of instruments- Microscope, autoclave, hot air oven, laminar airflow, inoculation loop and needle, incubator, B.O.D incubator, centrifuge machine, pH meter, colony counter, seitz filter, membrane filter, colourimeter, spectro photometer.	12
3.	• Preparation of different culture media- nutrient agar/nutrient broth for bacterial culture, PDA for fungal culture. • Enumeration of bacteria using spread plate and pour plate techniques. • Isolation of bacteria by pour plate, spread plate and streak plate method.	12

4.	• Staining of bacteria- 1. Simple staining- methylene blue 2. Gram's staining 3. Structural staining- endospore. 4. Negative staining 5. Staining of fungi using lactophenol and cotton blue.	**12**
5.	Study of slide and life materials • Bacteria- *Staphylococci, Streptococococci, Bacillus* sp., *Azospirillum* • Protozoans- *Amoeba, Paramaecium, Trypanaosoma, Plasmodium, Entamoeba hystolytica.* • Fungi- *Mucor, Rhizopus, Penicillium, Aspergillus, Alternaria.* • Cyanobacteria- *Chlorella, Spirulina, Nostoc, Anabaena.*	**12**

Suggested Readings:

1. Microbiology: A laboratory manual by J. Cappucino and C.T. Welsh. 11th edition, Pearson education, USA. 2016
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultiation, New Age International, New Delhi.
3. Dubey R.C.. and Maheshwari D.K., Textbook of practical microbiology, S Chand Publications.
4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology, 5th edition McMillan.
5. Lab Virtual links-
   - https://www.classcentral.com/course/basic-concepts-in-microbiology-and-clinical-pharm-32196
   - https://www.labster.com/microbiology-virtual-labs/
   - https://www.futurelearn.com/courses/basic-concepts-in-microbiology-and-clinical-pharmacology-of-antimicrobials

Programme/Class: Certificate	Year: First	Semester: Second
Subject: MICROBIOLOGY		
Course Code: B080201T	Course Title: Agriculture and Environmental Microbiology	

Course Outcomes:

The student at the completion of the course will be able to:

- Get acquainted with natural habitats of diverse protection.
- Understand how microbes interact among themselves and with higher plants and animals with the help of various examples.
- Become aware of the important role microbes play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance.
- Gain in depth knowledge of different types of solid waste, liquid waste and their management.
- Get familiar with problems of pollution and applications of clear up technologies for the pollutants.
- Know about the diverse microbial populations in various natural habitats like soil, air, water.
- Gain knowledge of the bio-fertilizer and their types.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	Min. Passing marks: as per rules

Total No. of Lectures-Tutorials-Practical(in hours per week): **L-T-P:** 4-0-0

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Microorganisms and their habitats** Structure and function of ecosystem; Terrestrial environment: soil profile and soil microflora; Aquatic Environment: microflora of fresh water and marine habitats; Atmosphere: Aeromicroflora and dispersion of microbes; Animal Environment: Microbes in/on human body (microbiomes) & animal (Ruminants) body; Extreme habitats: Extremophiles; Microbial succession in decomposition of plant organic matter.	8
II	**Microbial Interactions** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction; Microbe-Animal interaction; Microorganism of rhizosphere, rhizoplane and phylloplane, mycorhiza.	8
III	**Biogeochemical cycling** Carbon cycle: Microbial degradation of cellulose, hemicellulase, lignin and chitin; Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction; Phosphorous cycle: Phosphate Immobilisation and solubilisation; Sulphur cycle: Microbes involved in sulphur cycle.	8
IV	**Waste management** Solid waste management: Source and type of solid waste, method of solid waste disposal (composting and sanitary landfill), Liquid waste management: composition and strength of sewage (BOD & COD), primary, secondary, tertiary sewage treatment and disinfection.	8

V	**Microbial Bioremediation** Principle and degradation of common pesticides, organic (hydrocarbon, oil spills).	6
VI	**Water potablity** Treatment and safety of drinking water; Methods to detect potability of water sample: Standard qualitative procedure- MPN test/Presumptive test, confirmed and completed test for faecal-coliforms Membrane filter technique, Presence/Absence test fecal coliform.	6
VII	**Biofertilizer** Definition, Types- Bacterial, Fungal, BGA; Mode of application; Advantages and Disadvantages.	8
VIII	**Biopesticides** Introduction and definition; Types of biopesticides; Integrated pest management (IPM); Mode of action; Applications, advantages& disadvantages.	8

Suggested Readings:

1. Alexander M., Introduction to soil microbiology, Wiley Eastern limited, New Delhi.
2. Alexopoulas C.J. and MIMS C.W., Introductory Mycology, New age international, New Delhi.
3. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi
4. Hurst, C.J., Environmental Microbiology, ASM press, Washington D.C.
5. Mehrotra A.S., Plant Pathology, Tata Mcgraw Hill Publications limited, New Delhi.
6. Pelczar M.J., Chan E.C.S and Kreig N.R., Microbiology, Mcgraw-Hill Book Company, New York.
7. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB Mcgraw- Hill, New York.
8. Salle A.J., Fundamental Principles of Bacteriology, Tata Mcgraw-Hill Publishing Company Limited, New Delhi.
9. Stacey R.H. and Evans H.J., Biological Nitrogen Fixation, Chapman and Hall limited, London.
10. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
11. Subbarao N.S., Soil Microroganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
12. Steward W.D.P., Nitrogen Fixation in Plants, The Athlone Press, London.
13. Suggestive digital platforms web links-
    - https://www.classcentral.com/tag/microbiology
    - https://www.mooc-list.com/tags/biotechnology
    - https://asm.org/articles/2020/december/virtual-resources-to-teach-microbiology-techniques
    - https://www.futuredirections.org.au/publication/living-soils-role-microorganisms-soil-health

Programme/Class: Certificate	Year: First	Semester: Second
Subject: MICROBIOLOGY		
Course Code: B080202P	Course Title: Experiments in Agriculture and Environmental Microbiology	

Course Outcomes:

The student at the completion of the course will be able to:

- To understand the instruments, microbial techniques and good lab practices for working in a microbiology laboratory.
- Practical skill in the laboratory experiments in microbiology.
- Develop skills for identifying microbes and using them for industrial, agricultural and environmental purpose.
- To prepare slides and stain to see the microbial cell.

Credits: 2	Core: Compulsory
Max. Marks: 25+75	Min. Passing marks: as per rules

Total No. of Lectures-Tutorials-Practical(in hours per week): **L-T-P:** 0-0-2

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	• To analyse soil- pH, moisture, water holding capacity.	8
2	• Isolation of microorganisms (Bacteria & Fungi) from soil sample at different temperature (28° C & 45° C) • Isolation of bacteria and fungi from rhizosphere and rhizoplane. • Isolation of bacteria & fungi from air environment by exposure plate method. • Isolation of Rhizobium sp. from leguminous root nodule.	16
3	• To determine BOD of waste water sample. • Bacteriological examinaiton of water by MPN test, presumptive coliform, confirmed coliform and completed coliform test.	12
4	• Specimen study of plant pathogens. 1. Black rust of wheat 2. White rust of crucifer 3. Leaf curl of tomato 4. Downy mildew	10
5	Study of slide and life materials • *Mucor* • *Curvularia* • *Alternaria* • *Geotrichurn* • *Trichoderma* • *Rhizopus*	14

Suggested Readings:

1. Agrios A.G. Plant Pathology, Elsevier Academic Press, New Delhi, 2006.
2. Atlas RM and Bartha R (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
3. Maier RM, Pepper IL and Gerba Cp (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Subba Rao NS. (1999). Soil Microbiology, 4th edition. Oxford & IBH Publishing Co. New Delhi.
5. Virtual Lab Links-
    - https://vlab.amrita.edu/?sub=3&brch=73
    - https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering
    - https://opentextbc.ca/virtualscienceresources/chapter/environmental-science/

Detailed Syllabus of B.Sc. Second Year

Programme/Class: Diploma	**Year:** Second	**Semester:** Third
Subject: MICROBIOLOGY		
Course Code: B080301T	**Course Title:** Basic Biochemistry and Microbial Physiology	

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will have understanding of the basic principles of thermodynamics applied to biological systems
- Will be conversant with the structures of carbohydrates, lipids, proteins and nucleic acids
- Will comprehend the basic concepts of enzyme biochemistry including enzyme kinetics, and will become aware of different variants of enzymes found in living cells.
- Will be acquainted with the diverse physiological groups of bacteria/archaea and microbial transport systems.
- Will have an in-depth knowledge of patterns of bacterial growth, bacterial growth curve, calculation of generation time and specific growth rate, and effect of the environment on growth.
- Will apprehend how biochemical pathways are used by bacteria for energy generation and conservation during growth on glucose under aerobic and anaerobic conditions
- Will be familiar with the physiology of nitrogen fixation and assimilation of inorganic nitrogen by bacteria and understand how interactions between microbes and the environment affect cellular physiology.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week):**L-T-P:**4-0-0

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Overview of thermodynamics and bioenergetic** Basics of thermodynamics- First and second laws, concept of enthalpy, entropy, free energy change, standard free energy change, equilibrium constant and spontaneous reactions and coupled reactions	6
II	**Water & Carbohydrates** Structure and properties of water, Handerson Hasselbalch equation, Ionic product of water, pH and buffers. Structure & classification of carbohydrates, carbohydrates metabolism: glycolysis, ED pathway, fermentation, Krebs Cycle, Electron transport chain (ETC), oxidative phosphorylation and ATP generation	12
III	**Proteins** **Structure & Classification-** Protein structure: primary, secondary- peptide unit salient features, α helix, β sheet, β turn, tertiary and quaternary-human hemoglobin as an example. Forces involved in protein folding	6
IV	**Lipids & Nucleic acids** Structure and classification of lipids. Metabolism of lipids- Alpha and beta oxidation of lipids; Nucleic acids Structures, Double helical structure of DNA.	6
V	**Enzymology concepts:** Concepts of holozymes, apoenzyme, cofactors, prosthetic group, coenzyme, metal cofactors; Classification of enzymes; Active site and activation energy; Lock and key hypothesis, induced fit hypothesis; Allosteric enzymes; Enzyme inhibition	6

VI	**Microbial nutrient uptake and transport:** Microbial classification based on nutrient and energy source; Nutrient uptake mechanisms-passive and facilitated diffusion; Primary and secondary active transport; Concept of uniport, symport, antiport, group translocation	8
VII	**Microbial growth and effect of environmental factors on growth** Bacterial growth curve and kinetics-Generation time and specific growth rate; Diauxic growth and synchronous growth; Batch, Fed batch and continuous cultures; Chemostat and turbidostat	8
VIII	**Stress physiology and Nitrogen metabolism** Effect of oxygen, pH, osmotic pressure, heat shock, water activity on bacteria; Dissimilatory nitrate reduction, Nitrogen fixation	8

