RKDF UNIVERSITY RANCHI

SYLLABUS

B.SC. MICROBIOLOGY

NEP 2020

From Academic Year 2025 onwards

RKDF UNIVERSITY RANCHI

SEMESTER I

Subject Code	Subject title	Credit
MJ01MIC	**General Microbiology**	3

Unit 1 : 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.

Unit 2: 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.

Unit 3: Techniques in microbiology I

Principles of microscopy, construction and application of Compound Microscope (monocular and binocular), Bright field Microscopy, Dark field Microscopy ,Phase Contrast Microscopy, Fluorescence Microscopy, Electron Microscopy- TEM and SEM

Unit 4: Techniques in microbiology II

Principles, construction and application of centrifuge; bacteriological Incubator & Incubator Shaker; Laminar flow; Colourimeter & Spectrophotometer (UV Vis)

Unit 5: 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.

Unit 6: 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

Unit 7: 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.

Reference Books:

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..

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Subject Code	Subject title	Credit
MJL01MIC	General Microbiology-Lab	1

PRACTICALS:

- 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.
- 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.
- 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.
- Staining of bacteria-

  1. Simple staining- methylene blue
  2. Gram's staining
  3. Acid fast staining
  4. Ziehl Neelsen staining
  5. Giemsa staining
  6. Structural staining- capsule, endospore.
  7. Staining of fungi using lactophenol and cotton blue

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B.Sc. Microbiology

SEMESTER II

Subject Code	Subject title	Credit
MJ02MIC	**Cell Biology**	3

Unit 1. Tools and techniques of Cell Biology

•Microscopic-Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy; Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy;

•Analytical-Flow cytometry- flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis.

•Separation-Sub-cellular fractionation- differential and density gradient centrifugation; Chromatography- paper, thin-layer, gel-filtration, ion-exchange, affinity and High- Performance Liquid Chromatography (HPLC).

Unit 2. Composition of Cells:

•Cell Wall, the Extracellular Matrix and Cell Interactions

•Molecules of cell, cell membranes and cell Proteins, Structure; Transport of small molecules, Endocytosis

•The Nucleus Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.

•Mitochondria, Chloroplasts and Peroxisomes- Structural organization, Funct ion, Marker enzymes,Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitoc hondria and c hlo roplast, c hloro plast DNA, Peroxisomes'assembly.

Unit 3.

Protein Sorting and Transport - The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

Unit 4

Cytoskelton and Cell Movement- Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules.

Unit 5 Cell Signaling - Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

Unit 6 The Cell Cycle- Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis.

Unit 7 Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

Unit 8 Cancer- Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

Reference Books:

1. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
2. Karp, G. (201 0). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
3. Hardin, J., Becker, G., Skliensmith, L.J. (201 2). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL02MIC	**Cell Biology-Lab**	1

PRACTICALS:

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood glucose by glucose oxidase method.
5. Preparation of buffers.
6. Separation of Amino acids by paper chromatography.
7. Qualitative tests for Carbohydrates, lipids and proteins
8. Study the effect of temperature and organic solvents on semi permeable membrane.
9. Demonstration of dialysis.
10. Study of plasmolysis and de
11. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
12. Study of structure of any Prokaryotic and Eukaryotic cell

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ03MIC	Microbial Physiology & Biochemistry	3

Unit1

Biomolecules

1) Carbohydrates-Chemical structure, nature and properties, classification and importance in biological cells
2) Aminoacidsandproteins-Chemicalstructure,natureandproperties,classification, Proteolysis, transamination, deamination
3) Lipids and hormones- Saturated and unsaturated fatty ac ids, structure, classification, properties and function of lipids, oxidation of lipids Hormones: steroid hormones, structure and fuction
4) Nucleic Acid: Basic constituent of DNA, RNA rnRNA, tRNA, rRNA

Unit 2

Microbial Enzyme

a) Nature and structural properties, Nomenclature and classification.
b) Enzyme kinetic s- Energy of Activation, catalytic site, Interaction of enzyme substrate, Km, Inhibition, Activation.
c) Factors affecting Enzyme activity: Enzyme concentration, substrate concentration, Temperature, pH

Unit3.

Microbial growth

a) Definition of growth, growth curveve, Mathematical expression of growth, rate, generation time.
b) Batch and continuous culture, synchronous growth, diauxic growth.
c) Factors affecting microbial growth such as temperature, pH, O2concentration, radiation, pressure

Unit 4

Microbial Energetic

a) Principal of bioenergetics and high energy phosphate compound. Mode of energy producti on- phosphorylation
b) Concept of anabolism and catabolism
c) Chemo organotrophic catabolic process or energy yielding process, Aerobic respiration: Glycolysis, EM pathway, PP pathway, TCA, Electron transport and oxidative phosphorylation. Anaerobic respiration, fermentation
d) Phototrophy- Light reaction in oxygenic photosynthesis, light reaction in anoxygenic
Photosynthesis.

