

**Khandesh Education Society's
Pratap College, (Autonomous) Amalner**



Structure of syllabus for

F.Y.B.Sc.

[Microbiology]

As per NEP 2020

[2023-24]

F. Y. B. Sc. Microbiology (As per NEP 2020)

Prelude

The cumulative demand for trained and skilled manpower in the area of Microbiology requires in depth functional knowledge of the subject through hands-on training to the students. The syllabus has been prepared keeping in view the unique requirements of B.Sc. Microbiology students under NEP 2020 Program. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline and reflects the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The degree of Bachelor of Science in Microbiology (As per NEP 2020) aims to introduce various aspects of Microbiology to the students. The program in Microbiology as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of Microbiology in particular. This will help the students to become critical and curious in their outlook. The basic courses are infused with current application in modern life sciences, and awareness on Microbiology and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Microbiology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create zeal and zest about Microbiology which will pave a newer path for the development of society. At the end of the course, the students are expected to have good working knowledge in the field of Microbiology. Students will surely have an urge to continue higher studies in Microbiology and contribute significantly in the development.

The present syllabi is restructured anticipating the future needs of Microbiology in research, **industry Sector with more emphasis on imparting hands-on skills**. The core thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further microbiology.

The present syllabus has been prepared to (i) accommodate the advanced topic on the Microbiology discipline, (ii) build the basic science knowledge at the level of first year of Microbiology and (iii) reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Microbiology. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

Duration of Lecture: 30 Lectures of 60 minutes. Each theory and practical course has to complete in 30 and 60 lectures, respectively of 60 min duration,

Each theory and practical course will be of 50 marks comprising of 20 marks internal (10 marks of 3 internal examinations) and 30 marks external examination. (Separate Exam Pattern sheet is attached here with)

Theory examination (30 marks) will be of one hour's duration for each theory course.

There shall be 5 questions each carrying equal marks (6 marks each).

Internal examination (20 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions. (Separate sheet is attached here with)

Practical Examination: Practical examination shall be conducted at the end of the semester.

Practical examination can be scheduled 10 am -12 pm/ 2 – 4 pm for 2 consecutive days) in case of microbiology practical's where incubation condition, allied aspect are essential.

There shall be 5 marks for laboratory log book and well written journal, 5 marks for viva-voce and minimum two experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be two expert and two examiners (external and internal) per batch for the practical examination

Note: It may change as per guideline from Examination Department

F.Y.Bc. Microbiology SEMESTER I Syllabus

Class	Course	Paper code	Paper name	Paper Type
F.Y.B.Sc. Microbiology	Major	MB-MJ-101	Microbial Diversity	Theory
	Major	MB-MJ-102	Microscopy and Basic Bacteriology	Theory
	Major	MB-MJP-103	Microbiology Practical paper I	Practical
	Minor	MB-MN-111	Fundamentals of Microbiology	Theory
	Minor	MB-MN-112	Microbiology Practical paper	Practical
	Skill EC	MB-SEC-104	Microbiological Analysis of Air, Water	Theory
	GE/OE	MB-OE-121	Microbes in day-to-day life	Theory
	AEC	AEC-131	English	Theory
	VEC	VEC-132	Environmental studies	Theory
	IKS	IKS-S-133	Indian Knowledge system	Theory
	CC	CC-141	NCC-I	Practical
	CC	CC-142	NSS-I	Practical
	CC	CC-143	Yoga-I	Practical
	CC	CC-144	Sport-I	Practical

F. Y. B. Sc. Microbiology SEMESTER II Syllabus

Class	Course	Paper code	Paper name	Paper Type
F.Y.B.Sc. Microbiology	Major	MB-MJ-151	Basic Biochemistry and Cytology	Theory
	Major	MB-MJ-152	Microbial Techniques	Theory
	Major	MB-MJP-153	Microbiology Practical paper II	Practical
	Minor	MB-MN-161	Basic Techniques in Microbiology	Theory
	Minor	MB-MN-162	Microbiology Practical paper	Practical
	Skill EC	MB-SEC-154	Concepts in Agricultural Microbiology	Theory
	Skill EC	MB-SEC-155	Practicals in Environmental and Agricultural Microbiology	Practical
	GE/OE	MB-OE-171	Health and Hygiene	Theory
	AEC	AEC-181	English	Theory
	VEC	VEC-182	Constitution of India	Theory
	CC	CC-191	NCC –II	Practical
	CC	CC-192	NSS –II	Practical
	CC	CC-193	Yoga-II	Practical
	CC	CC-194	Sport-II	Practical

DSC-1(Major)
MB-MJ-101:Microbial Diversity(Theory)

Course objective: To acquaint students with basic concepts of microbial diversity and how the microbe concept emerged

Learning outcome: After successful completion of this course students are expected to: Understand the basic microbial structure and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural similarities and differences among various physiological groups of bacteria/archaea Know general bacteriology and microbial aspects pertinent to bacteria, fungi and algae

How the subject emerge as new branch of biology

Learn ancient view about life continuity and concept of experiment Aware about historical developments and their applications as technology Cognizant about contribution of various pioneers of microbiology

Aware about diversity of microorganism Impact of microbes on earth atmosphere, health and technology development Recognize the scope of microbiology in all spheres of life and industrial sector Ways to classify the living system Understand the taxonomy (identification, binomial nomenclature, and Classifications schemes/keys) and comprehend the various approaches of microbial taxonomy.