Suggested Readings:

1. Moat A.G., Foster J.W. and Spector M.P. 2002. *Microbial Physiology*, 4th edition. A Johan Wiley and sons inc., publication.
2. Kim B.H. and Gadd G.M. 2008. *Bacterial physiology and metabolism*. Cambridge University Press, Cambridge.
3. Gilbert H.F. 2000. *Basic concepts in biochemistry: A student's survival guide*. Second Edition. Mc-Graw-Hill Companies, health professions Division, New York.
4. Madigan M.T., Martinko J.M., Stahl D.A. and Calrk D.P. 2012. *Brock Biology of Microorganisms*. 13th ed. Pearson Education Inc.
5. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer.2015. Biochemistry 8th edition. W. H. Freeman.
6. Suggestive digital platforms web links-
   - https://lipidnanostructuresgroup.weebly.com
   - https://www.labster.com/microbiology-virtual-labs
   - https://www.microbiologybook.org
   - https://www.cpe.rutgers.edu/courses/current/lf0401wa.html
   - https://www.sciencedirect.com/topics/earth-and-planetary-sciences/microscopy
   - https://www.futurelearn.com/courses/introduction-to-microbiology

Programme/Class: Diploma	**Year:** Second	**Semester:** Third
Subject: MICROBIOLOGY		
Course Code: B080302P	**Course Title:** Experiment in Basic Biochemistry and Microbial Physiology	

Course Outcomes:

After completing the course, the student will be able to:

- Understand the structures of carbohydrates and their main properties, as well as conduct chemical tests to detect their presence in samples.
- Would have acquired practical knowledge of biochemical techniques for proteins and will be familiar with the use of a spectrophotometer.
- Understand the fundamental principles of enzyme biochemistry, including enzyme kinetics, at the end of the course.
- Will have a thorough understanding of bacterial growth patterns, bacterial growth curves, generation time and basic growth rate calculations, and the impact of the environment on growth.
- Will learn about the fermentation process in microbes.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing marks:** as per rules
Total No. of Lectures-Tutorials-Practical(in hours per week):**L-T-P:**0-0-2	

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	Use and calibration of pH meter and preparation of buffers. Preparation of stock and working solutions. Handling of pipettes and micropipettes and checking their accuracy.	4
2	**Qualitative tests** Carbohydrates: Molisch's Test, Fehling's Test, Benedict's Test, Iodine Test) Amino acids and Proteins: Ninhydrin test, Biuret test, Lowry test. Lipids: Solubility Test, Translucent Spot Test, Emulsification Test.	20
3	Quantitative estimation of carbohydrate by anthrone method. Quantitative estimation of proteins by Lowry's method	10
4	Amylase production, H_2S production, Urease production test	10
5	Effect of temperature and pH on growth of E. coli	8
6	Demonstration of carbohydrate fermentation, indole production, catalase test, oxidase test.	8

Suggested readings:

1. Daniel M. Bollag, Stuart J. Edelstein, Protein Methods, Volume 1, 1991, Wiley.
2. S. K. Sawhney, Randhir Singh,Introductory Practical Biochemistry, 2000, Narosa.
3. Sambrook J and Russell DW., Molecular Cloning: A Laboratory Manual. 4th Edition, 2004, Cold Spring Harbour Laboratory press.
4. Maloy SR, Cronan JE and Friefelder D, Microbial Genetics 2nd EDITION., 2004, Jones and Barlett Publishers
5. Larry Snyder. Molecular Genetics of Bacteria: 3rd (third) Edition.
6. Digital links
   - http://www.mooc.list.com/tag/molecular-biology
   - http://www.mooc.list.com/course/microbiology.sayloro
   - https://lipidnanostructuresgroup.weely.com
   - http://www.mooc.list.com/microbial
   - https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern

Programme/Class: Diploma	**Year:** Second	**Semester:** Fourth
Subject: MICROBIOLOGY		
Course Code: B080401T	**Course Title:** Molecular Biology and Microbial Genetics	

Course Outcomes:

At the end of the course, the student will be able to:

- Distinguish in prokaryotic cellular structure and functional components of cells, as well as the dissimilarities in genome organization between prokaryotes and eukaryotes.
- Describe the replication, transmission, and action mechanisms of chromosomal and extrachromosomal genes and sequences.
- Recognize and distinguish genetic regulatory mechanisms at various levels
- Gain an understanding of how internal and external signals regulate gene expression, influence microbial diversity, and shape microbial communities and their environments.
- Describe the processes that lead to mutations and other genetic changes.

Credits:4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing marks:** as per rules
Total No. of Lectures-Tutorials-Practical(in hours per week):**L-T-P:**4-0-0	

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Overview of the genome organization** – DNA/and RNA as genetic material, DNA double helix structure salient features, types of DNA. RNA Structure. Denaturation and renaturation, cot curves. DNA organization in prokaryotes, viruses, eukaryotes	6
II	**DNA Replication in Prokaryotes and Eukaryotes-** Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication.	6
III	**Transcription in Prokaryotes and Eukaryotes** Concept of transcription unit. General transcription process in prokaryotes and eukaryotes; Post-Transcriptional modification in eukaryotes.	8
IV	**Translation in prokaryotes and eukaryotes** Mechanisms of translation in both prokaryotes and eukaryotes, Genetic code, Wobble hypothesis	8
V	**Regulation of gene expression in prokaryotes** Overview of regulation of gene expression, Transcription control mechanisms, Operon System, Translation control mechanisms.	10
VI	**Plasmids in prokaryotes and eukaryotes** Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, curing of plasmids. Types of plasmids.	6
VII	**Bacterial gene exchange processes-** Mechanisms of Genetic Exchange, Horizontal gene transfer, Transformation; Conjugation; Transduction, Complementation.	8
VIII	**Mutations, mutagenesis and repair** Types of mutations, Physical and chemical mutagens. Loss and gain of function mutants. Reversion and suppression, Uses of mutations. Ames Test, DNA repair mechanism	8

Suggested **Readings:**

1. Watson, J. et. Al. 2004. Molecular Biology of the Gene,5th Edition, CSHL Press, New York.
2. Conn, E., & Stumpf, P. 2009.Outlines of Biochemistry, 5Th Ed. Wiley India Pvt. Limited.
3. T A Brown.2001. Essential Molecular Biology. Oxford University Press, USA
4. Brock, T.D. 1990. The Emergence of Bacterial Genetics, Cold Spring Harbor Lab Press.
5. Ptashne, M. 2002. Genes and Signals, Cold Spring Harbor Laboratory Press.
6. Miller, J.R. 1992. A Short Course in Bacterial Genetics: Lab Manual, Cold Spring Harbor Laboratory Press
7. Suggestive digital platforms web links-
    - https://www.classcentral.com/tag/microbiology
    - http://www.mooc.list.com/tag/molecular-biology
    - http://www.mooc.list.com/course/microbiology.sayloro
    - https://lipidnanostructuresgroup.weely.com
    - http://www.mooc.list.com/microbial
    - https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern

Programme/ Class: Diploma	Year: Second	Semester: Fourth
Subject: MICROBIOLOGY		
Course Code: B080402P	Course Title: Experiment in Molecular Biology and Microbial Genetics	

Course Outcomes:

The student at the completion of the course be able to:

- understand the fundamentals of molecular biology and genetic research.
- use some basic equipment in a molecular biology laboratory.
- extract genomic DNA from microbes using molecular biology techniques
- measure DNA and verify purity using UV spectrometer and electrophoresis.
- understand the basic principle of plasmid isolation and their conformations using electrophoresis.
- understand the mutagenic effect of chemical and physical agents and perform test to identify mutagenic effect of chemicals

Credits:2	Core: Compulsory
Max. Marks: 25+75	Min. Passing marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:**0-0-2

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	Isolation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis.	8
2	Estimation of DNA using diphenylamine reagent.	8
3	Resolution of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) and visualization using coomassie dye.	10
4	Replica plating method: Preparation of master and replica plates. Isolation of Histidine auxotrophs	10
5	Isolation of plasmid DNA from *E. coli.* Study the different conformations of plasmid DNA through agarose gel electrophoresis	8
6	Study of the effect of chemical (nitrous acid) and physical (UV) mutagens on bacterial cells.	8
7	Demonstration of Ames test.	8

Suggested readings:

1. Michael Wink, An Introduction to Molecular Biotechnology (2nd), 2012. ISBN: 9783527326372, TX Wiley-Blackwell.
2. Seidman & Moore, Basic Laboratory Methods for Biotechnology: Textbook & Laboratory Reference. 2nd edition. 2009. Prentice Hall. ISBN: 0321570146.
3. Sambrook J and Russell DW., Molecular Cloning: A Laboratory Manual. 4th Edition, 2004, Cold Spring Harbour Laboratory press.
4. Digital links:
   - https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/ames-test
   - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/

Detailed Syllabus of B.Sc. Third Year

Programme / Class: Bachelor of Science	**Year:** Third	**Semester:** Fifth
Subject: Microbiology		
Course Code: B080501T	**Course Title:** Medical Microbiology	

Course outcomes:

Upon completion the students will learn:

- The historical development of medical microbiology
- The importance of microorganisms in life.
- The microorganisms associated with various infectious diseases.
- The treatment strategies followed for the infectious diseases.
- Antibiotic resistance
- Processes of sample collection and processing

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**History of Medical Microbiology** Contribution of pioneers in the field of Medical Microbiology, Normal Microflora of human body: skin, mouth, alimentary canal and genitourinary tract	7
II	**Bacterial diseases** Diseases caused by certain bacterial pathogens *Staphylococcus aureus, Streptococcus pneumoniae, Mycobacterium tuberculosis, Salmonella typhi, Vibrio cholera*	8
III	**Viral diseases** Diseases caused by certain viruses Human Immunodeficiency Virus, Hepatitis Virus, Influenza virus, Herpes virus	8
IV	**Parasitic diseases** Diseases caused by protozoa *Giardia* sp., *Plasmodium* sp., *Leshmania* sp., and *Entamoeba* sp.	7
V	**Pathogenic fungal disease I** Dermatophytes- *Trichophyton, Microsporum* Filamentous fungi causing subcutaneous infection by Mucor, *Rhizopus* and *Aspergillus*	8
VI	**Pathogenic fungal disease II** Systemic mycoses caused by Blastomyces, Histoplasma and Yeast like fungi: *Candida* and *Cryptococci*	8

VII	**Antibiotics and Chemotherapeutics** Historical development of chemotherapeutic and antibiotic substances, Major antimicrobial agents, Mode of action of chemotherapeutic and antibiotic substances.	8
VIII	**Antibiotic resistance, Sample collection and processing** Drug resistance, Mechanism of antibiotic resistance, Antibiotic susceptibility assay. Collection and transport of appropriate clinical sample specimen for clinical diagnostics	6

Suggested Readings:

1. Annadurai, A. A textbook of Immunology and Immunotechnology. S. Chnd
2. Ananthanarayanan R and Panicker C K. Textbook of Microbiology. Orient Longman.
3. Baveja, CP. Text book of Microbiology. Arya publications.
4. Ken S.Rosenthal, Patrick R.Murray, and Michael A.Pfaller. Medical Microbiology 7th Edition, Elsevier
5. Karen C.Carroll, Geo.Brooks, Stephen Morse, and Janet Butel.Jawetz, Melinck, &Adelberg's Medical Microbiology, Lang
6. Suggestive digital platforms web links-
   https://www.futurelearn.com/courses/basic-concepts-in-microbiology-and-clinical-pharmacology-of-antimicrobials
   https://vlab.amrita.edu/?sub=3&rch=73
   https://www.mooc-list.co/tags/pathology
   https://online.creighton.ed/program/medical-microbioogy-and-immunology-ms

Programme / Class: Bachelor of Science	**Year:** Third	**Semester:** Fifth
Subject: Microbiology		
Course Code: B080502T	**Course Title:** Immunology	

Course outcomes:

Upon completion the students will learn

- The historical development of immunology
- The components of immune system, Immune responses, features of antigen and antibody, hypersensitivity responses
- Applications of antibody in diagnosis and therapy, and antigen-antibody reactions.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rule

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Overview of Immunology** History of immunology, Physical and physiological barriers, Innate and Acquired immunity, Organs and Cells of Immune system.	7

II	**Complement System** Complement System Proteins, Complement System Activation by Classical, Alternate and Lectin Pathway	8
III	**Immunity** Humoral and Cell Mediated Immunity, Active And Passive Immunity	8
IV	**Antigen & Immunogens** Antigen Characteristics, Types of Antigens, Adjuvants, Immunogenicity and Antigenicity, Cytokines,	7
V	**Immunoglobulins and MHC and their role** Classes of immunoglobulin, structure and function, Major Histocompatibility Complex: Types, Antigen Presentation through MHC class I and class II molecules	9
VI	**Hypersensitivity** Types of Hypersensitivity, Mechanism of hypersensitivities with examples	5
VII	**Immune Response** Antibody dependent Cell mediated Cytotoxicity, Phagocytosis, Inflammation and Inflammatory response mechanism.	6
VIII	**Applications of Immunoglobulins** Applications of antibody in diagnosis and therapy; *In vitro* serological test methods: Antigen-Antibody Reactions: Agglutination and immunodiffusion; ELISA and RIA.	10

Suggested Readings:

1. Kindt, Goldsby and Osborne. Kuby's Immunology. WH Freeman& Company,
2. Roitt I,Brostoff, J and Male D.Immunology, 6th edition, 2001, Mosby, London.
3. Ramesh SR, Immunology. Mc Graw Hill Publications.
4. Madhavee LP, A Textbook of Immunology, S Chand Publisher.
5. Reddy R, Textbook of Immunology, 3rd edition, AITBS Publisher.
6. Digital links
    - https://www.mcgill.ca/microimm/undergraduate-programs/courses
    - https://oline.creighton.edu/program/medical-microbiology-and-immunology-ms

Programme / Class: Bachelors of Science	**Year:** Third	**Semester:** Fifth
Subject: Microbiology		
Course Code: B080503P	**Course Title:** Experiments in Medical Microbiology & Immunology	

Course outcomes:

Upon completion of the practical course in medical microbiology and immunology the students will learn about

- The preparation of culture media, microorganisms associated with human body, characterization of microorganisms associated with disease.
- Antigen- antibody interaction
- Learning of the application of antibodies for diagnostic purposes, antibiotic sensitivity test and resistance transfer.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-2**

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	Preparation of blood agar, chocolate agar, and other media required for medically important microorganisms	6
2	Isolation and characterization of skin normal microflora	6
3	Isolation of bacteria from teeth crevices	6
4	Demonstration of α and β haemolysis on blood agar medium.	8
5	Demonstration of serological tests: blood groups, Rh factor determination, pregnancy test, Widal, VDRL, ELISA	12
6	Demonstration of pathogenic fungi in mycoses lesion	8
7	Antibiotic sensitivity test and MIC determination	6
8	Demonstration of antibiotic resistance transfer from resistant to sensitive microorganism	8

Suggested Readings:

1. Hudson L, and Hay FC, Practical Immunology, 3rd edition, Wiley.
2. Noel R. Rose, Herman Friedman, John L. Fahey., Manual of Clinical Laboratory Immunology, 3rd edition, ASM. Ed.3; 1986.
3. Talwar GP and Gupta SK, A Handbook of Practical and Clinical Immunology, Vol.I-II; CBS Publishers and Distributors. Delhi
4. Aneja KR, Experiments in Microbiology, Plant Pathology and Biotechnology, Ist edition, New Age International Publisher
5. Randhawa VS, Practicals and Viva in Medical Microbiology, Harcourt India Pvt. Ltd.
6. Digital Links

- http://www.vlab.co.in
- http://www.vlab.iitb.ac.in
- http://www.onlinelabs.in
- http://www.vlab.amrita.edu
- http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

Programme/Class: Bachelor of Science	**Year:** Third	**Semester:** Sixth
Subject: Microbiology		
Course Code: B08060IT	**Course Title:** Food Microbiology	

Course outcomes:

- Upon completion the students will learn about the role of Microorganism in food Microbiology.
- Learn the symptoms of deteriorated food.
- Assimilate knowledge about Microbial Examination of food.
- Learn about food preservation techniques.
- Will get sufficient knowledge regarding analysis of milk.
- Will be able to monitor food quality.

Credits: 4	**Core :** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Introduction to food & nutrition.** History, Development and Scope of food microbiology; Concept of food and nutrients; Physiochemical properties of food; Importance and types of	8
	microorganisms in food (bacteria, mold and yeast); Food as a substrate for microorganism- Intrinsic and extrinsic factors that affect growth and survival of microbes in food, natural flora and source of contamination of foods in general.	
II	**Microbial spoilage of various foods** Spoilage of vegetables, fruits, meats, eggs, milk and butter, bread, canned foods.	6
III	**Microbial examination of food** DMC, viable count, examination of faecal Streptococci. Food quality monitoring, Biosensors and Immunoassays.	6
IV	**Food Preservation** Basic Principles, Methods (heating, freezing, dehydration, chemical preservatives, radiation). Modern technologies in food preservation, Packaging material.	8
V	**Fermented foods:** Fermented dairy products (cheese, butter, yoghurt), Kefir; Other Fermented foods- Soya sauce, Saurkraut, Dosa, Tempe; Probiotics	8
VI	**Food borne diseases (Causative agents, foods involved, symptoms and preventive measures)** Food intoxication- Staphylococcus aureus, *Clostridium botulinum* and Mycotoxins; Food infections- *E. coli*, Salmonellosis, Sheigellosis, Listeria.	8

VII	**Microorganisms and milk** Physical and chemical properties of milk; Milk as a substrate for microorganisms; Microbiological analysis of milk – Rapid Platform test, standard plate count, MBRTtest, alkaline phosphatase enzyme test, DMC; Method of preservation of milk and milk product.	8
VIII	**Food sanitization and control** HACCP, Indices of food sanitary quality and sanitisers; Microbiological quality standard of food.	8

Suggested Readings:

1. Adams & Moss, Food Microbiology, Published by Royal Society of Chemistry, Cambridge, U.K.
2. R.S. Mehrotra – Plant Pathology, Tata Mc-Graw Hill
3. Frazier & Westhoff., Food Microbiology Tata Mc-Graw Hill (2014)
4. Varnam A.H. & Evans M G – Food borne pathogens. Wolfe Publishing House, London
5. B.D. Singh (2015) Biotechnology, Kalyani Publisher
6. Prajapati (2007) Fundamentals of Dairy microbiology, Indian Council of Agricultural Research, New Delhi
7. Andrew Proctor (2011) Alternatives to conventional food processing. RSC Publisher
8. Arun K. Bhunia & Bibek Ray, Fundamental Food Microbiology, 5th Ed., CRC Press

Suggestive digital platforms web links –

- Doyle. Michael P, Gonzalez-francisco Diez, Food Microbiology : Fundamentals and frontiers, 5th edition, Hill Colin, available on Wiley online Library.
- http://www.vlab.co.in
- http://www.vlab.amrita.edu
- http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques

Programme/Class: Bachelor of Science	**Year:** Third	**Semester:** Sixth
Subject: Microbiology		
Course Code: B080602T	**Course Title:** Industrial Microbiology	

Course outcomes :

- Develop understanding about IPR in industry
- Understand role of microorganism in industry
- Know about Processing & selection of best microbial strains for the industry
- Gain fundamental knowledge of fermentation process
- Gain knowledge about production of various pharmaceutical products or industrially important product

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rule

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)

I	History & Multidisciplinary nature of Industrial microbiology. A typical Bio process: Introduction, advantages & limitations. Patents and intellectual property rights.	7
II	Taxonomic diversity of industrially useful bacteria & fungi. Important characteristics of microbes used in Industrial Microbiology, Isolation techniques. Concept & examples of microorganisms classified as Generally Regarded as Safe (GRAS).	8
III	Exploitation of microorganism and their products, Screening, Strain development strategies, Immobilization methods.	8
IV	Fermentation: Media, Raw material, Antifoaming agents, Buffers. Equipments, Fermenter design. Types of fermentation – Single, Batch, Continuous.	7
V	Down-stream processing steps: Detection and assay of the product, Recovery (intercellular and extracellular product). Purification (solvent extraction & chromatography)	9
VI	Production of Alcohol (industrial alcohol, wine, beer, whiskey), Organic acid (Citric acid), Antibiotic (Penicillin)	7
VII	Production of Vitamin (B12), Enzyme (Amylase), Amino acid (Glutamic acid), Hormones (Insulin), Vaccine.	6
VIII	Biofuel (Methane), Production of Biofertilizers & Biopesticides, Biotransformation of steroids.	8

Suggested Readings:

1. Industrial Microbiology (2000) by AH Patel, Macmillan Publishers India
2. Biology of Industrial microorganism (1981) by Arnold L. Domain, Bejamin/ cummings Pub. Co.
3. Industrial Microbiology by Prescott & Dunns, AVI Publishing Company Inc.
4. Industrial Microbiology by Casida LE, New age International (P) Ltd.

Suggestive digital platforms web links

- http://foodhaccp.com/foodsafetymicro/onlineindex.html
- http://www.cpe.rutgers.ed/courses/current/If0401wa.html

Programme/ Class: Bachelor of Science	**Year:** Third	**Semester:** Sixth
Subject: Microbiology		
Course Code: B080603P	**Course Title:** Experiments in Food & Industrial Microbiology	

Course outcomes:

- Understand the instruments, techniques & Lab discipline
- Develop skill for identifying microbes used in industry
- Upon completion student will learn about the process of fermentation & design of bioreactors, a major part of pharmaceutical industry
- Will learn about the culture of microorganisms used in Food & Industrial microbiology.