Unit5.

Nitrogen Fixation

a) Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate eduction, biological nitrogen fixation. Nitrogen fixers and mechanism of nitrogen fixation,
properties of nitrogenase, and ammonia assimilation.
b) Genetics of nitrogen fixation and regulation of nitrogenase activity and synthesis.

Reference Books

1. Pelczar M.J. Chan, 5th Edition ,Microbiology
2. Roger Y. Stanier, 5th Edition General microbiology
3. Powar & DaginawalaVol I & VolII, General Microbiology
4. Prescott L. M. Microbiology, 6thEdition
5. Atlas R.M. Microbiologyy Lenhinger. Principles of Biochemistry, Nelson & Cox, 4th Edition.
6. Stryer – Biochemistry. W.H. Freeman & Co.
7. Plumner. An introduction to practical Biochemistry, 3rd Edition
8. J. Jayraman. Lab Manual in Biochemistry.
9. Cohn and Stumph. Outline of Biochemistry. Wiley eastern.
10. Zube's Biochemistry.4th Edition Macmillan

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL03MIC	**Microbial Physiology & Biochemistry-Lab**	1

PRACTICALS:

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.
2. **Qualitative tests**
   - **a)** Carbohydrates: Molisch's Test, Fehling's Test, Benedict's Test, Iodine Test) Amino acids and Proteins: Ninhydrin test, Biuret test, Lowry's assay. Lipids: Solubility Test, Translucent Spot Test, Emulsification Test.
   - b) Quantitative estimation of carbohydrate by anthrone method. Quantitative estimation of proteins by Lowry's method Determination of the acid value of a fat
3. Amylase production, H2S production, Urease production test, IMViC test
4. Effect of temperature and pH on growth of E. coli, Effect of carbon and nitrogen on microbial growth.
5. emonstration of carbohydrate fermentation, indole production, catalase test, oxidase test.

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SEMESTER III

Subject Code	Subject title	Credit
MJ04MIC	**Microbial Diversity**	3

Unit 1

Timeline, major discoveries and contribution of important scientists: From 1800 1900: Leeuwenhoek, Jenner, Pasteur, Koch, Gram, Mechnikoff and Ehrlich; Ivanovsky; Winogradsky. From1900 - 1950: Bergey, Griffith; Fleming; Luria Delbruck; Waksman; Lederberg and Tatum; From1950 to 2000: Lederberg and Zinder, Benzer; Jacob and Monod, Ames, Temin and Baltimore; CarlWoese and Craig Venter. Microbiological growth techniques: Pure culture techniques, Enrichment, Anaerobicculturing. Staining techniques: Gram's staining, Endospore, Capsule, Acid faststaining.

Unit 2

Bacterial Diversity: Habitat, structure, physiology & significance of Photo autotrophic bacteria (Cyanobacteria, Green and Purple bacteria), Photo heterotrophic bacteria (Green Non-sulfur and Purple Non-sulfur bacteria) and Chemoautotrophic bacteria (sulfur oxidizers, iron bacteria, hydrogen bacteria). Extremophiles physiological characteristics and significance of (Methanogenic bacteria, Methylotrophs, Halobacteria).

Unit 3

Ultra-structure of bacterial cell A)Cell wall; B) Surface adherents: capsule and slimelayer; C) Surface appendages: Flagella and Pili; D) Endospores. Bacteriology: Classification, habitat, structure, reproduction & significance of Chemoheterotrophic bacteria (filamentous & gliding bacteria, Gram-Positive (Bacillus, Actinomycetes) and Gram-negative bacteria Spirochetes, Chlamydia, Rickettsia and Mycoplasma).

Unit 4

Mycology: Thallus morphology and modifications in fungi. Nutrition and physiology of fungi. Reproduction (asexual, sexual and para sexual) characteristics of fungi. Major taxonomic group

Of fungi with focus on structure, reproduction, life cycle and significance of the following: representatives: i) Gymnomycota (Cellular slime moulds), ii) Mastigomycota (Phytophthora),

iii) Amastigomycota: a) Zygomyocotina (Mucor/ Rhizopus), b) Ascomycotina (Saccharomyces), c) Basidiomycotina (Agaricus), d) Deutromycotina (Fusarium). Characteristics and importance of Deuteromycetes.