Total Hours: 30

Credits: 2

Unit	Title	Topic Particular	Lectures
Unit I	Historical developments and Scope of Microbiology	<ul style="list-style-type: none"> • Concept of Spontaneous generation (abiogenesis) and biogenesis. • Concept of Microorganisms, prokaryotic and eukaryotic cell • Discovery of Microscope • Germ theory of Fermentation • Germ theory of Disease: Koch's and Revere's postulate • Development of pure culture, methods and preparation of Decimal Dilution, solidifying agent (potato, gelatine, agar agar) • Contribution(s) of: Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, 	10

		<p>Paul Ehrlich, Elie Metchnikoff, Edward Jenner in the development of microbiology</p> <ul style="list-style-type: none"> • Development and scope of microbiology in: Soil microbiology, Geomicrobiology, Microbial Ecology, Food and Agricultural Microbiology, Immunology, Molecular Biology, Industrial Microbiology, Pharmaceutical Microbiology, Chemotherapy and Health, Nano-technology and Bioinformatics, etc. 	
Unit II	Microbial Diversity	<ul style="list-style-type: none"> • Concept of microbial diversity, ecology and its importance and ecological interactions • General characteristics, Morphological features and Significance: • Viruses, Virion and Prions • Bacteria (Eubacteria, Rickettsia, Mycoplasma, Actinomycetes,) and wall less bacteria, Cyanobacteria, • Archae, • Algae, • Fungi and • Protozoa 	10
Unit III	Microbial Taxonomy	<ul style="list-style-type: none"> • Whitakers' Five Kingdom system • Carl Woese's three Domain system • Binomial Nomenclature and basic rules • Methods in microbial taxonomy: Cultural, Biochemical and molecular Characteristics, • Numerical taxonomy and Chemotaxonomy • Bergey's System of Bacterial Classification: structure, scheme and overview • Introduction to classification of algae, fungi and • Viruses 	10
	Suggested readings	<ol style="list-style-type: none"> 1. Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi 2. Talaro K and Chess B (2012) Foundations in Microbiology, 8th edition, The McGraw-Hill Companies, Inc., New York 3. Tortora, Funke, and Case (2010) Microbiology, 10th edition, Benjamin Cummings Inc., California. 4. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune 5. Frobisher M. Hinsdill, Crabtree, and Goodheart, (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co., USA 	

DSC-2 (Major)
MB-MJ-102:Microscopy and Basic Bacteriology (Theory)

Course objective: To complement the students with the basic knowledge about microbial growth and microscopy

Learning outcome: After successful completion of this course students are expected to:

- Demonstrate theory in microscopy and their handling techniques and staining procedures
- Know various Culture media and their applications and also understand various physical and chemical means of sterilization
- Know general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae
- Learn aseptic techniques and be able to perform routine culture handling tasks safely and effectively
- Comprehend the various methods for identification of unknown microorganisms
- Understand the modes of nutrition in microbial metabolism and able to classify the bacteria based on nutrition
- Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.

Total Hours: 30

Credits: 2

Unit	Title	Topic Particular	Lectures
Unit I	Microscopy and Staining	Basics of Microscopy: Magnification, Resolution, Numerical Aperture, Illumination system. Compound Microscope: Principle with Ray diagram, Working and Significance of Bright field and Dark filed Microscope Concept and types of aberrations, correction for aberrations Oil immersion objective Dyes and Stains (Acidic and Basic) Mordant and fixative Methods of staining: Simple (Monochrome and Negative) and Differential (Gram and Acid fast)	10
Unit II	Growth and Reproduction of Bacteria	Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding Mathematical expression of Growth, Growth rate and Generation time (Illustration with problem). Batch culture, typical growth curve of bacterial population and its significance, Diauxic growth Quantitative measurement of bacterial growth Synchronous and continuous culture growth with applications in microbiology	10

Unit III	Cultivation of Bacteria	<p>Physical parameters: pH, temperature, water activity, Oxygen</p> <p>Types of bacteria, mode of their adaptations with respect to</p> <p>Temperature requirement (psychrophiles, mesophiles, thermophiles, thermodurics, psychrotrophs),</p> <p>Salt/solute and water activity (halophiles, xerophiles, osmophilic),</p> <p>Oxygen requirement (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative</p>	10
		<p>anaerobe),</p> <p>Pressure (barophile).</p> <p>Nutrition: C, N, S, P, salts, growth factors etc. requirements with their significance.</p> <p>Media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factor)</p> <p>Types of media: complex, synthetic, natural, selective, differential, enriched media</p> <p>Enrichment culture technique</p> <p>Concept Auxotroph and Prototroph</p> <p>Classification of bacteria based on nutrition: Phototroph (Photo-autotroph, Photo-heterotroph) and Chemotroph (Chemo-autotroph, Chemoheterotroph)</p>	
	Suggested readings	<ol style="list-style-type: none"> 1. Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York 2. Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA. 3. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi 4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York 5. Tortora, Funke and Case (2010). Microbiology, 10th edition, Benjamin Cummings Inc, California. 6. Ulhas Pati, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune 7. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad 	

Semester- I
DSC-3 (Major)
MB-MJP-103: Microbiology Practical Paper - I

Course objective:

- To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory

- **Learning outcomes:** After successful completion of this course students are expected to:

Inculcate the ability to apply the process of science

- Analyse and interpret results from a variety of microbiological methods and apply these

methods to analogous situations.

- Develop ability to use quantitative reasoning to solve problems in microbiology
- Effectively communicate fundamental concepts of microbiology in written and oral format.
- Identify credible scientific sources and interpret and evaluate the information therein.
- Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures.
- Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes
- Prepare and view specimens using microscopy (bright field microscope).

Aware and train in aseptic handling of microbial specimens. Practice safe microbiology, using appropriate protective and emergency procedures.

Use appropriate microbiological and molecular lab equipment and methods. Document and report on experimental protocols, results and conclusions

Total Hours: 60

Credit-2

Serial No.	Title of Practical	Hours
1	Microbiology Good Laboratory Practices and Biosafety.	4
2	To study the principle, working and application of instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory	4
3	Acquainting basic microbiology tools: Cleaning and washing of Glassware, Wrapping the items prior to sterilization, Cotton Plugging, Aseptic handling (LAF/Bunsen burner), Inoculation of bacterial culture and inoculating needle, Microbial culture and biological waste Disposal	4
4	Demonstration and handling of Glasswares used in Microbiology Laboratories. (Pipettes, Petri Plate, Test Tube, Flasks etc.)	4
5	Use and Care of Compound Microscope with functions of each part	4
6	Study of fungi using temporary mounts and permanent slides (e.g. Rhizopus/ Penicillium/ Aspergillus/ Fusarium)	4
7	Study of Algae/BGA temporary mounts and permanent slides (e.g. Spirogyra /Anabena / Nostoc/ Cyanobacteria)	4
8	Study of the protozoans using temporary and	4

	permanent mounts (e.g. Amoeba/Entamoeba/ Paramecium /Plasmodium)	
9	Preparation of culture media for bacterialcultivation.(Nutrient broth and nutrient agar/ MacConkeys broth and MacConkes agar	4
10	Study of colony characteristics of different bacteria (e.g. Escherichia coli, Staphylococcus aurous, Actinomycetes)	4
11	Study of bacterial morphology using Monochrome staining	4
12	Study of morphological features of bacteria using Negative Staining	4
13	Study of Gram characteristics of bacteria using Gram's staining	4
14	Study of acid fast charactristics of bacteria using Acid fast staining (Nocardia spp/ Atypical mycobacteria)	4
Reference Books:	<ul style="list-style-type: none"> •Atlas, R. M. (1997) Principles of Microbiology, 2nd edition,WM.T.Brown Publishers, Dubuque, USA. •Cappucino J and Sherman N. (2010) Microbiology: A Laboratory Manual, 9th edition, Pearson Education Limited, New Delhi •Parija S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. •Dubey RC and Maheshwari DK (2004) Practical Microbiology,1st edition, S. Chand and Co., Delhi. •Harley, J. P. and Prescott L. M. (2002) Laboratory Exercises inMicrobiology, 5th edition, The McGraw-Hill Co., New York •Benson H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York •Aneja K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi. 	

Semester I
SEC- 1
MB-SEC-104 Microbiological Analysis of Air and Water

Course objective:

- To highlight the number and range of pathogens that may be found in air, water and soil.
- To introduce the concept and use of indicator bacteria specially in water quality monitoring
- To emphasize the value of *E. coli* and thermotolerant fecal coliforms as routine indicators

Learning outcome

- aware about the pollution, Water and air-borne diseases and their transmission, methods of determination of sanitary quality of water and sewage treatment methods employed in waste water treatment.
- appreciate the diversity of microorganisms and learn the abundance, distribution and significance of microorganism in the environment such as bioremediation and plant microbe interactions
- understand various biogeochemical cycles - microbes involved and biochemical mechanisms of Carbon, Nitrogen, Phosphorus cycles etc.

Total hours-30

Credit-2

Unit	Title	Topic Particular	Lectures
Unit I	Microbiological analysis of air	<ul style="list-style-type: none"> ● Concept of air Microbiology Aero-microbiology: ● Bio-aerosols, droplet nuclei, Air borne microbes, impact on human health and environmental, Significance in food, pharma industries, allergens, surgical operation theatres ● Techniques for microbial sampling of air from various sources, Aerosol sampling, fate of aerosols, inactivation by UV light and HEPA filter ● Assessment of air quality by solid, liquid impingement, Enumeration of microflora by different techniques. ● Air borne transmission of microbes, their diseases and preventive control measures 	15
Unit II	Water Microbiology	<ul style="list-style-type: none"> ● Water ecosystem: Fresh water (Ponds, Lakes, Stream); Marine water (Estuaries, mangroves, deep sea, hydrothermal vents, salt pans, Coral reef) ● Microflora of water ● Bacterial assessment of water and potability of water ● Indicator bacteria: <i>E. coli</i>, <i>Staphylococcus aureus</i>, <i>Clostridium perfringens</i>, MPN (Black, White), MPN index, IMViC test 	15

		<ul style="list-style-type: none"> ● Physiochemical characteristics of water: ● TSS, TDS, DO, BOD and COD ● Brief account of water borne diseases and their control measures 	
	<p>References</p>	<ol style="list-style-type: none"> 1. Clesceri L S., Greenberg, A. E, and Eaton A. D. (1998) Standard Methods for Examination of Water and Wastewater, 18th Edition, American Public Health Association, Washington. 2. Maier R.M., pepper, I.L. and Gerba, C.P. (2009) Environmental Microbiology, 2nd edn., Academic Press, NY 3. Salle, S.J. (1974) Fundamental Principals of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 4. SubbaRao, N.S. (1999) Soil Microbiology, 4th edn., Oxford and IBH Publ. Co., New Delhi 5. Coyne, M.S. (2001) Soil Microbiology: An Exploratory Approach, Delmar Thomson Learning 6. Alexander, M. (1977) Introduction to Soil Microbiology, John Wiley and sons Inc. New York 7. Burns, R.G. and Slater, J.H. (1982) Experimental Microbial Ecology, Blackwell Scientific Publ., Oxford 8. Atlas, R.M. and Bartha, R. (2000) Microbial Ecology, 4th edn., Benjamin/Cumming Science Publ., USA 9. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York. 10. Dubey, R.C. and Maheshwari D.K (2004) Practical Microbiology, S. Chand and Co. New Delhi. 11. Harley, J.P. and Prescott, L.M (1996) Laboratory Exercise in Microbiology, 3rd edition, WCB/McGraw Hill, London 	

Semester I
MIN- 1
MB-MN-111 Fundamentals of Microbiology (Theory)

Total hours-30

Credit-2

Unit	Title	Topic Particular	Lectures
Unit I	Scope of Microbiology and significance of microorganisms	<p>Development and scope of microbiology in:</p> <ul style="list-style-type: none"> • Soil microbiology, Geo microbiology, Microbial Ecology, • Food and Agricultural Microbiology, Immunology, • Molecular Biology, Industrial Microbiology, Pharmaceutical Microbiology, Chemotherapy and Health, Nano-technology and Bioinformatics, etc. <p>General characteristics, Morphological features and Significance of :</p> <ul style="list-style-type: none"> • Viruses, Virion and Prions • Bacteria (Eubacteria, Rickettsia • Mycoplasma, Actinomycetes) • Cyanobacteria • Archae • Algae • Fungi and Protozoa 	10
Unit II	Study of Prokaryotes.	<ul style="list-style-type: none"> • Prokaryotic Cell structure and functions . Morphology of prokaryotic cells: Size, shape and arrangement • Cell wall • Cell membrane: Fluid mosaic model • Components external to cell wall: Capsule, slime layer, flagella, pili, fimbriae • Cytoplasmic matrix: Ribosomes, Nucleoid, Inclusion bodies, Magnetosomes, Gas vesicles • Plasmids • Bacterial endospores and their formation 	10
Unit III	Microscopy & Staining	<p>Microscopy: History of microscopy, Optical spectrum, Simple and compound light microscope, Parts and functions of compound microscope Darkfield microscopy</p> <p>Staining procedures:</p> <ul style="list-style-type: none"> • Types of dyes and stains, fixatives, mordants, and decolourizes. • Simple Staining: Monochrome, Negative staining • Differential staining: Gram's Staining, Acid Fast Staining • Special staining: Capsule staining, Spores staining 	10

	Suggested readings	1. Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New Delhi 2. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar(2016). Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune 3. Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WBSaunders's Co. USA. 7. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad	
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Semester- I

Min-2

MB-MNP-112: Microbiology Practical Paper - I

Course objective:

- To introduce various microorganisms present in the ecosystem and acquaint with common equipment used in routine microbiology laboratory
- **Learning outcomes:** After successful completion of this course students are expected to:

Inculcate the ability to apply the process of science

- Analyse and interpret results from a variety of microbiological methods and apply these

methods to analogous situations.

- Develop ability to use quantitative reasoning to solve problems in microbiology
- Effectively communicate fundamental concepts of microbiology in written and oral format.
- Identify credible scientific sources and interpret and evaluate the information therein.
- Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures.
- Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes
- Prepare and view specimens using microscopy (bright field microscope).
- Aware and train in aseptic handling of microbial specimens. Practice safe microbiology, using

appropriate protective and emergency procedures.

- Use appropriate microbiological and molecular lab equipment and methods. Document and report on experimental protocols, results and conclusions

Total Hours: 60

Credit-2

Serial No.	Title of Practical	Hours
1	Microbiology Good Laboratory Practices and Biosafety.	4
2	To study the principle, working and application of instruments(biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory	4
3	Acquainting basic microbiology tools: Cleaning and washing of Glassware, Wrapping the items prior to sterilization, Cotton Plugging, Aseptic handling (LAF/Bunsen burner), Inoculation of bacterial culture and inoculating needle, Microbial culture and biological waste Disposal	4
4	Demonstration and handling of Glasswares used in Microbiology Laboratories. (Pipettes, Petri Plate, Test Tube, Flasks etc.)	4
5	Use and Care of Compound Microscope with functions of each part	4
6	Study of fungi using temporary mounts and permanent slides (e.g. Rhizopus/ Penicillium/ Aspergillus/ Fusarium)	4
7	Study of Algae/BGA temporary mounts and permanent slides (e.g. Spirogyra /Anabena / Nostoc/ Cyanobacteria)	4
8	Study of the protozoans using temporary and permanent mounts (e.g. Amoeba/Entamoeba/ Paramecium /Plasmodium)	4
9	Preparation of culture media for bacterial cultivation.(Nutrient broth and nutrient agar/ MacConkeys broth and MacConkes agar	4
10	Study of colony characteristics of different bacteria (e.g. Escherichia coli, Staphylococcus aureus, Actinomycetes)	4
11	Study of bacterial morphology using Monochrome staining	4
12	Study of morphological features of bacteria using Negative Staining	4
13	Study of Gram characteristics of bacteria using Gram's staining	4
14	Study of acid fast characteristics of bacteria using Acid fast staining (Nocardia spp/ Atypical mycobacteria)	4
Reference Books:	<ul style="list-style-type: none"> • Atlas, R. M. (1997) Principles of Microbiology, 2nd edition, W.M.T. Brown Publishers, Dubuque, USA. • Cappucino J and Sherman N. (2010) Microbiology: A Laboratory Manual, 9th edition, Pearson Education Limited, New Delhi • Parija S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. • Dubey RC and Maheshwari DK (2004) Practical Microbiology, 1st edition, S. Chand and Co., Delhi. • Harley, J. P. and Prescott L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Co., New York • Benson H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York • Aneja K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi. 	

B.Sc. I SEMESTER – I
Open/General Elective (OE/GE) Course-1
MB-OE-121 Title: Microorganisms in Day-to-day life
(Credit-2, No. of lectures -30)

Learning outcomes:

1. Students will be able to understand basic knowledge about microorganisms.
2. Students will understand role of microbes in day-to-day life.
3. Students will aware about useful and harmful microbes.
4. They will able to apply knowledge of microorganisms in their daily life.

Credits(Total Credits 2)	SEMESTER – I OE/GE Course – I Microorganisms in Day-to-day life	No. of hours per unit
Unit -I	Basic introduction to Microorganisms.	10
	1.1 Concept of Microbiology 1.2 Concept of Microorganisms and their structures. (Virus, Bacteria, Fungi, Algae, Protozoa) 1.3 Microscope -tool to observe microbes 1.4 Habitats of Microorganisms.	
Unit -II	Uses of microbes in day-to-day life.	10
	2.1 Concept of friendly microorganisms 2.2 Involvement of microbes in various processes. a) Curd making b) Idli making c) Preparation of Vaccines d) Preparation of Antibiotics e) Biodegradation f) Biofertilizers	
Unit- III	Harmful Microorganisms involved in-	10
	3.1 Food spoilage 3.2 Water pollution 3.3 Diseases – i) Plant diseases ii) Animal diseases	
Suggested Readings	1. Tortora GJ, Funke BR and Case CL (2008). Microbiology: AnIntroduction, 9th edition, Pearson Education, New Delhi 2. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar(2016). Foundations in Microbiology, 9th edition, Nirali Prakashan,Pune 3. Frazier, W. C, Westhoff, D C., (1988), Food	

	<p>Microbiology, Tata McGraw Hill, New Delhi.</p> <p>4. James M. Jay, Martin J. Loessner, David A. (2012), Modern Food Microbiology, 7th Edition (Food Science Texts Series).</p> <p>5. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).</p> <p>6. Ananthnarayan, P., Paniker, C. K. J., (1990), Textbook of Micro-biology, Orient Longman, Madras.</p>	
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SEMESTER-II

DSC-4 (Major)

MB-MJ-151

Basic Biochemistry and Cytology (Theory)

Course objective: To acquaint students with basic concepts in biochemistry and familiarize with cellular architecture

Learning outcome: After successful completion of this course students are expected to:

Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also Understand the structural architecture and differences among bacteria/archaea

Know basic knowledge pertinent to cell biomolecules as such.

Total Hours: 30

Credits: 2

Unit	Title	Topic Particulars	Lectures
Unit I	Biomolecules	Proteins and amino acids <ul style="list-style-type: none">• Concept, general structure and properties of amino acids, Classification of amino acids• Classification of protein based on shape, composition, solubility and functions• Chemical bonds in protein structure (Covalent, hydrogen, hydrophobic, electrostatic, van der Waal's forces)• Structural levels of protein organization: Primary, secondary, tertiary and quaternary Protein denaturation Carbohydrates: <ul style="list-style-type: none">• Concept, properties, Classification of carbohydrates• Structure of common carbohydrates (Glucose, lactose, starch and peptidoglycan) and• biological significance Lipids: <p>Concept, function and classification of lipid, fatty acids (Definition nomenclature, saturated and unsaturated)</p> <ul style="list-style-type: none">• Structure and biological significance of phospholipids and sterols. Nucleic acids <ul style="list-style-type: none">• Concept and structural constituents of Nucleic acids (nucleoside, nucleotide, polynucleotide,	10

		<p>purines and pyrimidines</p> <ul style="list-style-type: none"> • DNA: Structure (Watson and Crick Model), Chargaff's Rule • RNA: Structure and significance of : mRNA, tRNA and rRNA, hnRNA • Forms of DNA: A, B and Z (structure and differences) and unusual structures of DNA 	
Unit II	Study of Prokaryotes	<ul style="list-style-type: none"> • Prokaryotic Cell structure and functions . Morphology of prokaryotic cells: Size, shape and arrangement • Cell wall • Cell membrane: Fluid mosaic model • Components external to cell wall: Capsule, slime layer, flagella, pili, fimbriae • Cytoplasmic matrix: Ribosomes, Nucleoid, Inclusion bodies, Magnetosomes, Gas vesicles • Plasmids • Bacterial endospores and their formation 	10
Unit III	Anatomy of Eukaryotic cells	<p>structure of Fungal, Algal and Protozoal Cell</p> <p>Structure, Function and Chemical composition of:</p> <ul style="list-style-type: none"> • Flagella, • Cell wall, • Nucleus, • Mitochondria, • Chloroplast, • Golgi bodies, • Ribosomes • Lysosomes 	10
	Suggested Readings	<ol style="list-style-type: none"> 1. Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey. 2. Madigan, MT and Martinko, JM. (2014). Brock Biology of Microorganisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey. 3. Stanier, RY, Ingraham, JL, Wheelis, ML and Painter, PR. (2005) General Microbiology, 5th edition, McMillan, London 4. Salle, S.J. (1974) Fundamental Principles of Bacteriology, 2nd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 5. Willey, JM, Sherwood, LM, and Woolverton, CJ. (2013) Prescott's Microbiology, 9th edition, McGraw Hill Higher Education, New Delhi. <p>Patil, UK., Kulkarni, JS., Chaudhari, AB. and Chincholkar, SB. (2016) Foundation in Microbiology, 9th edition, Nirali Prakashan, Pune</p>	

Semester -II
DSC-5 (Major)
MB-MJ-152:
Microbial Techniques(Theory)

Course objective: To complement the students with cultivation and control of microbes with physical and chemical approach

Learning outcome: After successful completion of this course students are expected to:

- ▣ Know general bacteriology and introduce microbial techniques for isolation of pure cultures of bacteria, fungi, algae and virus
- ▣ Demonstrate theory and practical skills in handling microbial culture
- ▣ Know various bacteria based on nutritional needs and also understand various physical and chemical means of sterilization
- ▣ Discern knowledge about sterility assessment of sterilizing agents

Total Hours: 30

Credits: 2

Unit	Title	Topic Particular	Lectures
Unit I	Isolation and Cultivation of Microbes	<p style="text-align: center;">culture technique for bacteria: Streak plate, Pour plate, Spread plate, agar droplet, Mile's and Misra's Method</p> <ul style="list-style-type: none"> ▣ Cultivation of anaerobes: Roll tube method, anaerobic jar and anaerobic cabinet/chamber ▣ Enrichment methods for bacteria (photoautotroph, photoheterotroph, chemoautotroph, chemoheterotroph) ▣ Cultivation of fungi, Blue green algae, algae ▣ Cultivation of animal and plant viruses (living animals, embryonated eggs and cell line cultures). ▣ Cultivation of bacteriophage 	10
Unit II	Control of Microbes	<p style="text-align: center;">- necessity and application</p> <ul style="list-style-type: none"> ▣ Disinfection: Concept of disinfectant and characters of an ideal disinfectant, Phenol coefficient ▣ Concept of: Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis. rization (HTST, UHT) ▣ Control of microbes by Ultraviolet light, gamma rays, Low Temperature, Desiccation, Osmotic pressure, Surface tension,, chemical and biological. Mode of action and applications of Phenol and Phenolic compounds, Alcohols, Halogens, Heavy metals and their compounds, Dyes, Detergents, Quaternary ammonium compounds, H₂O₂. 	10
Unit III	Control of microbes by sterilization	<ul style="list-style-type: none"> ▣ Concept of sterilization and parameters, TDT, TDR (Hot air oven, Incineration), Moist heat (Autoclave, Tyndallisation) and Radiation- (X-rays, Gamma rays and UV rays) ▣ Sterilization by Filtration: Membrane filter, LAF (HEPA), Nucleopore filters ▣ Chemical methods: Ethylene oxide and 	10

		Formaldehyde Indicators of Sterilization: Chemical and Biological system □ Validation of sterility in autoclave and LAF	
	Suggested readings	1. Pawar, CB, and Daginawala, HF. (1998) General Microbiology, Vol. I and II, 1st edition, Himalaya Publishing House, Mumbai. 2. Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey. 3. Madigan, MT and Martinko, JM. (2014) Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey.	

Semester II
DSC-6 (Major)
MB-MJP-153 Microbiology Practical Paper -II

Total hours- 60

Credit- 2

Serial No.	Title of Practical	Hours
1	Preparation of Bacterial Suspension from well isolated colony, and its Microscopic examination by staining.	4
2	Isolation of bacteria by Streak Plate technique	
3	Isolation of bacteria by spread plate technique from water sample	4
4	Determination of Colony Forming Unit (cfu) by pour plate method from soil/water sample	4
5	Effect of heavy metal(s) on growth of bacteria and demonstration of oligodynamic action	4
6	Effect of pH /Temperature on growth of bacteria	
7	Study micro-flora of the air and water on nutrient agar plates	4
8	Slide culture technique for fungi	4
9	Preparation of standard solutions (Normal/ Molar/ Percentage)	4
10	Demonstration of motility by hanging drop and swarming growth	4
11	Demonstration of bacterial growth by spectrophotometer	4
12	Cultivation of anaerobic bacteria by anaerobic jar method.	4
13	Validation of Autoclave	4
14	Sterilization of heat sensitive material by membrane filtration	4
	1. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis. 2. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India 3. Parija, S.C. (2005) Text Book of Practical	

	<p>Microbiology, 1st edition, Ahuja Publishing House, New Delhi.</p> <p>4. Harley, J. P. and Prescott, L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Companies, London.</p> <p>5. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New Delhi</p> <p>6. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.</p>	
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SEC -2

MB-SEC-154 Concepts in Agricultural Microbiology

Course objective:

- To aware the students to the adverse effects of plant production and protection of chemicals on the biotic and abiotic components of environment.
- To familiarize students with the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Learning outcome: After successful completion of this course students are expected to

1. Completion of the course will give an overview of relevant use of microbial biofertilizers and biopesticides.
2. The students will become familiar with the vast reserves of available microbial biodiversity that provide abundant opportunities to harness the ability of micro - organisms and their chemical constituents
3. To sustainably minimize damage from pests or increase agricultural productivity and production.

Unit	Title	Topic Particular	Lectures
Unit I	Biofertilizers	<p>Biofertilizers</p> <ol style="list-style-type: none"> 1. General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers 2. Screening and isolation of symbiotic and non-symbiotic nitrogen fixing bacteria for production of biofertilizer 3. Rhizobium: Isolation, characteristics, types, inoculum production and field application, legume/pulses plants 4. <i>Frankia</i>: Isolation, characteristics, <i>Alder</i>, <i>Casurina</i> plants, non-leguminous crop symbiosis 5. Cyanobacteria, <i>Azolla</i>: Isolation, characterization and role in crop cultivation 6. Non-symbiotic nitrogen fixing bacteria: <i>Azospirillum</i>, <i>Azotobacter</i>: isolation, characteristics, mass inoculum production 	20

		<p>and field application</p> <p>7. PGPR, phosphate solubilizing bacteria and Mycorrhizal biofertilizers: isolation, characteristics, mass inoculum production and field application</p> <p>8. Application of biofertilizers: Liquid, and preparation of carrier-based formulation, Seed bacterization, soil broadcasting</p> <p>9. Bio-efficacy and quality parameters</p>	
Unit II	Biopesticides	<p>1. General account of microbes used as biopesticides / bioinsecticides and their advantages over synthetic pesticides</p> <p>2. Screening and isolation of bioagents <i>Bacillus thuringiensis</i>, <i>Pseudomonas ugftdpmp</i>, mass production, formulation, Field applications</p> <p>3. NPV and <i>Beauveria bassiana</i>: Action, Cultivation and field applications</p> <p>4. Advantages and disadvantages of biopesticides</p> <p>5. Bio-efficacy and quality parameters assessment</p>	10
	References	<p>Kannaiyan, S. (2003) Biotechnology of Biofertilizers, CHIPS, Texas.</p> <p>2. Rai M. K. (2005) Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.</p> <p>3. Reddy, S.M. et. al. (2002) Bioinoculants for sustainable Agriculture and Forestry, Scientific Publishers, New Delhi</p> <p>4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH Publishing co. Pvt. Ltd., New Delhi.</p> <p>5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG</p> <p>6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH Publication, New Delhi</p> <p>●</p>	

SEC-3

MB-SEC-155 Practicals on Environment and Agri-Microbiology

Serial No.	Title of Practical	Hours
1	Terms ,concept, rules and regulations followed in biopesticide laboratory.	4
2	Demonstration of Koch's postulates in plants	
3	Isolation and identification of Rhizobium sp. from root nodules.	4

4	Isolation of phosphate solubilizing microorganism from rhizosphere soil.	4
5	Evaluation of efficacy of biofertilizer (Azotobacter/ Rhizobium/ Trichoderma sp.) by pot assay.	4
6	Determine pH of given soil sample	
7	Isolation of phosphate solubilizing microorganism from rhizosphere soil	4
8	Determine electrical conductivity of given sample.	4
9	Isolation and identification of Azotobacter from rhizosphere sample	4
10	Isolation of Cyanobacteria.	4
Suggested Readings	<p>1. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.</p> <p>2. . Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.</p> <p>Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi</p>	

Semester -II
MIN-3
MB-MN-161 Basic Techniques in Microbiology (Theory)

Total hours -30

Credit-2

Unit	Title	Topic Particular	Lectures
Unit I	Cultivation of Microorganisms	<ul style="list-style-type: none"> • Pure culture techniques for bacteria- Streak plate, Pour plate, Spread plate, agar droplet, Cultivation of anaerobes – Roll tube method, anaerobic jar and anaerobic cabinet/chamber • Cultivation of Fungi, Blue-green algae and Algae • Cultivation of Animal and Plant viruses (Living animals, embryonated eggs and cell line cultures) • Cultivation of Bacteriophage • Types of bacteria, mode of their adaptations with respect to- <ul style="list-style-type: none"> • Temperature requirement (psychrophiles, mesophiles, thermophiles thermodurics, psychrotrophs) • Salt/solute and water activity (halophiles, xerophiles, osmophilic) • Oxygen requirement (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe) • Pressure (barophile). 	10
Unit II	Growth and Reproduction in Bacteria	<p>Bacterial growth:</p> <ul style="list-style-type: none"> • Concept of Growth and Reproduction, Mechanism of binary fission, Fragmentation, budding • Growth curve and Generation time • Diauxic growth • Measurement of bacterial growth- Methods of enumeration: <ol style="list-style-type: none"> 1. Microscopic methods (Direct microscopic count, counting cells using improved Neubauer, Petroff-Hausser's chamber) Plate counts (Total viable count) 2. Turbidometric methods (including Nephelometry) , Estimation of biomass (Dry mass, Packed cell volume) , Chemical methods (Cell carbon and nitrogen estimation) • Factors affecting bacterial growth [pH, Temperature, Solute Concentration (Salt and Sugar)] and Heavy metals 	10
Unit III	Control of Microbes	Control of microbes by Disinfection and Sterilization	10

		<ul style="list-style-type: none"> • Disinfection: Concept of disinfectant and characters of an ideal disinfectant • Concept of: Antiseptic, Sanitizer, Germicide, Antibiotics, Microbiocide, Microbiostasis • Pasteurization (HTST, UHT) • Concept of sterilization and parameters, TDT, TDP, TDR • Physical methods: Dry heat (Hot air oven, Incineration), Moist heat (Autoclave, Tyndallisation) and Radiation- (X-rays, Gamma rays and UV rays) • Sterilization by Filtration: Membrane filter, LAF (HEPA), Nucleopore filters • Chemical methods: Ethylene oxide and Formaldehyde 	
	<p>Suggested readings</p>	<ol style="list-style-type: none"> 1. Pawar, CB, and Dagainawala, HF. (1998) General Microbiology, Vol. I and II, 1st edition, Himalaya Publishing House, Mumbai. 2. Black, JG. (2008) Microbiology: Principles and Explorations, 7th edition, Prentice Hall, New Jersey. 3. Madigan, MT and Martinko, JM. (2014) Brock Biology of Micro-organisms, 14th edition, Parker J. Prentice Hall International, Inc., New Jersey. 4. Frobisher, M. Hinsdill, R., Crabtree, KT., and Goodheart, CR. (1974) Fundamentals of Microbiology, 9th edition, WB Saunder's Co., Many, USA. 5. Pelczar MJ, Chan, ECS and Krieg, NR. (1993) Microbiology. 5th edition. McGraw Hill Book Company, Penguin, USA 6. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016) Foundations in Microbiology, 9th edition, Nirali Prakashan, Pune. 7. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad 	

Semester II
MIN- 4
MB-MNP-162
Microbiology Practical Paper

Total hours- 60

Credit- 2

Serial No.	Title of Practical	Hours
1	Preparation of Bacterial Suspension from well isolated colony, and its Microscopic examination by staining.	4
2	Isolation of bacteria by Streak Plate technique	
3	Isolation of bacteria by spread plate technique from water sample	4
4	Determination of Colony Forming Unit (cfu) by pour plate method from soil/water sample	4
5	Effect of heavy metal(s) on growth of bacteria and demonstration of oligodynamic action	4
6	Effect of pH /Temperature on growth of bacteria	
7	Study micro-flora of the air and water on nutrient agar plates	4
8	Slide culture technique for fungi	4
9	Preparation of standard solutions (Normal/ Molar/ Percentage)	4
10	Demonstration of motility by hanging drop and swarming growth	4
11	Demonstration of bacterial growth by spectrophotometer	4
12	Cultivation of anaerobic bacteria by anaerobic jar method.	4
13	Validation of Autoclave	4
14	Sterilization of heat sensitive material by membrane filtration	4
	1. Atlas R. M. (2010). Handbook of Microbiological Media. Ukraine: Taylor and Francis. 2. Dubey R. C. and Maheshwari D. K. (2012). Practical Microbiology. S. Chand and Company Limited, New Delhi, India 3. Parija, S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. 4. Harley, J. P. and Prescott, L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Companies, London. 5. Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New Delhi 6. Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.	

B.Sc. I SEMESTER – II
Open/General Elective (OE/GE) Course-2
MB-OE-171
Title: Health and Hygiene
(Credit-2, No. of lectures -30)

Learning outcomes-

1. Students will be able to understand why good personal hygiene is important.
2. Students can be able to provide proper first aid to self, family members, and others in emergencies.
3. They will be able to be aware of people about hygienic practices, benefits and demerits.

Credits (Total Credits 2)	SEMESTER – II OE/GE Course – II Health and hygiene	No. of hours per unit
Unit -I	Health	
	1.1 Definition of Health.Factors affecting on health 1.2 Features of healthy human being 1.3 How to maintain healthy environment? 1.4 Health awareness programmes by WHO, slogans	10
Unit- II	Hygiene	10
	2.1 Importance of cleanliness 2.2 Concept and Types of Hygiene – Public and Personal 2.3 Hygiene Practices 2.3 Consequences of poor Hygiene	
Unit-III	First Aid	10
	3.1 Objectives of First Aid 3.2 First Aid Kit 3.3 First Aid- Do's and Don'ts in followings – Burns, Frost bite, Bleeding, Electric shock, SnakeBite, Heat stroke, Dehydration, Dog bite	
Suggested readings	1.Textbook by Dr. Pratibha Lakshmi, Health and Hygiene, (First Aid)Vani's publication 2. Dr. Sudhir R. Wagh, Dr. V.B. Kakade Public health and Hygiene,, Success Publication 3.Dr. A.P.Ekhande, Dr. R.M.Chaudhari, Public Health and Hygiene ,Prashant publication. 4. Textbook on First Aid and emergency nursing, Panchali Pal, Ananda publication	