Credits: 2	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-2**

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	Study of Bioreactor & its essential parts	4
2	Necessity & procedure of writing SOPs for instruments used in large scale production	6
3	Isolation and microscopic observation of industrially important microorganism	8
4	Isolation and characterization of microorganism used in Dairy industry	8
5	Isolation and characterization of Yeast used in Bakery/distillery/winery	8
6	Isolation & identification of important microorganism of food microbiology	8
7	Bacteriological analysis of food products	8
8	Determination of the quality of milk by MBRT	2
9	Bacterial examination of milk – Alcohol test	4
10	Preservation methods	4

Suggested Readings:

7. Aneja, K.R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
8. Dubey, R.C. and Maheshwari. D.K. 2012. Practical Microbiology, S.Chand & Company, Pvt. Ltd., New Delhi.
9. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
10. W.F. Harrigan, Laboratory methods in Microbiology, Publisher – Elsevier
11. Lynne Mc Landsborough, Food Microbiology Laboratory, CRC Press
12. Brain McNeil & Harvey (2008), Practical Fermentation Technology, John Wiley & Sons Ltd.
13. Digital links
    - http://www.vlab.co.in
    - http://www.vlab.iitb.ac.in
    - http://www.onlinelabs.in
    - http://www.vlab.amrita.edu
    - http://asm.org/articles/2020/december/virtual-resources-to-teach-microiology-techniques
    - http://foodhaccp.com/foodsafetymicro/onlineindex.html
    - http://www.cpe.rutgers.ed/courses/current/lf0401wa.html

Detail Syllabus of

B.Sc. IV Year

Microbiology

Or

Bachelor of Science in Microbiology (Honors)/ Bachelor of Science in Microbiology (Honors with Research)

Programme / Class: Bachelor of Science	Year: Forth	Semester: Seventh
Subject: Microbiology		
Course Code: B080701T	Course Title: Principles of Microbiology	

Course outcomes:

1. Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures
2. Identify use of different culture media and their applications and microbial techniques for microbial growth estimation, cultivation and culture preservation for routine microbiological skill handling
3. Develop methods associated with the various physical and chemical growth requirements of bacteria and get equipped with various methods of disinfection and sterilization.
4. Understand different systems for microbial classification and nomenclature for study of biodiversity.
5. Apply the knowledge to understand the differentiating microbial characteristics for their identification and further characterization

Credits: 4	Core :Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	History, development and scope of microbiology. Major contributions of scientist to microbiology (Antony van Leeuwenhoek, Lazzaro Spallanzani, John Tyndall, Louis Pasteur, Joseph Lister, Iwanowski, Robert Koch). #Contribution of Indian researchers, Indian Knowledge System, Pure culture Isolation Techniques; Microscopy and preparation of microbial samples: wet mount, smear; Staining: types; simple and differential staining	15
II	Nutritional requirement and Growth of microorganism: culture media- types, factors affecting growth, Measurement of growth, growth phases, growth kinetics, diauxic growth, synchronous and asynchronous culture; batch, fed batch and continuous culture; Growth of aerobic and anaerobic bacteria. Culture preservation and Culture Collection.	15
III	Physical and Chemical control of microorganisms: Disinfectants and Sterilization principles. Antimicrobial chemotherapy	8
IV	Microbial Taxonomy, Systematics, Phylogeny and Nomenclature. Hierarchial organization of organisms- Haeckel, Whittaker and Woese classification. Numerical and Chemotaxanomy of microorganism. Salient features of archaebacteria and eubacteria. Classification of bacteria according to Bergey's Manual of Determinative Bacteriology.	15
V	Differentiating features, habitats, reproduction and classification of Mollicutes, Slime Molds, Algae, Fungi, Viruses	7

Suggested Readings:

1. Microbiology. Prescott LM, Hurley JP, Klein DA. Microbiology- Edition. McGraw Hill Publication, New York
2. Microbiology. M J Pelczar, Chan, Krieg. 5th Edition. Mc Graw Hill
3. Microbiology. RP Singh. Kalyani Publisher
   Textbook of Microbiology. Dubey & Maheshwari. S Chand Publications.

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Seventh
Subject: Microbiology		
Course Code: B080702T	**Course Title:** Biochemistry	

Course outcomes:

1. To know the basic concept of life on the molecular level.
2: Chemical nature of biomolecules, its arrangement and interaction with other biomolecules.
3: To understand the properties of biomolecules and their importance in biological systems.
4: Understanding of concepts of acids, bases, indicators, pKa values, etc. Acquiring skill to determine pKa value of amino acids.
5: Will have learnt basic concepts of enzyme biochemistry, its kinetics and regulation and details of protein, lipid and nucleotide metabolism in E. coli and eukaryotes and its regulation.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Contribution of Indian Researchers in biochemistry, Composition, structure and function of biomolecules –carbohydrates-mono, di and polysaccharides, lipids - storage and structural lipids, proteins - amino acids, peptides, primary, secondary, tertiary and quaternary structure of protein, nucleic acids –Nucleotides and nucleic acid structure. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).	15
II	Principles of biophysical chemistry water, ionization of water, weak acids, and weak bases, pH, buffer, Henderson Hasselbalch equation, biological buffer.	7
III	Principles of catalysis, enzymes, its classification and enzyme kinetics, Michaelis Menten equation. regulatory enzymes, Allosteric enzymes, enzyme inhibition, mechanism of enzyme catalysis, isozymes, coenzyme.	8
IV	Thermodynamics endergonic and exergonic processes, enthalpy, entropy, free energy change, law of thermodynamics, Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.	15
V	Metabolism of carbohydrates (Glycolysis, Kreb cycle, Gluconeogenesis), lipids (beta oxidation, ketone bodies, biosynthesis of fatty acid), amino acids (amino acid oxidation and urea cycle) nucleotides (degradation and biosynthesis of nucleotides)	15

Suggested Readings:

1. Lehninger Principles of Biochemistry, Nelson and Cox, Macmillan Higher education
2. Biochemistry. R. H. Garret and C. H. Grishm Nelson Education ltd.
3. Biochemistry Voet and Voet

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Seventh
Subject: Microbiology		
Course Code: B080703T	**Course Title: ANALYTICAL TECHNIQUES AND BIOSTATISTICS**	

Course outcomes:

1. Learn about the principle, working and applications of commonly used instruments in microbiology.
2. Get knowledge of applications of different separation and analytical techniques such as electrophoresis, centrifugation, chromatography, etc.
3. Students will be able to handle, calibrate and use the instruments.
4. To formulate basic understanding of biostatistics.
5. To create and grasp the information on kinds of biological data, collection of data and statistical analysis

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Contribution of Indian scientists in various techniques. Electrophoretic Techniques-Theory and application of polyacrylamide and agarose gel electrophoresis, native and SDS PAGE, IEF	8
II	Chromatography techniques – TLC, paper, column chromatography, gel filtration, ion exchange, HPLC, GLC, partition, affinity, adsorption chromatography	12
III	Centrifugation techniques – basic principle, type of centrifuge, micro-centrifuge, high speed, ultracentrifuge, preparative centrifugation, (differential and density gradient), analytical centrifugation	8
IV	Spectroscopy techniques – basic principle, instrumentation and biological application of UV- visible spectroscopy, spectrofluorometry, CD, ORD, atomic spectroscopy (absorption and emission), NMR, ESR	12
V	Radioactivity – radioactive and stable isotopes, radioactive decay, unit of radioactivity, measurement of radioactivity- Geiger Mueller, solid and liquid scintillation counting, SPA, autoradiography; application of radioisotopes in biochemistry, clinical application	10
VI	Introduction to statistics: mean, median, mode, standard deviation, standard error, probability distribution, chi-square test, t- test, f- test, analysis of Variance.	10

Suggested Readings:

1. Wilson K and Walker J. Principles and Techniques of biochemistry and molecular biology. Cambridge.
2. J. D. Seader and E. J. Henley, Separation Process Principles, 1st Edition (1998), John Wiley & Sons, Inc., New York.
3. Fundamentals of Biostatistics. Khan and Khanum, Shiba Khan. Ukaaz publications
4. Fundamentals of Biostatistics. Veer Bala Rastogi.3 Ed.

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Seventh
Subject: Microbiology		
Course Code: B080704T	**Course Title: CELLULAR MICROBIOLOGY**	

1. To know basic structural and functional aspects of living cells
2. To differentiate between prokaryotic and eukaryotic cells
3. To understand the organization of prokaryotic and eukaryotic nuclear organization
4. To understand the different cell division, cell cycle progression proteins
5. To infer which protein and pathways can in affected in abnormal/cancer or normal cells
6. To understand the different signal transduction pathways and their functions in cell regulation.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Indian Knowledge System: Cellular microbiology Cell Theory, Differentiate between prokaryotic and eukaryotic cells. Prokaryotes: Cell morphology, Structure, function and synthesis of cell wall, cell membrane, capsules, Endospores, flagella, pili, cilia. Storage granule metabolism- volutin, polyhydroxybutyrates and glycogen. Gas vesicles, carboxysomes, magnetosomes and phycobilisomes.	10
II	Eukaryotes: Structural organization and function of intracellular organelles: Cell wall, molecular organization of cell membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	12
III	Organization of prokaryotic and eukaryotic genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin.	11
IV	Cell division and cell cycle, cell cycle regulation and control of cell cycle, Cancer and Microbiology	12
V	Principles of cell signaling, different types of receptors: G protein, ion channel linked, Enzyme linked receptors, receptors containing intrinsic enzymatic activity, tyrosine kinase receptor, intracellular receptors of extracellular signals, Protein phosphorylation, kinases, phosphatase: serine threonine kinase, tyrosine kinase, histidine kinase activity in bacterial chemotaxis, serine, threonine and tyrosine phosphatase, cyclic nucleotides, Programmed Cell Death	15

Suggested Readings:

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
5. Alberts et al. Molecular biology of cell- Bruce Alberts, Cell Biology – Karp, Cell signaling by John T Hancock (Oxford), Darnell, Prescott, Stanier..

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Seventh
Subject: Microbiology		
Course Code: B080705P	**Course Title:** Practicals	

Course outcomes:

1. Is able to use different sterilization procedures and learn handling of micropipette.
2. Is able to work in Biosafety Cabinet for culturing cells.
3. Is versed with identification and classification of given bacterial isolate by performing variety of cultural, biochemical tests.
4. Can use microscopy for cell imaging.
5. Use various techniques like pH metry, chromatography, centrifugation, spectrophotometry

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1.	To observe using wet mount preparation for observation of pond algae	
2.	To perform lactophenol cotton blue staining for observation of fungi	
3.	Preparation of bacterial smear, fixation of suspension and simple staining for study of bacterial morphology.	
4.	To perform negative staining using Nigrosine	
5.	To perform Gram Staining for differentiation of bacteria	
6.	To perform capsule staining using given microbial sample	
7.	To perform endopore staining using Schaeffer- Fulton staining method	
8.	To perform staining of poly hydroxyl alkanoate granules using Sudan Black	
9.	To study the principle and working of pH meter and preparation of phosphate buffer	
10.	To study principle, working and types of centrifuges and perform separation of bacterial pellet from supernatant.	
11.	To study the principle and working of spectrophotometer by turbidometric measurement of bacterial growth	
12.	To study principle and working of Thin layer chromatography by chlorophyll separation	
13.	Preparation of nutrient broth and its sterilization	
14.	Preparation of nutrient agar and pouring of plates	
15.	To perform serial dilution and isolation of micro-organisms using spread plate technique	
16.	To perform isolation of pure culture using the streak plate technique	
17.	To perform pour plate technique	
18.	Preparation of slants for the preservation of micro-organisms	

19. Carbohydrate estimation 20. Protein Coagulation 21. Determination of mean, median and mode of given bacterial population
Suggested Readings: 1. Weaver, D. and Tart, R. C., "A Laboratory Manual for General Microbiology" (1998). *Biology*. 46. https://cufind.campbell.edu/biology/46 2. Campbell, JL "A Manual of Scientific and Practical" Publ. BiblioBazaar. 3. Dr. R. C. Dubey and Dr. D. K. Maheshwari 'Practical Microbiology' S. Chand Publications

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Seventh
Subject: Microbiology		
Course Code: B080705R	**Course Title:** Dissertation/ Internship/ Field or Survey Work	
Course outcomes: Upon successful completion students should be able to: 1. Collect information of given problem statement and compile it in sequential order. 2. Review notes to find main sub-divisions (problems, possible solutions) of the subject.		
Credits: 4	**Core:** Compulsory	
Max. Marks: 25+75	**Min. Passing Marks:** as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**		

S. No.	Objectives	Total No. of Lectures/ Hours (60)
A term (or research) paper is primarily a record of intelligent reading in several sources on a particular subject. The students will get informed about the topic at the beginning of the session in consultation with the assigned faculty. The progress of the dissertation/ report writing will be developed under regular monitoring of the faculty. At the end of the semester the detailed report and/or presentation on the topic will be submitted to the faculty assigned.		
Note: The IPR rights of all such work lie with the University only.		

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Eighth
Subject: Microbiology		
Course Code: B080801T	**Course Title: BACTERIAL METABOLISM AND PHYSIOLOGY**	

Course outcomes:

1. 1. Apply knowledge of theory to practice.
2. Describe the diversity of mechanisms by which microorganisms adapt to their environment.
3. Determine metabolic rates in closed and continuous culture, and balances of carbon and reducing power of different metabolic processes.
4. Solve problems in relation to the metabolism and physiology of microorganisms.
5. Understand the regulation of metabolic pathways and possible process activation of microbial product synthesis.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Transport of nutrients – passive diffusion, facilitated diffusion, active transport (ABC transport, proton and sodium gradient driven active transport), group translocation (phosphotransferase system), iron transport (siderophores); transport proteins; thermodynamics of transport system; bacteriorhodopsin.	13
II	Photosynthetic pigments; oxygenic and anoxygenic photosynthesis; autotrophy (calvin cycle, reductive TCA cycle, acetyl CoA pathway); chemolithtrophy (H, N, S, Fe oxidations), methanogens, methanotrophs.	12
III	Central catabolic pathways – glycolysis, pentose phosphate pathway, EntnerDoudoroff pathway, Krebs cycle, electron transport system and ATP generation, glyoxylate cycle, fermentation of carbohydrate (homo and heterolactic fermentation), Pasteur effect.	10
IV	Biochemistry of nitrogen fixation – nitrogenase complex, regulation of nitrogenase by oxygen and combined nitrogen sources; genetics of nitrogen fixation-nif genes and their regulation; nitrification; denitrification; pathways of nitrate and ammonia assimilation; sulphur assimilation; phosphate assimilation (Pho system).	15
V	Stress physiology – adaptations to oxygen toxicity, pH, osmotic pressure, temperature; Donnan equilibrium; quorum sensing related signaling pathways, bioluminescence, multicellular organization in microbes (coordination in microbes).	10

Suggested Readings:

1. Moat A.G. Foster J.W. Spector M.P. 2002. Microbial Physiology (4th ed). Wiley.
2. Caldwell, D.R. 1995 Microbial Physiology and Metabolism, Wm. C. Brown Publishers, U.S.A.
3. White, D., 2003 The Physiology and Biochemistry of Prokaryotes, second edn, Oxford University Press
4. Gottschalk, G. 1985 Bacterial Metabolism, second edn, Springer

Programme / Class: Bachelor of Science	Year: Forth	Semester: Eighth
Subject: Microbiology		
Course Code: B080802T	Course Title: PRINCIPLES OF MOLECULAR BIOLOGY	

Course outcomes:

1. Is able to describe structure of DNA and RNA, organization of eukaryotic genome
2. Is able to compare and contrast the mechanisms of bacterial and eukaryotic DNA replication, DNA repair and and recombination
3. Is able to explain transcription, post-transcriptional processes and various levels of gene regulation in both prokaryotic and eukaryotic organisms
4. Is able to describe translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing.
5. Is able to describe various type of inhibitors in gene expression system.

Credits: 4	Core :Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Genetic information and nucleic acids, DNA as the genetic blue print, experimental evidence, Physical and chemical structure of DNA structure, circular and super helical DNA, denaturation of DNA, renaturation, Hybridization, replication is semiconservative (experimental evidence).	13
II	DNA replication, repair and recombination -Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.	12
III	RNA synthesis and processing - transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport, transcriptional inhibitors.	10
IV	Protein synthesis and processing - Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyltRNAsynthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins, Protein trafficking	15
V	Control of gene expression at transcription and translation level - regulating the expression of prokaryotic (*lac, trp, ara*operon) and eukaryotic genes response element, role of chromatin in gene expression and gene silencing.	10

Suggested Readings:

1. George M Malacinski. Freifelder's Essentials of molecular biology. Jones & Bartlett Learning
2. Krebs JE, Goldstein ES, Kilpatrick ST. Lewin's Essential Genes. Jones & Bartlett Learning

Programme / Class: Bachelor of Science	Year: Forth	Semester: Eighth

Subject: Microbiology		
Course Code: B080803T	**Course Title: RECOMBINANT DNA TECHNOLOGY**	

Course outcomes:

Upon successful completion of the course, the student:

1. will know about basic principle of RDT, different restriction & modifying enzymes, library construction and screening.
2. Will be familiar with the use of various cloning vectors, expression vectors and purification of recombinant proteins.
3. Will be able to describe the various methods of gene transfer in both plant and animal.
4. Will be able to understand the methods by which labeling of nucleic acid is done and hybridization techniques like southern, northern and western blotting.

Will be aware of DNA is sequenced and will gain insights into how entire genomes of organisms are sequence, the many uses of the reporter genes & molecular markers, various applications of PCR, creation of plant and animal transgenics.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Basic Tool of RDT: Host controlled restriction and modification, Restriction enzymes & its nomenclature, DNA modifying enzymes, Cohesive & Blunt end ligation, Linkers, Adaptors, Homopolymer tailing, c DNA library & Genomic DNA library construction	13
II	Introduction to cloning: Cloning Vectors-plasmid (pBR322, pUC) Cosmid, Phasmid, Bacteriophage λ, Single stranded DNA Vectors (M 13, f1, fd), Cloning vectors for Yeast, Artificial Chromosomal Vectors (BACs, YACs), Prokaryotic & Eukaryotic Expression Vectors with GST, His, MBP tags, Affinity Purification of Recombinant Protein, Yeast two-hybrid system, Phage display technique	15
III	Gene Transfer Methodologies: Gene Transfer in Plants- Direct/ Vectorless, Vector mediated gene transfer (Agrobacterium mediated Binary, Conjugate Vector, Viral Vector), Gene Transfer in animals – Direct/ Vectorless, Vector mediated, Embryonic stem cell gene transfer, Genetic manipulation of animals (Production of transgenic/ Knock-out mice), Nuclear transfer technology and animal cloning	10
IV	Labelling & Detection of nucleic acid: End labeling, Random Priming, Nick Translation using radioactive, Nonradioactive probes, FISH, Hybridization techniques-Southern Blotting, Northern Blotting, Western Blotting, Dot Blot	12
V	DNA sequencing, Next-generation sequencing technologies, PCR & its types (including real time, reverse transcriptase), RACE technique, Site-directed mutagenesis, Molecular markers (RAPD, RFLP, AFLP), DNA fingerprinting, Applications of RDT in various fields	10

Suggested Readings:

1. TA Brown. Gene cloning and DNA analysis. Blackwell Publ.
2. Old and Primrose. Principles of gene manipulation. An introduction to genetic engineering. Blackwell Scientific Publ.

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Eighth
Subject: Microbiology		
Course Code: B080804T	**Course Title: VIROLOGY**	

Course outcomes:

1: Apply knowledge of virus structure and classification to understand nature of viruses
2: Explain the methods used in cultivation and assay of viruses
3: Discern the general replication strategies of viruses including bacteriophages
4: Describe the structure, replication cycle and pathogenesis of select plant and animal viruses CO 5: Apply knowledge to describe different antiviral mechanisms and recent application in virology

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	History of Virology; Contribution of Indian Virologists. Classification and Morphology of Viruses: Cataloging the virus through virus classification schemes of ICTV / ICNV. Baltimore's Classification; Ultra-structure of viruses: envelop, capsid and nucleic acid; Virus related agents: viroids, virusoids and prions.	13
II	Cultivation and assay of viruses: Cultivation of viruses using embryonated eggs, experimental animals, and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses: Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point dilution assay). Serological Assays.	15
III	Viral Multiplication: Mechanism of virus adsorption and entry into the host cell. Replication strategies of DNA and RNA viruses. Post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions. Latent infections, persistent infections. Host Immune Evasion. Lifecycle of bacteriophages-lytic and lysogenic pathways: T series, λ, Mu, M13, ϕX174; Cyanophages and Mycophages.	10
IV	Pathogenesis of Viruses: Structure, genomic organization, replication cycle; pathogenesis, diagnosis and control. Poxvirus, Adenovirus, Herpes virus, Hepatitis virus, Rota Virus, HIV, Toga Viruses. Pathogenesis of plant Viruses: TMV, PVX, PVY and insect viruses NPV. Role of insect vectors in transmission of plant viruses. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.	12

V	Control of viral infections through vaccines, interferons, chemotherapeutic agents Antisense RNA, siRNA, ribozymes. Control of plant viral diseases. Recent applications of viruses: Nanotechnology, Phage therapy; Phage Display; Gene therapy etc.	10

Suggested Readings:

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C. Churchil Livingstone, London.
2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. Blackwell Scientific Publications. Oxford.
3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. Prentice Hall, Englewood Cliff, New Jersey.
4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons.
5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press, Washington, D.C.
6. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Eighth
Subject: Microbiology		
Course Code: B080805P	**Course Title:** Practicals	

Course outcomes:

1. Can make qualitative and quantitative detection of different types of molecules.
2. Understand the effect of various physiological conditions on growth
3. Isolate and handle viruses, fungi and algae
4. Develop method for isolating genomic DNA and plasmid DNA.
5. Appraise restriction analysis of DNA.
6. Analyze the outcome of transformation.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1.	To determine the effect of pH, temperature and salinity on growth of given microbial sample	
2.	To determine the effect of temperature on growth of given microbial sample	
3.	To determine the effect of salinity on growth of given microbial sample	
4.	To determine catalase activity of given microbial culture	
5.	To perform oxidase activity of given microbial culture	
6.	To perform oxidative fermentative test for given microbial culture	
7.	To determine amylase forming ability of given isolates	
8.	T determine gelatinase forming ability of given isolates	
9.	To perform sugar fermentative tests for given microbial cultures	
10.	Isolation of fungi by baiting method.	
11.	Culturing and morphological study of some common molds: *Rhizopus*, *Mucor*, Penicillium, *Alternaria*, *Trichodema*	
12.	To observe budding of *Saccharomyces cerevisiae*	

13. Isolation of algae from soil and water
14. Study of morphology of given algal sample
15. Isolation of bacteriophages from sewage/ Ganga water using plaque assay
16. Study of DAS –ELISA assay for given viruses.
17. Observation of viral pathogenicity using phase contrast microscope.
18. Isolation of bacterial DNA and its separation using agarose gel electrophoresis
19. Preparation of competent cells for transformation.
20. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
21. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
22. To demonstrate *in vitro* transcription assay and *in vitro* translation assay

Suggested Readings:

2. Weaver, D. and Tart, R. C., "A Laboratory Manual for General Microbiology" (1998). *Biology*. 46. https://cufind.campbell.edu/biology/46
3. Campbell, JL "A Manual of Scientific and Practical" Publ. BiblioBazaar.
4. Dr. R. C. Dubey and Dr. D. K. Maheshwari 'Practical Microbiology' S. Chand PublicationsMolecular Cloning: A Laboratory Manual, Volume 1, Joseph Sambrook, David William Russell Cold Spring Harbor Laboratory Press.
4. Molecular Cloning, Volume 2, Joseph Sambrook, Cold Spring Harbor Laboratory Press

Programme / Class: Bachelor of Science	**Year:** Forth	**Semester:** Eighth
Subject: Microbiology		
Course Code: B080805R	**Course Title:** Dissertation/ Internship/ Field or Survey Work	

Course outcomes:

Upon successful completion students should be able to:

1. Collect information of given problem statement and compile it in sequential order.
2. Review notes to find main sub-divisions (problems, possible solutions) of the subject.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**

S. No.	Objectives	Total No. of Lectures/ Hours (60)
	A term (or research) paper is primarily a record of intelligent reading in several sources on a particular subject. The students will get informed about the topic at the beginning of the session in consultation with the assigned faculty. The progress of the dissertation/ report writing will be developed under regular monitoring of the faculty. At the end of the semester the detailed report and/or presentation on the topic will be submitted to the faculty assigned.	

Note:

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Detail Syllabus of

V Year

Master of Science (M.Sc.)
In
Microbiology

Programme / Class: Master of Science	Year: Fifth	Semester: Ninth
Subject: Microbiology		
Course Code: B080901T	Course Title: MICROBIAL GENETICS	

Course outcomes:

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

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

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

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

5: Can list the outcomes of transposition events, can design strategies to mutagenize bacteria using transposons, can explain the construction of conditional knockouts

Credits: 4	Core :Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Experimental evidence for the hereditary molecule in all organisms is DNA. Mutation in bacteria, Auxotrophic & conditional lethal mutants, Types of mutation, Physical and chemical mutagens, biochemical basis of mutation, Reversion verses suppression mutation, Different types of DNA repair mechanism. -direct reversal, mismatch repair, excision repair, recombination repair and SOS repair. Genetic analysis of microbes- bacteria and yeast, complementation	15
II	Plasmids: Different types of plasmids, F Factor description and their uses in genetic analyses, col and R plasmids. Function encoded by plasmids, Replication of plasmids, incompatibility, host range, copy number, curing of plasmid, Transfer of plasmid Artificial plasmid, Plasmid as vector for gene cloning	12
III	Gene transfer mechanisms – Transformation, conjugation and Transduction-Generalized and Specialized, mechanism and application, Molecular basis of recombination, Insertion Sequences & Transposons, types of transposons, site specific recombination	10
IV	Bacteriophage: Lytic phages T4 &T7, Lysogenic phages lambda and P1 Life cycle, replication, transcription and regulation of gene expression, prions and their genetic composition, disease caused by prions.	12
V	Acquired and adaptive immunity in bacteria, antiphage defense system, programmed genetic variation, CRISPR-Cas machinery, spacers, Quorum sensing induced bacteriophage defense mechanism, Programmed genetic variation, Epigenetics	11

Suggested Readings:

1. Snyder L and Champness W. Molecular genetics of bacteria. ASM Press.
2. David Freifelder. Microbial genetics. Jones & Bartlett Publ.
3. Cronan J. and Freifelder D., Microbial Genetics; Second Edition
4. Khalifa AE; Fundamentals of Microbial Genetics; Lamber Academic Pub.Sundara R.S. Microbial Genetics; Amol Publications Pvt Ltd
3. Modern Microbial Genetics, Second Edition; Editor(s):Uldis N. Streips, Ronald E. Yasbin; Wiley Liss, Inc.

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Ninth
Subject: Microbiology		
Course Code: B080902T	**Course Title: CELLULAR AND MOLECULAR IMMUNOLOGY**	

Course outcomes:

1. Distinguish between the specificity and memory of acquired versus innate immune response
2. Differentiate between different types of specific immune response
3. Discuss the generation of immune diversity and different molecular aspects of immune response generation
4. Apply knowledge of cellular and humoral immune response to different antigens
5. Identify the role of immune response in vaccine development and immunotherapy

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Introduction to the immune system, History of Immunology with contribution of Indian Scientists, Physical and chemical barriers, Cells and molecules involved in innate and adaptive immunity, Cytokines and Chemokines, Complement system, Toll-like receptors, Inflammation, Primary and Secondary lymphoid organs.	13
II	Major Histocompatibility Complex- genes, structure and functions, antigen presenting cells, antigen processing and presentation, antigens, antigenicity and immunogenicity, Superantigens, Linear and conformational epitopes, paratope	12
III	Primary and Secondary Immune response. Clonal Selection Theory, Humoral Immunity: structure and function of antibody molecules. Generation of antibody diversity, Activation and differentiation of B cells, B cell signaling, Types of B cells, Memory B cells. Antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies	12
IV	T cell Immune response: activation and differentiation of T cells, T cell receptors, genetic diversity of T cell response, T cell signaling, types of T cells, Peripheral and Central tolerance, Autoimmunity, Hypersensitivity.	10
V	Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections. Vaccinology: Active and passive immunization; Hapten & Adjuvants, Types: live, attenuated, killed, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate	13

	vaccines.	

Suggested Readings:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman
2. Abul Abbas, AdrewLitchman, Shiv Pillai. Cellular and Molecular Immunology.9th Edition. Elsevier.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications.
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt
4. Roitt's Essential Immunology.13th Edition, Wiley Black Publications.

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Ninth
Subject: Microbiology		
Course Code: B080903T	**Course Title: AGRO-ENVIRONMENTAL MICROBIOLOGY**	

Course outcomes:

1. Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in agriculture and mitigating environment pollution.
2. Will be able to describe the role of soil microbes in nutrient transformation, plant-microbe interactions and biotechnology.
3. Understands the role of microorganisms in eco-friendly agriculture and sustainable environmental practices.
4. Will understand the information about inter-relationship of soil and microorganisms, different group of beneficial microorganisms in agriculture, microbes as a biofertilizer, plant pathogen and biocontrol agent.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Environment microbiology: Role of microbes in environment, microbes in air - aerosol and droplet nuclei, assessment of air quality (impactor and impingement methods). Microbes in water – fresh water, deep sea, estuaries, mangroves, hydrothermal vents, eutrophication.	13
II	Community ecology: Microbial interactions (symbiosis, mutualism, commensalisms, competition, amensalism, synergism, parasitism and predation), rhizosphere, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins).	12
III	Waste treatment: Solid waste treatment – landfill, composting; liquid waste treatment - (aerobic, anaerobic, primary, secondary & tertiary) treatment, advanced treatments (nitrate and phosphate removal). Bioremediation, cometabolism, biodegradation of xenobiotics (pesticides, oil spill hydrocarbons), bioaccumulation of heavy metals and detoxification.	12
IV	Agriculture microbiology: Plant-microbe (plant growth promoting microorganisms) interaction mechanisms; biological nitrogen fixation (asymbiotic and symbiotic), strategies of transfer of nif genes in plants;	10

	biofertilizers types, application methods an agronomic importance	
V	Major plant disease symptoms caused by fungi, bacteria and viruses. Life cycle, symptoms and control measures of the following diseases: Fungal – *Puccinia graminis*, *Fusarium oxysporum*. Bacterial – *Xanthomonas oryzae*, *Pseudomonas syringae*. Viral and mycoplasmal – TMV, CaMV, Phytoplasma; biopesticides (fungal, bacterial and viral biocontrol agents).	13

Suggested Readings:

1. Manual of environmental microbiology, Christon J. Hurst, Ronald L. Crawford Second edition, ASM Press.
2. Agricultural Microbiology: Subbarao
3. Microbial Ecology –Atlas and Bartha.

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Ninth
Subject: Microbiology		
Course Code: B080904T	**Course Title: MICROBIAL GENOMICS, PROTEOMICS AND BIOINFORMATICS**	

Course outcomes:

1. Describe history and advanced in technologies for obtaining genomics and proteomics data
2. Explain data obtained from using genomics and proteomics in silico and wet lab tools
3. Apply knowledge of different Omics technologies to microbial systems
4. Discuss recent advances, techniques and applications in the field of genomics, transcriptomics and proteomics
5. Application based understanding of different bioinformatics databases and softwares

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Introduction to Genomics, Transcriptomics and Proteomics; Current Status of microbial genomics- History and Scope. Developments in India with respect to genomics and proteomics. Whole genome cloning- Shotgun & Hierarchial cloning. BAC, YAC, Metagenomics; Next Generation Sequencing methodology, 3rd generation sequencing	12
II	Introduction to Bioinformatics and OMICS; History and Scope of Bioinformatics; Biological databases; primary nucleotide sequence databases, Annotated sequence databases, protein sequence and structure databases; Organism specific databases	10
III	Types of Genomics: Structural Genomics, Functional Genomics, Metagenomics, Single Cell Genomics; GenBank, Ref Seq – NCBI, EMBL & DDBJ – retrieving sequences. Genome sequence comparison, SNP analysis, Genome annotation and Gene prediction. Transcriptomics: RNA structure prediction, High throughput Screening methodologies, Microarrays	10

IV	Proteomics: Basics of mass spectrometry. Maldi TOF and ESI, and their application in proteomics. Peptide sequencing by tandem mass spectrometry, Affinity purification of protein, Protein Microarrays, Protein Structural databases; Protein structure prediction: homology and ab initio methods.	10
V	Comparative genomics: Tools used for phylogenetic analysis – Ribosomal Database Project, Clustal, MEGA, Interactomics tools	8
VI	Recent advances in genomics and proteomics. Application of microbial genomics and proteomics. GWAS, IPR in genomics and proteomics. Sequence analysis software: BLAST, CLUSTAL W	10

Suggested Readings:

1. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
2. Functional Genomics. A Practical Approach Edited by Stephen P Hunt and Rick Liveey (OUP) 2000.
3. Introduction to Bioinformatics. A Lesk.
4. Bioinformatics: Sequence and Genome Analyis. David Mount. CSHL Press

Programme / Class: Master of Science Year II	**Year:** Fifth	**Semester:** Ninth/ Third
Subject: Microbiology		
Course Code: B080905T	**Course Title: INFECTIOUS DISEASE MICROBIOLOGY**	

Course outcomes:

1. Will have gained insight on medically important microbial pathogens
2. Will attains knowledge of various micropathogenecity strategies and antimicrobial resistance mechanisms
3. Learn about the different bacterial diseases and their causative agents and their pathogenesis mechanisms
4. To gain knowledge about fungal and viral diseases and their pathogenesis mechanism
5. Understand the role of zoonotic infections and emerging infectious diseases.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Early discovery of pathogenic microorganism, Normal microflora of human body, True and Opportunistic pathogens; virulence factor and pathogenicity factor of bacteria and virus, Infection, Adhesion, colonization, Invasion, toxigenicity, infectivity, transmissibility, communicability. Antibiotics and antibiotic resistance mechanisms.	15
II	Bacterial disease: Morphology, cultural characteristics, pathogenesis, lab diagnosis & treatment of Causative agent of air borne disease (Diptheria, pertussis, tuberculosis), Food and water borne disease (typhoid, shigellosis, cholera), soil borne disease (anthrax, tetanus and gas gangrene), contact disease (leprosy)	15

III	Fungal disease: Etiology, geographical distribution, pathogenesis, symptomatology, lab diagnosis and treatment of *Candida, Histoplasma, Aspergillus and Cryptococcus, Dermatophytes*	10
IV	Viral disease: Pneumotropical (Influenza), Dermotropical (Herpes, chicken pox, small pox, measles and rubella), Viscerotropic (Hepatitis, Acquired immunodeficiency syndrome), Neurotropic (Rabies and Polio).	10
V	Zoonotic infection: Bacterial (Brucellosis, Plague) Viral (Hemorrhagic and encephalitic fever), Parasitic (Malaria, Leishmaniasis)	10

Suggested Readings:

1. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition. Williams and Wilkins, Baltimore.
2. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.
3. Joan Stokes E, Ridgway GL and Wren MWD. (1993). Clinical Microbiology, 7th edition. Edward Arnold. A division of Hodder and Stoughton.
4. Ronald M. Atlas. (1989) Microbiology. Fundamentals and Applications. II edition, Maxwell Macmillan international editions.
5. Topley& Wilsons's. (1990) Principles of Bacteriology, Virology and Immunity, VIII edition, Vol. III Bacterial Diseases, Edward Arnold, London.
6. Ananthanaran and Paniker's "Text of Microbioloy". Universities Pres

Programme / Class: Master of Science Year II	**Year:** Fifth	**Semester:** Ninth/ Third
Subject: Microbiology		
Course Code: B080906T	**Course Title: APPLIED FOOD MIRCROBIOLOGY**	

Course outcomes:

1. Knows traditional food preservation techniques including drying, salting, pickling, refrigeration, freezing, oxidation, vacuum packaging, canning/bottling, smoking, sugaring, chemical preservation and irradiation.
2. Gains knowledge about factors influencing microbial growth in food: extrinsic and intrinsic factors
3. Gathers information regarding microbes causing food intoxications and food-borne infections.
4. Gains knowledge about conventional methods for food quality analysis and is able to use the most recent techniques of quantification and detection of food borne microbes and pathogens.
5. Gains knowledge about microbiology of milk and production and evaluation of the quality of starter cultures and fermented milk products such as yogurt cheese etc.
6. Will know about production and evaluation of the quality of starter cultures and fermented milk products.
7. Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety and understands the use and production of probiotics and prebiotics.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)

I	Microorganisms important in food microbiology: molds, yeasts, bacteria – General characteristics classification and importance. Principles of food preservation- Asepsis, Preservation by use of high temperature, drying, chemical preservatives and additives, preservation by radiation.	12
II	Factors influencing microbial growth in food: extrinsic and intrinsic factors, Microbial spoilage of food. Spoilage of fish, meat, poultry, eggs, fruits and vegetables and canned foods.	8
III	Classification of food borne diseases. Bacteral and Viral Food borne diseases- *Brucella, Clostridium, Escherichia, Salmonella, Shigella, Listeria, Vibrio* and *Yersinia*. General methods for diagnosis of infections, intoxications and preventive measures.	10
IV	Microbiology of milk: Sources of microorganisms in milk and types of microorganisms in milk. Microbial contamination of milk (SPC, direct microscopic count, reductase and phosphatase test) Dehydration and Pasteurization of milk.	10
V	Food fermentations: Starter cultures, their biochemical activities and production of following fermented foods: Oriental foods- Mycoprotein, Tempeh, Soyasauce, Idli, Natto and Poi. Dairy fermented foods- Cheese, Yogurt and Butter, Fermented vegetables- Sauerkraut.	10
VI	Application of microbial enzymes in food industry. Production and application of baker's yeast. Genetically modified foods. Biosensors in food. Food laws and quality control-HACCP, PFA, FPO, BIS, AGMARK, ISI, FDA. Beneficial uses of microorganisms. Concept of prebiotics and probiotics.	10

Suggested Readings:

1. Food microbiology by M.R. Adams and M.O. Moss, royal Society of Chemistry
2. Modern food microbiology, James. M Jay 4th edition CBS publishers and distributers New Delhi
3. Fundamental Food Microbiology 3rd edition Bibek Ray. CRC press 2006
4. Topley& Wilsons's. (1990) Principles of Bacteriology, Virology and Immunity, VIII edition, Vol. III Bacterial Diseases, Edward Arnold, London.
5. Ananthanaran and Paniker's "Text of Microbioloy". Universities Pres

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Ninth
Subject: Microbiology		
Course Code: B080907P	**Course Title:** Practicals	

Course outcomes:

1. Demonstrate an understanding of the concepts of microbial genetics.
2. Use the properties of microorganisms, principally bacteria, as bioindicators of contamination and to remedy problems of contamination and other environmental impacts.
3. Deal with plant-associated microbes and to combat diseases that attack important food crops.
4. Evaluate extremophiles for beneficial characteristics.
5. Uses basic methods and research tools applied in host-microbe interactions.
7. Design and present results of immune techniques-based experiment.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**

S. No.	Objectives	Total No. of Lectures/ Hours (60)

1. Isolation and enumeration of aero microflora using settle gravity method
2. Isolation of urease producing isolates.
3. Detection of biofilm forming ability of isolates using Congo Red Binding agar
4. Isolation of Enterobactericeae from sewage water using EMB/ MacConkeys Agar
5. Presumptive MPN test
6. Determination of Dissolved oxygen and Biological Oxygen Demand of given water sample
7. IMVic and TSI test for differentiation of Enterobactericeae
8. Determination of R: S value of rhizospheric soil
9. Isolation of Rhizobiafrom root nodules
10. Isolation and enumeration of isolated from phyllosphere
11. Isolation of phosphate solubilizing bacteria using Pikovaskiya Agar
12. Plant growth promoting products: HCN, Indole acetic acid
13. Isolation of UV resistant mutants
14. Isolation of antibiotic resistant mutants and their isolation using replica plating method
15. Demonstration of antigen antibody precipitation using Widal test
16. Blood group estimation
17. To perform Total Leukocyte Count of the given blood sample.
18. To perform Differential Leukocyte Count of the given blood sample.
19. Perform antibacterial sensitivity by Kirby-Bauer method.

*Perform any of the suggested practicals. Practicals maybe changes as per course instructor.

Suggested Readings:

1. Campbell, JL "A Manual of Scientific and Practical" Publ. BiblioBazaar.
2. Dr. R. C. Dubey and Dr. D. K. Maheshwari 'Practical Microbiology' S. Chand Publications
3. Molecular Cloning: A Laboratory Manual, Volume 1, Joseph Sambrook, David William Russell Cold Spring Harbor Laboratory Press.
4. Molecular Cloning, Volume 2, Joseph Sambrook, Cold Spring Harbor Laboratory Press
5. Molecular Microbiology: Diagnostic Principles and Practice (ASM Books Book 51) 3rd Edition, Kindle Edition by David H. Persing, Fred C. Tenover, Randall T. Hayden, Margareta Ieven, Melissa
6. Miller, Frederick S. Nolte, Yi-Wei Tang, Alex van Belkum

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Ninth
Subject: Microbiology		
Course Code: B080908R	**Course Title: Research Project/ Dissertation/ Internship/ Field or Survey Work**	

Course outcomes:

1. List the objectives and state the hypothesis of the research project.
2. Outline the methodology that will be followed to achieve the listed objectives.
3. Employ the finalised methodology to solve the problem which has been undertaken.
4. Analyse the data which has been generated by carrying out several experiments.
5. Evaluate the data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results.
6. Organize the inferences to prove the hypothesis.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**

S. No.	Objectives	Total No. of Lectures/ Hours (60)
This course objective is to impart competent skills to thrive in research institutions and industries		

Note:

1. Project work will involve experimental work.
2. Students are required to do an individual research project.
3. Students are required to submit a report for assessment and need to demonstrate the working of research findings.
4. Students will be asked their choice for Project work at the end of ninth semester and all formalities of topic and mentor selection will be completed by this time.
5. The IPR rights of all such work lie with the University only.

Programme / Class: Master of Science	Year: Fifth	Semester: Tenth
Subject: Microbiology		
Course Code: B081001T	Course Title: MICROBIAL TECHNOLOGY	

Course outcomes:

1. Learn about the concepts of processes, instruments, management, quality etc. being used in industries to produce the products using microorganisms.
2. Acquire knowledge of the environmental and nutritional factors affecting the production of various metabolites.
3. Will attains knowledge of various fermentation optimization strategies.
4. Acquires knowledge about the production process of various industrially relevant microbial products.
5. Able to solve the difficulties related to the microbial production of certain metabolites.

Credits: 4	Core :Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Screening for production strains, strain improvement, Maintenance of industrially important microorganisms, scale up and scale down of the fermentation process (shake flask – lab fermenter – pilot plant - production level), Parameters to be scaled-up (fermenter design, media, sterilization of media, etc).	13
II	Construction and types of fermentors, media, sterilization, inoculum preparation (bacterial, fungal, immobilization), aeration, agitation, foam control. Downstream processing of biologicals, economics of fermentation process, Hygiene and safety.	12
III	Fermented beverages – beer and wine; Development of industrially important microbial enzymes (amylolytic enzymes, proteases); production of organic acids by microbes (citric acid, acetic acid); industrial production of amino acids (L-lysine, L-glutamate), microbial production of vitamins (B2, B12).	15
IV	Production process of antibiotics (penicillin, streptomycin); industrial production of interferon, microbial production of insulin, vaccine production and formulation, Biotransformation of steroids.	10
V	Microbial production of polymers (xanthan, dextran), production of bioplastic compound - polyhydroxyalkanoates; Generation of microbial biomass as single cell protein, mushroom; production of bacterial, algal and fungal biofertilizers and their application methods.	10

Suggested Readings:

1. Casida, L.E., 1984, Industrial Microbiology. Wiley Eastern, New Delhi
2. Prescott and Dunn's.: Industrial Microbiology, AVI Publishing Co. USA.
3. Waites M.J. et al.: Industrial Microbiology, Blackwell Science Ltd.
4. Glazer A.N and Nikaido H.: Microbial Biotechnology, W.N. Freeman and Co.

Programme / Class: Master of Science	Year: Fifth	Semester: Tenth
Subject: Microbiology		
Course Code: B081002T	Course Title: ADVANCED IMMUNOLOGY AND IMMUNOTECHNIQUES	

Course outcomes:

1. Demonstrate detailed knowledge of how the immune system normally responds to infection.
2. Apply knowledge and incorporate principles to show how aberrations in immuno-regulation underlie autoimmunity, immunodeficiency, allergy and cancer.
3. Acquire, analyse and interpret experimental data on research in immunology.
4. Apply immunotechniques for assaying cellular and humoral immune responses
5. Explain working of the immune system to protect from foreign material

Credits: 4	Core :Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Immunology – Overview** Distinguishing features of innate and specific immune response, Passive and Active immunity, Three lines of immune defense, Primary and secondary lymphoid organs, Haematopoiesis- innate and acquired immune cells, Inflammation, Cytokines, Defensins	10
II	**Humoral Immunity** Classes and subclasses, structure-function relationship, isotypes, idiotypes and allotypes. B cell receptor and B cell signalling, B cell differentiation. T cell dependant and independent B cell activation, Jerne's Idiotypic network	10
III	**Immunogenetics and Cellular Immunology** Blood groups and transplantation antigens, HLA and disease association, antigen processing and MHC, Theories of antibody synthesis and generation of antibody diversity-molecular basis of repertoire generation, Generation of T cell diversity, Burnets cloning selection theory, TCR, T cell signalling, Types of T and B cells, Regulatory T cells, Immune tolerance- Central and Peripheral mechanisms, Autoimmunity mechanisms	15
IV	**Immunity to infections** Immunity to infection by viruses, bacteria, fungi and parasites and immunity to tumors, autoimmune diseases, Vaccine, adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, edible and plant vaccines, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs. Targeted immunotherapy, Vaccine & peptide therapy in Transplantation	15

V	**Immunotechniques** Antigen-antibody reactions – complement fixation, agglutination, precipitation, immuno-diffusion, immunoelectrophoresis, Immuno-fluorescence, enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA). Production and applications of monoclonal and polyclonal antibodies for diagnosis and therapy Flow cytometry analysis, ELISPOT, Intracellular cytokine staining, Cytotoxicity assays, apoptosis assays, generation of transgenic and knock out mice.	10

Suggested Readings:

1. Therapeutic Immunology, authors. K Frank Austen, Steven J Burakoff, Fred Rosen, Terry B Strom, Publisher : Blackwell Science
2. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
3. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland Science Publishers, New York.
4. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
5. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Tenth
Subject: Microbiology		
Course Code: B081003T	**Course Title:**	**ENTREPRENEURIAL MICROBIOLOGY**

Course outcomes:

1. Research and develop entrepreneurship with strong ethics.
2. Understand communication and management skills to usher next generation of Indian industrialists and researchers.
3. Know the importance and scope of the IPR in Microbiology
4. Get acquainted with regulatory practices undertaken at commercial level.

Credits: 4	**Core :**Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 4-0-0**

Unit	Topics	Total No. of Lectures/ Hours (60)
I	**Entrepreneur development** Concept and need of entrepreneurship development, activity, Institutes involved, Differences betweenentrepreneurship, Entrepreneur & Enterprise, Government contributions to entrepreneur. Business Idea to Start-up opportunities, sources, challenges and factors influencing opportunity identification- risk assessment and development, idea canvas.	10

II	**Microbial cells as fermentation products** Baker's yeast, food and feed yeasts, bacterial insecticides, legume inoculants, Mushrooms, Algae, Enzymes as fermentation products-bacterial and fungal amylases, proteolytic enzymes. prebiotics, probiotics – their use as flavor enhancers and disease/ infection combats.	10
III	**Recycling of wastes** Production of biofuels-ethanol, methane, hydrogen, other hydrocarbons, compost, vermicompost, production of single cell protein, mushroom cultivation (*Agaricus campestris*, *Agaricus bisporous* and *Volvoriella volvacea* eg.), microbial bioplastics. Bioleaching of copper, gold and uranium.	10
IV	**Agriculture technologies** Microbial Bioinoculants – production (Bacterial, fungal and Mycorhhiza), Silent features of secondary agriculture, use of agricultural and agro-industrial waste for biodegradable packaging, higher value secondary products (dietary fiber, phenolic acids), food colours/dyes. Genetic engineering in biological control and plant growth promotory product production, transgenic plants for biotic and abiotic stress resistence, quality enhancement.	12
V	**Brewing** Media components, preparation of medium, microorganisms involved, maturation, carbonation, packaging, keeping quality, contamination, by products. Production of industrial alcohol.	8
VI	**Patients and secret process** History of patenting, composition, subject matter and characteristics of a patent, inventor, infringement, cost of patent. Patents in India and other countries. Fermentation economics. Advances and trends, ethical issues, quality control, legislation, FDA & FPO, (India), safety and security at workplace	10

Suggested Readings:

1. Prescott LM, Harley JP and Klein DA (2003) Microbiology (10th edition) McGraw Hill, New York.
2. PelczarJr, M.J. Chan, E.C.S and Krei N.R (1993) Microbiology McGraw Hill, New York.
3. Subba Rao NS (1997). Biofertilizer in Agriculture and Forestry, 3rd edition, Oxford & IBU Publications.
4. LE Cassida JR (2005). Industrial Microbiology. New Age International (P) Ltd., New Delhi.
5. Arora. Entrepreneurial Development in India.
6. Aneja, K.R. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, 6th Edition, New age International Publication.
7. Goyal P (2017) Before You Start Up: How to Prepare to Make Your Startup Dream a Reality. Fingerprint! Publishion

Programme / Class: Master of Science	Year: Fifth	Semester: Tenth
Subject: Microbiology		
Course Code: B081004T	Course Title: MOOC	
Course outcomes: Upon successful completion students should be able to: 1. Can get the skills of discipline specific selected course.		
Credits: 4	Core : Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Programme / Class: Master of Science	Year: Fifth	Semester: Tenth
Subject: Microbiology		
Course Code: B081005P	Course Title: Practicals	
Course outcomes: 1. Demonstrate techniques for large-scale cultivation of industrially important microorganisms (e.g., bacteria, fungi, yeast). 2. Apply methods for downstream processing, including product extraction, purification, and quality assessment. 3. Interpret immunological assay results for diagnostic and research applications. 4. Apply microbiological principles in designing viable product prototypes for entrepreneurship. 5. Perform cost-benefit analysis and prepare a business plan or model for a microbial start-up.		
Credits: 4	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:0-0-4		

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1.	To perform immunodiffusion by Ouchterlony method.	
2.	Alkaline phosphatase test to check the efficiency of pasteurization of milk.	
3.	Isolation of spoilage microorganisms from spoiled vegetables/fruits.	
4.	Isolation of spoilage microorganisms from bread.	
5.	Optimization of microbial processes	
6.	Wine production.	
7.	Perform DOT ELISA	
8.	Identification of *S. typhi* by serotyping.	
9.	Clinical diagnosis of viral diseases by PCR, ELISA.	
10.	Production of Biofertilizers	
11.	Presentation and Pitch of Microbial Business Ideas	
*Perform any of the suggested practicals. Practicals maybe changes as per course instructor.		

Suggested Readings:

1. Campbell, JL "A Manual of Scientific and Practical" Publ. BiblioBazaar.
2. Dr. R. C. Dubey and Dr. D. K. Maheshwari 'Practical Microbiology' S. Chand Publications
3. Molecular Microbiology: Diagnostic Principles and Practice (ASM Books Book 51) 3rd Edition, Kindle Edition by David H. Persing, Fred C. Tenover, Randall T. Hayden, Margareta Ieven, Melissa
4. "Industrial Microbiology and Biotechnology" by Wulf Crueger & Anneliese Crueger – Advanced practical and conceptual coverage of microbial production
5. Tandon or Trivedi for biofertilizer/bioproduct lab work

Programme / Class: Master of Science	**Year:** Fifth	**Semester:** Tenth
Subject: Microbiology		
Course Code: B081006R	**Course Title: Research Project/ Dissertation/ Internship/ Field or Survey Work**	

Course outcomes:

1. List the objectives and state the hypothesis of the research project.
2. Outline the methodology that will be followed to achieve the listed objectives.
3. Employ the finalised methodology to solve the problem which has been undertaken.
4. Analyse the data which has been generated by carrying out several experiments.
5. Evaluate the data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results.
6. Organize the inferences to prove the hypothesis.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75	**Min. Passing Marks:** as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-4**

S. No.	**Objectives**	**Total No. of Lectures/ Hours (60)**
This course objective is to impart competent skills to thrive in research institutions and industries		

Note:

1. Project work will involve experimental work.
2. Students are required to do an individual research project.
3. Students are required to submit a report for assessment and need to demonstrate the working of research findings.
4. Students will be asked their choice for Project work at the end of ninth semester and all formalities of topic and mentor selection will be completed by this time.
5. The IPR rights of all such work lie with the University only.