Unit 5

Baltimore classification of virus. General methods for isolation and cultivation of virus. One step growth curve, burst size and determination of titre value of virus. Concept of Viroids & Prions. General characteristics and life cycle of Bacterial virus (T4 bacteriophage), Plant virus (TMV), Animal virus (e.g. Herpes Simplex)

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL04MIC	**Microbial Diversity-Lab**	1

1. Preparation of A) Nutrient agar (NA) for bacterial isolation and B) Potato/ Sabouraud Dextrose Agar (PDA/SDA) for fungal/ yeast growth.
1. Isolation and growth of rhizosphere bacteria on NA plateusing serial dilution and spread plate method.
2. Isolation and growth of fungal colony on PDA/ SDA plate.
3. Preparation of single bacterial colony using streak plate method.
4. Bacterial identification: Morphological staining and biochemical testson isolated bacteria.
5. Fungal identification: Spore and hyphalstaining and their characteristics.
6. General characteristics and microscopic identification of Bacteria & Fungi.
7. Isolation of plaques from sewage water.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ05MIC	**Phycology and Virology**	3

Section A: PHYCOLOGY

Unit 1. Classification of Algae

Unit 2.

Study of the following classes with reference to genera listed below: (occurrence, thallus organization and life cycles):

a) Chlorophyceae: Volvox, Coleochaete

b) Charophyceae: Chara

c) Diatoms: General features with reference to pinnate and centric diat oms

d) Xanthophyceae: Vaucheria

e) Phaeophyceae: Ectocarpus

f) Rhodophyceae: Polysiphonia

g) Cyanobacteria: Nostoc , Anabaena, Spirulina, Oscillatoria

Unit 3. Applications of algae in Agriculture, Industry, Environment and Food

Section B: VIROLOGY

Unit 4. Introduction: Discovery of viruses, nature and definition of viruses, general properties of viruses. Concept of viroids, virusoids, satellite viruses and prions. Theories

of viral origin.

Unit 5. Structure of viruses: Capsid symmetry, enveloped and non-enveloped viruses.

Unit 6. Isolation, purification and cultivation of viruses.

Unit 7. Viral Taxonomy: Classification and nomenclature of different groups of viruses infecting microbes, plants and animals.

Unit 8. Salient features of viral genomes: Unusual bases (TMV, T4 phage), overlapping
genes (ΦX174, Hepatitis B virus), alternate splicing (Picornavirus), terminal redundancy
(T4 phage), terminal cohesive ends (lambda phage), ambisense genomes (arenavirus), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (influenza virus) and non segmented genomes (picornavirus), capping and tailing (TMV)

Reference Books:

1. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
2. Sharma P.D., Microbiology, Rastogi Publications.
3. Tortora G.J., Funke B.R. and Case C.L., Microbiology: An introduction, 9th edition, Pearson Education.

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

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL05MIC	**Phycology and Virology-Lab**	1

PRACTICALS:

- Use Microscopes, Camera Lucida, Stage and Ocular Micrometers.
- Total Counting of RBC / WBC using haemocytometer.
- Blood Smear Preparation, Differential count of WBC.
- Mounting Buccal Epithelium and observing living cells using vital staining.
- Study of mitotic division using onion root tips. Study of prepared slides of different tissues.
- Use of counting chamber for bacterial count.
- Effect of temperature on bacterial growth.
- Effect of pH on bacterial growth.
- Effect of osmotic pressure (salt and sugar concentration) on bacterial growth.

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SEMESTER IV

Subject Code	Subject title	Credit
MJ06MIC	**Industrial Microbiology**	3

Group - A

1. Introduction to Bioprocess Engineering.
2. Bioreactors.
3. Isolation, preservation and maintenance of industrial microorganisms.
4. Kinetic of microbial growth and death.
5. Air and media sterilization.

Group - B

1. Media of industrial Fermentation.
2. Types of fermentation process: Analysis of batch, Fed-batch and continuous bioreactors, solid state fermentation, bio transformation.
3. Stability of microbial reactors, analysis of mixed microbial population, specialized bioreactors (pulsed, fluidized, photo-bioreactor etc.).
4. Measurement and control of bioprocess parameters.

Group - C

1. Downstream processing: Introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation.
2. Cell disruption, liquid extraction, Chromatography, membrane process, drying and crystallization.
3. Enzyme and whole cell immobilization and their industrial applications.

Group - D

1. Industrial production of - alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol).
2. Industrial production of - Antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid), single cellprotein.
3. Introduction to food technology

a. Elementary idea of canning and packing.

• Sterilization and pasteurization of food products.

• Technology of typical food / food products (bread, cheese, idli)

• Food preservation.

Essential Readings

a. Pappler, Microbial technology, Volume 1,2 7 3 Academic press

b. E.L. Mansi, Fermentation, Microbiology & Biotechnology, Taylor Pub.

c. Murray Moo & Young, Comprehensive Biotechnology, Vol-1 to4.

d. Tripathi, Food Biotechnology, Dominant Publication

e. Mukhopadhyay. Process Biotechnology Fundamental. Viva book

f. Shuler and Kargi, Bioprocess engineering. Prentice-Hall.

g. Schugerl. 1987. Bioreaction engineering.J/W.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL06BIO	**Industrial Microbiology -LAB**	1

1. Effect of Environmental Factors on Growth of Bacteria: Salt, Temp, pH.
2. Viable count of bacteria from soil sample (Dilution Plating Method)
3. Biochemical characterization of selected Microbes
4. Isolation of bacterio phages from sewage sample
5. Enrichment and Isolation of:
    a. Halophiles b) Acidophiles c) Phenol Degraders
6. d) Nitrogen Fixers e) Antibiotic Producers f) Kojic Acid Producers
7. Alcohol Fermentation
8. Comparative studies of ethanol production using different substrates
9. Immobilization of Whole Cells
10. Effect of Antibiotics on various Gram Positive and Gram Negative bacteria
11. Determination of Minimum Inhibitory Concentration (MIC) and Minimum
12. Bactericidal Concentration (MBC) of various Antibiotics on different Organisms
13. Biochemical tests for identification of Bacteria- Oxidase, Catalase, IMVIC test, TSI Test etc

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ07MIC	Environmental Biotechnology	3

Unit 1: 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: Microbes thriving at high & low temperature, pH. High hydrostatic & osmotic pressures, salinity and low nutrient level; Microbial succession in decomposition of plant organic matter

Unit 2: Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: positive-negative interaction; Microbe-Animal interaction: positive-negative interaction; Microorganism of rhizosphere, rhizoplane and phylloplane, mycorrhiza (types and its applications).

Unit 3: 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.

Reference Books:

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.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL07MIC	**Environmental Biotechnology -Lab**	1

PRACTICALS:

To analyses soil- pH, moisture, water holding capacity.

Isolation of microorganisms (Bacteria & Fungi) from soil sample at different temperature (28o C & 45o C)

- Isolation of bacteria and fungi from rhizosphere and rhizoplane.
- Isolation of bacteria & fungi from air environment by exposure plate method.
- To determine BOD of waste water sample.\
- Bacteriological examinaiton of water by MPN test, presumptive coliform, confirmed coliform and completed coliform test.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ08BIO	**Microbial Genetics**	3

Unit 1: 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 topology: linking number, topoisomerases. DNA organization in prokaryotes, viruses, eukaryotes

Unit 2: **DNA Replication in Prokaryotes and Eukaryotes**

Bidirectional and unidirectional replication, semi-conservative and semi discontinuous replication. Mechanism of DNA replication, Replication of chromosome ends.

Unit 3: Transcription in Prokaryotes and Eukaryotes

Concept of transcription unit. General transcription process in prokaryotes and eukaryotes; Post-Transcriptional modification in eukaryotes, Aternative splicing mechanism, RNA interference

Unit 4: Translation in prokaryotes and eukaryotes

Ribosome structure, tRNA structure and processing, Mechanisms of translation in both prokaryotes and eukaryotes, Genetic code, Wobble hypothesis, Fidelity of translation

Unit 5: Regulation of gene expression

In prokaryotes and eukaryotes Overview of regulation of gene expression, Regulation of gene expression by

DNA methylation, histone acetylation and histone methylation mechanisms; Transcription control mechanisms, Inducible Operon System, Repressible Operon System, Translation control mechanisms.

Unit 6: Regulation of gene expression in prokaryotes and eukaryotes Overview of regulation of gene expression, Regulation of gene expression by DNA methylation, histone acetylation and histone methylation mechanisms; Transcription control mechanisms, Inducible Operon System, Repressible Operon System, Translation control mechanisms.

Unit 7: Bacterial gene exchange processes

Mechanisms of Genetic Exchange, Horizontal gene transfer, Transformation; Conjugation; Transduction, Complementation.

Unit 8: **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

Reference Books:

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.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL08(BIO)	**Microbial Genetics -LAB**	1

PRACTICALS:

1. Isolation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis.
2. Estimation of DNA using diphenylamine reagent.
3. Resolution of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) and visualization using coomassie dye.
4. Replica plating method: Preparation of master and replica plates. Isolation of Histidine auxotrophs
5. Isolation of plasmid DNA from *E. coli.* Study the different conformations of plasmid DNA through agarose gel electrophoresis
6. Study of the effect of chemical (nitrous acid) and physical (UV) mutagens on bacterial cells
7. Demonstration of Ames test.

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B.Sc. Microbiology

SEMESTER V

Subject Code	Subject title	Credit
MJ09MIC	**Microbial Systematics**	3

UNIT I. Genetic analysis of bacteria: Importance and uses of mutation analysis. Inheritance in bacteria, types of mutations, spontaneous and induced mutagenesis, isolating mutants, selecting mutants, mutant enrichment. Reversions versus suppression. Complementation tests, recombination tests and gene replacements. Cloning genes By complementation. Cloning genes by marker rescue.

UNIT II. Gene transfer and mapping by conjugation: Basis of fertility in bacteria. Self-transmissible and mobilizable plasmids. Molecular mechanism of gene transfer by conjugation – genes and proteins involved. Regulation of gene transfer by conjugation. Hfr strains. Mapping bacterial genomes using Hfr strains. Chromosomal DNA transfer by plasmids – by integrated plasmids, by chromosome mobilization and by creation of prime factors. Ti plasmid transfer system and its application in creating transgenics.

UNIT III. Lytic bacteriophages: Lytic development cycle using phages T4 and T7 as models. Regulation of expression of genes in phage T4 – transcriptional activators, antitermination, a new sigma factor and replication-coupled transcription. Regulation of gene expression in phage T7 – a phage-encoded RNA polymerase. Replication of T4versus T7 phages – recent advances. Replication and packaging of filamentous phages M13 and f1 – recent advances. Genetic analysis of phages – complementation and recombination tests with phages.

UNIT IV. Lysogenic phages: Lambda phage – gene and promoter organization. Lambda lytic Cyle – regulation of gene expression – very early, early and late genes. Establishment and maintenance of lysogeny. Regulation of gene expression in lysogenic phase - role of cI, Cii and c III proteins. Lambda immunity region and immunity to super infection. Events leading to

induction – role of cI and cro repressors in regulating the events. Other lysogenic phages – P2 and P4.

UNIT V. Gene transfer by transformation and transduction: Natural transformation and competence. Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram-negative bacteria. Artificially induced competence. Generalized versus specialized transduction - T4 and lambda phage. Mapping bacterial genes by transduction.

UNIT VI. Transposons: Discovery of transposition. Classes of bacterial transposons. Regulation of transposition activity. Effects of transposition in bacteria. Genetic requirements for transposition. Molecular mechanisms of transposition – genetic evidence supporting the mechanisms. Conjugative transposons. Transposon mutagenesis. Cloning out genes by transposon mutagenesis.

UNIT VII. Gene regulation: Control of gene expression. Positive gene regulation, negative gene regulation and attenuation, using the lac, gal, trp,

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Subject Code	Subject title	Credit
MJL09MIC	**Microbial Systematics**-Lab	1

1. Estimation of proteins by Biuret method and Folin Ciocalteau method.
2. Production of citric acid by A. niger. Recovery & Fermentation.
3. Estimation of Ethanol by dichromate method.
4. Production of Ethanol by fermentation and recovery.
5. Preparation of Wine from grapes by fermentation.
6. Production of glutamic acid by fermentation.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ10MIC	**Quantitative Biology**	3

Unit 1: **Descriptive Statistics**

Basic concept in statistics:

Sample Statistics, Population
parameter, variables, Sampling methods, Types of data
(qualitative and quantitative data, discrete and continuous
series data), Sources of data, measurement scales (nominal,
ordinal, interval and ratio), variability and uncertainty in
measurements

Measures of central tendency :

Mean, Mode and median

Measures of dispersion : Mean deviation, Standard deviation and
Variance

Data presentation :

Tables and Graphs (Histogram, bar, pie and
line) Simple linear Regression and correlation

Unit 2 Inferential Statistics - I

1. Uncertainty: Variation, Probability and inference
2. Central Limit Theorem, Standard deviation of the means standard error and confidence interval
3. Basic concepts: Null hypothesis, P-value significance level, Test statistics, type I and type II errors, one tailed and two tailed tests, degrees of freedom.
4. Importance of Parametric and nonparametric tests
5. Parametric statistical test: Z-test, t-test and F-test

Unit 3: **Inferential Statistics-II**

1. Test of Significance: Chi square test (Goodness of fit and Independence)
2. ANOVA : One way and two- way, Post Hoc test(Tukey's)
3. Non-parametric Tests: Sign test, Wilcoxon's signed rank test and Mann-Whitney U test.

Unit 4: Probability and Probability Distribution

1. Concept of experiment, event (mutually exclusive & non exclusive events, dependent & independent events).
2. Laws of probability (addition and multiplication);
3. Probability distribution – Normal (x-scale and z-scale), Binomial and Poisson distributions

Reference Books:

1. Bailey N. T. J. (1981). Statistical Methods in Biology. United Kingdom: Hodder and Stoughton.ISBN:9780340247563,
2. Brown D. and Rothery P. (1993). Models in biology: mathematics, statistics, and computing. UnitedKingdom: Wiley. ISBN: 9780471933229. Digitized 20th June 200
3. Chetwynd A., Chetwynd A. G. and Diggle P. J. (2011). Statistics and Scientific Method:
4. An Introductionfor Students and Researchers. Italy: OUP Oxford. ISBN:9780199543182
5. Daniel W. W. and Cross C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences.United Kingdom: Wiley. ISBN:9781119282372
6. Doran P. M. (2013). Bioprocess Engineering Principles. Netherlands: Elsevier Science. ISBN:9780122208515
7. Gupta S. P. (2021). Statistical Methods. 46th edition. Sultan Chand & Sons Publisher, New Delhi.ISBN13:9789351611769
8. Haefner J. W. (2012). Modeling Biological Systems: Principles and Applications. United States:Springer US. ISBN:9781461541196

8. Harvey L. and McNeil B. (2008). Practical Fermentation Technology. Germany: Wiley. ISBN:9780470014349

9. Khan I. A. and Khanum A. (2016). Fundamentals of Biostatistics. 5th Edition. Ukaaz, Publications,Hyderabad. ISBN-13:9788190044103

10. Lindgren B. (2017). Statistical Theory. United Kingdom: CRC Press. ISBN: 9781351414173

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	CREDIT
MJL10MIC	**Quantitative Biology-lab**	1

PRACTICALS:

1. Computer applications: Using data sheets, and sorting data with different parameters, plotting graphs – bar charts, line graphs, pie charts, adding error bars. (Using Microsoft Excel)
2. Statistical analysis of data – Students t test, F test using computer software (Using Microsoft Excel)
3. Swiss PDB Viewer
4. Use of XLSTAT.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ11MIC	**Genetic Engineering**	3

UNIT I. The nature of Genetic mate rial: The structure of DNA and RNA; Melting of DNA, Super helicity, Organization of Microbial Genomes, Organization of Eukaryotic Genomes, Chromatin arrangement, nucleosome formation.

UNIT II.DNA replication: Arrangement of replicons in a genome, Various modes of replication, specific features of replication in Prokaryotes and Eukaryotes, action of topoisomerases, Telomere maintenance and Chromatin Assembly, Single stranded DNA replication. DNA repair and recombination, DNA Mismatch Repair, Double Strand Break Repair, Recombination as a molecular biology tool.

UNIT II. Transcription: Transcription machinery of prokaryotes, eukaryotes, various forms of RNA polymerase promoters, enhancers, silencers, activators, effect of chromatin structure, regulation of transcription.

UNIT III. Post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing, RNA Editing; RNAi and miRNAs, Antisense RNA, Post-transcriptional gene regulation.

UNIT IV. Translation: The genetic code and protein structure, Mechanisms of translation in prokaryotes, Mechanisms of translation in eukaryotes, in vi/retranslation systems, polycistronic/ monocistronic synthesis, Regulation of translation, RNA instability, inhibitors of translation, stringent response in bacteria. Post-translational processes: Protein modification, folding, chaperones, transportation; The Signal Hypothesis, protein degradation.

UNIT V. Molecular basis of cell physiology: Signals and cascad s in organism development Molecular mechanisms of Oncogenesis and cancer, genetic disorders, aging, mitochondrial

inheritance. Implications of genome organization, Genes and behavior, Genome analysis, DNA typing, Genomics and beyond.

Subject Code	Subject title	Credit
MJL11MIC	**Genetic Engineering**-Lab	1

1. Plasmid Curing by Acridine Orange
2. Restriction Digestion of Z DNA using three Restriction Endonuclease enzymes:
   a) EcoR V b) Hind III c) BamH I
3. Replica plating techniques
4. Agarose gel electrophoresis and restriction mapping of DNA
5. Demonstration of techniques of PCR
6. Isolation of Genomic DNA from bacterial cell / plant cell
7. Isolation of RNA from Yeast cells
8. Determination of Tm values of DNA

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
B.Sc. Microbiology	**Internship / Project work**	**SIP**

Overall Internship/ Apprenticeship/ Project may be evaluated under the following heads:

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope &References
- Presentation style
- Viva-voce

Internship/ Apprenticeship/ Project

Each student has to submit two copies of the Internship/ Apprenticeship/ Project work duly forwarded by the HOD of Department concerned. The forwarded copies will be submitted in the Department of Microbiology, RKDF University, for evaluation (Seven days before the seminar).

The paper will consist of

(a) Field work/Lab work related to the project.

(b) Preparation of dissertation based on the work undertaken.

(c) Presentation of project work in the seminar on the assigned topic in the U.G. Department of Microbiology, RKDF University, Ranchi & open viva thereon.

- Student alone or in a group of not more than five, shall undertake one Project approved by the Subject Teacher/H.O.D. of the Department/College concerned. The progress of the Project shall be monitored by the faculty members at regular Intervals.

OR

- Paper presentation on 'Topic Provided' and group discussion

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

SEMESTER VI

Subject Code	Subject title	Credit
MJ12MIC	Immunology	3

Structure, function and Cells of the immune system:

The classification of human immune response: Humoral and cellular immunity, Innate and Adaptive immune response, Cellular components of the adaptive immune system, Phases of adaptive immune responses, Clonal expression, Toll like receptors, ABO blood Group. Lymphoid cells, clinical focus on the stem cells. Clinical uses and potential. B-lymphocytes and T-lymphocytes. Primary and Secondary lymphoid organs.

Antigens and Antigen presentation

Super antigens. Immunogenicity versus Antigenicity. Haptens. Autoimmunity, Epitopes and paratopes, Properties of antigens recognized by T lymphocytes. Cell biology of antigen processing. Monoclonal and polyclonal antibodies.

The HLA major histocompatibility complex

Discovery of the MHC its role in immune responses. Structure of MHC molecule (properties, binding of peptides to MHC molecules genomic organization of the MHC , expression of MHC molecules.

Cytokine, cellular adhesion and interactions

Properties of cytokines. Cytokine receptor. Cytokine antagonists. Cytokine secretion by TH 1 and TH 2 subsets. Cytokine related diseases-Septic shock, Chagas's diseases. Cell adhesion molecule. Chemokines. Leukocyte Extravasation – the multistep paradigm. Lymphocyte Extravasation. Immune regulation. Immuno globin function

Basic structure of antibodies. Antibody binding site. Antibody-mediated effector function.Antibody classes and biological activity. Antigenic determinants on immunoglobulins. Immunoglobin super family.

Monoclonal antibodies.

Regulatory and Cytotoxic T cell, macrophages and NK cell function

T cell maturation and the thymus. T cell activation. T cell differentiation. Cell death and T population. Effector responses. General principles of effector T cells. Cytotoxic T cell. NK cell Antibody dependent cell mediated cytotoxicity (ADCC). Experimental assessment of cell mediated cytotoxicity.

Immunoglobulin genes and proteins

Devising a genetic model compatible with Ig structure. Multigene organization of Ig genes. Generation of antibody diversity. Synthesis, Assembly and Secretion of immunoglobulins. Regulation of Ig gene transcription Antibody genes and antibody engineering.

TCR genes, gene products and co-repressors

Early studies of T-cell receptor. Aβ and γδ T cell receptors. Organization and rearrangement of TCR genes. T-cell receptor complex : TCR-CD3.

Complement

The function of complement. The components of complement. Complement activation. Regulation of the complement system. Biological consequences of complement activation. Complement deficiencies. Immune response to microbes:

Function of phagocytes, mast cells, basophils and eosinophils. Viral infections. Bacterial infections. Parasitic diseases. Fungal diseases. Emerging infection diseases. Clinical manifestations

Reference Books:

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. Janeway et al., Immunobiology, 4th Edition, Current Biology, publications., 1999.
7. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
8. Goding, Monoclonal antibodies, Academic Press. 1985.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL12BIO	**Immunology**	1

PRACTICALS:

- Blood Grouping.
- Differential Leukocyte Count.
- Total Leukocyte Count.
- Widal Test.
- Rapid Plasma Reagin (RPR) Test.
- Single Radial Immunodiffusion (SRID)
- Ouchterlony Double Diffusion.
- Rocket Immuno Electrophoresis.
- Identification of lymphoid cells in blood smears and tissue sections.
- Separation of PBMC from blood
- Spleen cell preparation from mouse
- Identification of lymphocyte populations by FACS
- Ouchterlony immunodiffusion
- Immuno-electrophoresis of rabbit serum proteins
- Agglutination of erythrocytes by lectin
- Enzyme linked immunosorbent assay for cytokines
- ABO blood grouping
- Immuno dot blot.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ13MIC	**Tissue Culture**	3

1. Introduction to Tissue Culture Techniques

Introduction to tissue culture: Definition, principle and significance of tissue culture; Animal tissue culture; Maintenance of sterility and use of antibiotics, Mycoplasma and viral contaminants; Various systems of tissue culture – their distinguishing features advantages and limitations; Culture medium: Logic of formulation (natural media, synthetic media, and sera); Methodology: (i) Primary culture: Behaviour of cells, properties, utility (ii) Explant culture (iii) Suspension culture.

2. Fundamentals of Plant Tissue Culture

History & Development of plant tissue culture; Nutrient media: Obligatory and optional constituents; Plant Growth Regulators: mode and mechanism of action; Incubation systems: static & agitated culture systems; Maintenance of in vitro cultures.

Animal Cell and Organ Culture

Cell lines: development, maintenance and management; Established cell lines: Their characteristic features and utility, Cross contamination hazards; Characteristics of cells in culture; Contact inhibition, anchorage (in)dependence, cell-cell communication etc., Growth studies: Cell proliferation, cell cycle, mitosis in growing cells; Organ and histo typic cultures; Methods, behaviourof organ explant, and utility of organ culture; Organ transplants., Scaling-up of animal cell culture; Cell cloning and micromanipulation, cell transformation; Freeze storing of cells and transport of cultures; Separation of cell types: Various methods: advantages and limitations; Nuclear transplantation, Cell hybridization, Transfection studies.

3. Plant Cell, Tissue and Organ Culture

Growth and development of plant cells and tissues in vitro; Callus culture, Cell suspensionculture,Organculture,Protoplastculture,Organogenesis;Embryogenesis;Invitroculture :physical,genetic,chemical and genotypic factors; Assessment of growth and development in vitro; Problems in plant tissue culture (Recalcitrance, Contamination, Phenolic Browning, Seasonal Variation).

4. Applications of Tissue Culture

Application of animal cell culture; Cell culture based vaccines. Stem cell cultures- embryonic stem cells and their applications, three dimensional culture and tissue engineering : Tissue culture as a screening system; Cytotoxicity and diagnostic tests; Development and preparation of vaccines against infecting organisms, mammalian cloning; Establishment of cell lines from tissue of genetic diseases; Commercial applications of plant tissue culture for clonally identical plants, Synthetic Seeds, Use in multiplication of specific genotypes, rare and/or improved varieties, endangered species, disease elimination

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL13MIC	**Tissue Culture-**Lab	1

1. Isolation of chloroplast & estimation of chlorophyll
2. Preparation of media & Surface sterilization of Explant
3. Selection, preparation and inoculation of explant for callusing
4. Study of callus characteristics
5. Sub-culturing of callus in differentiation media
6. Sub-culturing callus for Suspension culture
7. Extraction of secondary metabolites from callusculture
8. Protoplast Isolation &Culture

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ14MIC	**Bio-Molecules and Enzymes**	3

UNIT I. Major Biomolecules: Carbohydrates – Classification, chemistry, properties, and function –. Conjugated polysaccharides– lycoproteins, muriens and lipopolysaccharides.

UNIT II. Lipids – classification, chemistry, properties and function –Conjugated lipids – lipoproteins. Major steroids of biological importance – prostaglandins.

UNIT III. Amino acids and proteins: classification, structure and function. Peptide structure. Ramachandran's plot.. Structural levels of proteins – primary, secondary, tertiary and quaternary, denaturation of proteins. Hydrolysis of proteins, Protein sequencing using various methods.

UNIT IV. Nucleic acids – Structure, function and their properties. Structural polymorphism of DNA, RNA. Structural characteristics of RNA. Sources,

.

UNIT V. Enzymology- Introduction, General characteristics of enzymes, Activation energy, coupled reactions, active site and its importance, Factors influencing catalytic efficiency. Enzyme kinetics, Rapid Equilibrium, Henry-Nucgaekkus-Menten's equations, Steady State approach, significance of Km, Haldane equation, Velocity vital Substrate concentration curves. Methods of plotting enzyme kinetics data-Lineweaver-Burk. Equilibrium dialysis, Effect of pH and temperature on enzyme stability and activity, Arrhenius equation

.

UNIT VI. Regulation of enzyme activity: Feedback inhibition, reversible covalent modification, irreversible covalent modification, allosteric concept, Aspartate transcarbamylalse, ligand-protein interaction, scatchard plot, Hill plot, cooperativity index, Models for allostery (MWC, KNF), Half site reactivity. Enzyme Inhibition, Models and types of inhibition.

UNIT VII. Applied enzymology: Application of enzymes in analytical labs. (clinical and industrial), enzymes as industrial catalysts, Immobilized enzymes, enzyme electrodes, assay of enzyme activities for diagnostic purposes, abymes, recent developments

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL14MIC	**Bio-Molecules and Enzymes -Lab**	1

1. Estimation of proteins by Biuret method and FolinCiocalteau method.
2. Production of citric acid by A.niger. Recovery & Fermentation.
3. Estimation of Ethanol by dichromate method.
4. Production of Ethanol by fermentation and recovery.
5. Preparation of Wine from grapes by fermentation.
6. Production of glutamic acid by fermentation.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ15MIC	**Bio Informatics**	3

UNIT I. Introduction to computers and bioinformatics - Types of operating systems, concepts of networking and remote login, basic fundamentals of working with unix.

UNIT II. Biological databases- