

B.Sc. in Microbiology Syllabus, NBU

B.Sc. in Microbiology Syllabus for 1st Year (Semester I & Semester II) (FYUGP Regulation 2022) University of North Bengal

**B.Sc. Syllabus in Microbiology according to the new curriculum and credit framework 2022,
University of North Bengal**

UG Syllabus scheme in microbiology for 1st year

| Course Component | No. of Course | Credit distribution of each paper | | Total credit |
|---|----------------------|--|------------------|---------------------|
| | | Theory | Practical | |
| Major Course (MAJ) | 2 | 3 | 1 | 2x4=8 |
| Minor Course (MIN) | 2 | 3 | 1 | 2x4=8 |
| Multidisciplinary Course (MDC) | 2 | 3 | 0 | 2x3=6 |
| Ability Enhancement Course (AEC) | 2 | 2 | 0 | 2x2=4 |
| Skill Enhancement Course (SEC) | 2 | 2 | 1 | 2x3=6 |
| Value Added Course (VAC) | 2 | 4 | 0 | 2x4=8 |
| | | | | 40 |

B.Sc. in Microbiology Syllabus, NBU

Paper: MAJOR Paper code: UMICMAJ11001 Paper level: 100
INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY
(Paper type: THEORY)

Semester: I

Lecture Hours: 45 h Marks: 40 Credits: 3

Unit 1 History of Development of Microbiology

No. of Hour: 10 h

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky with reference to chemoautotrophy, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit 2 Diversity of Microbial World

No. of Hour: 30 h

General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Bacteria

General characteristics of bacteria, Size, Shape and arrangement

• Algae

General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles.

• Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

• Protozoa

General characteristics with special reference to *Amoeba*, *Plasmodium*

Unit 3 Bacteriological techniques

No. of Hour: 5 h

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-

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culturable bacteria. Microbiological media: Nutrient Agar and Potato Dextrose Agar.

Paper: MAJOR Paper code: UMICMAJ11001 Paper level: 100

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

(Paper type: Practical)

Semester: I

Total Hour:30h Marks: 20 Credits: 1

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, Autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the Microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Detection of microflora in the environment by exposing nutrient agar Plates to air.
8. Study of *Rhizopus*, *Aspergillus* using scotch tape method
9. Study of the following protozoans using permanent mounts: *Amoeba*, *Plasmodium*
10. Preservation of bacterial cultures by various techniques.
11. Estimation of CFU count by spread plate method/pour plate method.
12. Isolation of pure cultures of bacteria by streaking method.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

B.Sc. in Microbiology Syllabus, NBU

Paper: MINOR Paper code: UMICMIN10001 Paper level: 100

MICROBIAL DIVERSITY AND BACTERIOLOGY

(Paper type: THEORY)

Semester: I/II

Lecture Hours: 45 h Marks: 40 Credits: 3

Unit 1 History of Development of Microbiology

No. of Hours: 10 h

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit 2 Microscopy

No. Of Hours: 5 h

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 3 Diversity of Microbial World

No. of Hours: 5 h

General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit 4 Systems of classification

No. Of Hours: 5 h

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: evolutionary chronometers, rRNA oligonucleotide sequencing. Differences between eubacteria and archaebacteria.

Unit 5 Bacteriological techniques

No. Of Hours: 5 h

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures. Culture media: complex media, synthetic media, selective media and differential media.

Unit 6 Cell organization

No. Of Hours: 10 h

Cell size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls,

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Archaeobacterial cell wall, 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, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation and staining.

Unit 7 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

Paper: MINOR Paper code: UMICMIN10001 Paper level: 100

MICROBIAL DIVERSITY AND BACTERIOLOGY

(Paper type: Practical)

Semester: I/II

Total Hour: 30h Marks : 20 Credits: 1

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, Autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the Microbiology laboratory.
3. Preparation of different media and isolation of microorganism in the preaperd media: synthetic media simon citrate agar, Complex media-McConkey agar, EMB agar.
4. Sterilization of medium using Autoclave and assessment for sterility.
5. Study of *Rhizopus* using scotch tape method
6. Preservation of bacterial cultures by various techniques.
7. Estimation of CFU count by spread plate method/pour plate method.
8. Isolation of pure cultures of bacteria by streaking method.
9. Gram staining
10. Simple staining

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

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3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

**Paper: SEC Paper code: UMICSEC11001 Paper level: 100
BIOTECHNIQUES AND BIOSTATISTICS**

(Paper Type: Theory)

Semester: I

Lecture Hours: 30 h Marks: 40 Credits: 2

A. BIOTECHNIQUES

Unit 1 Microscopy

No. of Hours: 6 h

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2 Chromatography

No. Of Hours: 6 h

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC

Unit 3 Spectrophotometry

No. of Hours: 2h

Lamberts Beers Law; Working Principle of UV and visible spectroscopy.

Unit 4 Centrifugation

No. Of Hours: 2 h

Sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

B. BIOSTATISTICS

No. Of Hours: 14 h

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Classification of data; Measures of central tendency (Mean, median and mode from grouped and ungrouped data); Measures of dispersion (Range, Standard deviation, mean deviation, standard error and coefficient of variation); skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Correlation and Regression. Emphasis on examples from Biological Sciences; Sampling distribution; Concept of Sample and population, Testing of Hypothesis, Null and alternative hypothesis, Type1 and Type2 error, critical regions, Level of Significance and Degree of Freedom, Small sample test based on t-test (Fisher t test and Student t test), standard error of mean, confidence limits of mean, Z test, Chi² square test (Goodness of fit test).

**Paper: SEC Paper code: UMICSEC11001 Paper level: 100
BIOTECHNIQUES AND BIOSTATISTICS**

(Paper Type: Practical)

Semester: I

Total Hour:30h Marks:20 Credits: 1

1. Separation of mixtures (Amino acids/carbohydrate) by paper / thin layer chromatography.
2. Demonstration of column packing in any form of column chromatography.
3. Separation of protein mixtures by ion exchange chromatography.
4. Determination of λ_{max} for an unknown sample and calculation of extinction coefficient.
5. Separation of components of a given mixture using a laboratory scale centrifuge.
6. Calibration of microscope by stage and ocular micrometer.
7. Mean, Median and Mode from grouped and ungrouped experimental data sets.
8. Range, Standard deviation, mean deviation, Standard error and coefficient of variation of experimental data sets.
9. Skewness and Kurtosis of experimental dataset.
10. Correlation and regression analysis of experimental dataset.
11. Testing of Hypothesis, t-test (Fisher and Student's t test) and Chi-square test with experimental data set.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular

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Biology. 7th Ed., Cambridge University Press.

2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.
8. Introduction to Biostatistics (A Textbook of Biometry) Author: Pranab Kumar Banerjee: Publisher: S. Chand Publishing, 2007: ISBN: 8121923298, 9788121923293:
、
9. Statistics in Biology and Psychology. Author: Debajyoti Das and Arati Das Edition: 6th Edition Reprint. Year: 2015. ISBN: 978-93-80599-04-5. Price: 375.
10. Jim Fowler, Lou Cohen, Philip Jarvis. 1998. Practical Statistics for Field Biology, 2nd Edition. Wiley.
11. Salil Kumar Chaudhuri. Statistical Methods. Asian Books Pvt. Ltd., 2008

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Paper: MAJOR Paper code: UMICMAJ12002 Paper level: 100

BACTERIOLOGY

(Paper type: Theory)

Semester II

Lecture Hours: 45 h Marks:40 CREDITS: 3

Unit 1 Cell organization

No. of Hours: 15 h

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, Archaeobacterial 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: 4h

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 archaeobacteria

Unit 5 Important archaeal and eubacterial groups

No. of Hours:16 h

Archaeobacteria: 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 (*Neisseria meningitides*) and Gamma proteobacteria (*Escherichia.coli*)

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Gram Positive:

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

Paper: MAJOR Paper code: UMICMAJ12002 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.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.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

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editionMcMillan.

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

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.
PearsonEducation Limited

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Paper: SEC Paper code: UMICSEC12002 Paper level: 100

BIOFERTILIZERS

(Paper type: Theory)

Semester II

Lecture Hours: 30 h Marks: 40 CREDITS: 2

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 N₂ 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, Crop response, field application.

Indole acetic acid (IAA) producer isolation, biological pathway, characteristics, inoculum 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 mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

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Paper: SEC Paper code: UMICSEC12002 Paper level: 100

BIOFERTILIZERS

(Paper type: Practical)

Semester II

Total Hour: 30h Marks: 20 CREDITS: 1

1. Isolation of N₂ fixers from rhizospheric soil using Asbhy's N₂ free agar medium.
2. Quantification of fixed N₂ in the form of NH₃ 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.

Suggested Readings

1. Kannaiyan, S. (2003). Bioethnology 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. NewDelhi.
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.

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Question Pattern for MAJ, MIN & SEC (Theoretical) for 40 marks

| Sl. No | Question to be answered | Out of | Marks of each question | Total Marks |
|---------------|--------------------------------|---------------|-------------------------------|--------------------|
| 1 | 5 | 8 | 1 | 5X1=5 |
| 2 | 3 | 5 | 5 | 3X5=15 |
| 3 | 2 | 4 | 10 | 2X10=20 |