Format of question papers for semester end examination

1. **For 60 Marks (Theory papers)**

Sl.No	Question to be answered	Out of	Marks of each question	Total Marks
1.	06	08	01	1X6=6
2.	05	07	06	6X5=30
3.	02	04	12	12X2=24
			Total	60

2. **For 20 Marks (Practical Papers)**

Sl.No	Question to be answered	Marks of each question	Question type	Total Marks
1.	01	08	Practical	8X1=8
2.	01	05	Parctical	5X1=5
3.	01	05	Viva	5X1=5
4.	01	02	Lab recods	2X1=2
All questions are compulsory			Total	20

MAJOR

Paper: 3 (MAJOR) Paper code: MICRMAJ203 Paper level: 100
BACTERIOLOGY
(Paper type: Theory)
Semester II
Lecture Hours: 45 h Marks: 60 CREDITS: 3

Unit 1 Cell organization **No. of Hours: 20 h**

Cell size, shape and arrangement, Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. glycocalyx, capsule, flagella, endoflagella, fimbriae and pili Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation and staining.

Unit 2 Growth and nutrition **No. of Hours: 5h**

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media *Physical methods of microbial control*: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation *Chemical methods of microbial control*: disinfectants, types and mode of action

Unit 3 Reproduction in Bacteria **No. of Hours: 5h**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 4 Bacterial Systematics **No. of Hours: 5 h**

Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing. Differences between eubacteria and archaebacteria

Unit 5 Important archaeal and eubacterial groups **No. of Hours: 10 h**

Archaebacteria: General characteristics, Overview to Nanoarchaeota, Crenarchaeota ,Euryarchaeota, thermophiles and Halophiles

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:
General characteristics with suitable examples of Alpha proteobacteria (*Zymomonas mobilis*), Beta proteobacteria (*Neiserria meningitides*) and Gamma proteobacteria (*Escherichia.coli*)

Gram Positive:
Low G+ C (Firmicutes): General characteristics, examples (*Bacillus subtilis*) (High G+C (Actinobacteria): General characteristic examples (*Streptomyces* sp.)

Paper: 3 (MAJOR) Paper code: MICRMAJ203 Paper level: 100
BACTERIOLOGY
(Paper type: Practical)
Semester II
Total Hour: 30h Marks:20 CREDITS: 1

1. Preparation, isolation and enumeration of microorganism in Simon citrate agar (Synthetic media) using standard plate count method.
2. Preparation, isolation and enumeration of microorganism in McConkey agar (Complex media) using standard plate count method.
3. Preparation, isolation and enumeration of microorganism in EMB agar (Complex media) using standard plate count method.
4. Simple staining
5. Negative staining
6. Gram's staining
7. Capsule staining
8. Endospore staining.
9. Motility by hanging drop method.
10. Autoclaving and assessment of sterility.
11. Phenol coefficient.

SUGGESTED READINGS

1. Atlas RM. (1997).Principles of Microbiology.2nd edition.WM.T.Brown Publishers.

2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall

3. Madigan MT, and Martinko JM.(2014). Brock Biology of Micro-organisms.14th edition.Parker J.Prentice Hall International, Inc.

4. Pelczar Jr MJ, Chan ECS, and Krieg NR.(2004). Microbiology.5th edition Tata McGraw Hill.

5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht

6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.

7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton CJ.(2013). Prescott's Microbiology.9th edition. McGraw Hill Higher Education.

9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

Paper: 4 (MAJOR) Paper code: MICRMAJ204 Paper level: 100
MICROBES IN SUSTAINABLE AGRICULTURE
AND DEVELOPMENT
(Paper type: Theory)
Semester II
Lecture Hours: 45 h Marks: 60 CREDITS: 3

Unit 1 Biofertilizers **No. of Hours: 15 h**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.
Symbiotic N_2 fixers: Biological pathway, *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, General characteristic, Heterocyst and its function, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Cropresponse, field application.
Indole acetic acid (IAA) producer isolation, biological pathway, characteristics, inoculam production and field application

Unit 2 Non - Symbiotic Nitrogen Fixers **No. of Hours: 5 h**

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Unit 3 Phosphate Solubilizers **No. of Hours: 5 h**

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field Application

Unit 4 Mycorrhizal Biofertilizers **No. of Hours: 5 h**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculumproduction of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Microbial Control of Soil Borne Plant Pathogens **No of Hours: 6 h**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit 6 Secondary Agriculture Biotechnology **No of Hours: 5h**

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Unit 7 GM crops **No of Hours: 4h**

Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

Paper: 4 (MAJOR) Paper code: MICRMAJ204 Paper level: 100
MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT
(Paper type: Practical)
Semester II
Total Hour: 30 h Marks: 20 CREDITS: 1

1. Isolation of N2 fixers from rhizospheric soil using Asbhy's N_2 free agar medium.
2. Quantification of fixed N_2 in the form of NH_3 using Nessler's reagent.
3. Isolation of phosphate solubilizer using Pikovskaya's Agar and quantification of soluble phosphorus.
4. Isolation of IAA producer and quantification of IAA using Salkowski reagent.
5. Isolation of Cyanobacteria using BG11 media.
6. Liquid formulation of biofertilizer (N2 fixer, phosphate solubilizer, IAA producer) according to BIS standard and its application in seed germination.
7. Isolation of cellulase producing bacteria from soil.

Suggested Readings

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. New Delhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

MINOR

Paper: 2 (MINOR) Paper code: MICRMIN202 Paper level: 100
BACTERIAL MORPHOLOGY AND GROWTH
(Paper type: Theory)
Semester II
Lecture Hours: 45 h Marks: 60 CREDITS: 3

Unit 1 Cell organization **No. of Hours: 20 h**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2 Microbial Control **No. of Hours: 10 h**

Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation *Chemical methods of microbial control*: disinfectants, types and mode of action

Unit 3 Reproduction in Bacteria **No. of Hours: 5 h**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 4 Important archaeal and eubacterial groups **No. of Hours: 10h**

General characteristics and Morphology, metabolism, ecological significance and economic importance of thermophiles and Halophiles, actinobacteria, cyanobacteria

Paper: 2 (MINOR) Paper code: MICRMIN202 Paper level: 100
BACTERIAL MORPHOLOGY AND GROWTH
(Paper type: Practical)
Semester II
Lecture Hours: 30 h Marks: 20 CREDITS: 1

1. Simple staining
2. Negative staining
3. Gram's staining
4. Capsule staining
5. Endospore staining.
6. Autoclaving and assessment of sterility.

7. Phenol coefficient
8. Motility by hanging drop method.

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McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.
Pearson
Education Limited

Inter Disciplinary (IDC) Course

Life Science Group 2
Paper: 1 (IDC) Paper Code: LSC2IDC203 Paper Level: 100
BASIC MICROBIOLOGY
(Paper type: Theory)
(Semester: II)
Lecture Hours: 30 h Marks: 40 Credits:2

Unit 1 History of Development of Microbiology **No. of Hour: 4 h**

Development of microbiology as a discipline, Spontaneous generation*vs.* biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming

Unit 2 Diversity of Microbial World **No. of Hour: 8 h**

Whittaker's five kingdom classification system, General characteristics of different groups: Viruses, Bacteria, Algae, Fungi, Protozoa, Archaebacteria

Unit 3 Cell organization **No. of Hours: 10 h**

Cell size, shape and arrangement, flagella, Cell-wall: Composition and structure of Gram-positive and Gram-negative cell walls, Gram staining mechanisms. Cell Membrane: Structure, function and chemical composition of bacterial cell membranes. Cytoplasm: Ribosomes, nucleoid, plasmids. Endospore: Structure.

Unit 4 Microbial Control **No. of Hours: 5 h**

Physical methods of microbial control: heat, low temperature, filtration, desiccation, radiation Chemical methods of microbial control: disinfectants, types and mode of action

Unit 5 Reproduction in Bacteria **No. of Hours: 3 h**

Phases of growth, calculation of generation time and specific growth rate

Life Science Group 2
Paper: 1 (IDC) Paper Code: LSC2IDC203 Paper Level: 100
BASIC MICROBIOLOGY
(Paper type: Tutorial)
(Semester: II)
Lecture Hours: 15 h Marks: 20 Credits:1

Evaluation of the students will be done as suggested in the FYUGP, NBU regulation 2024-25.

SUGGESTED READINGS

1. Atlas RM. (1997).Principles of Microbiology.2nd edition.WM.T.Brown Publishers.
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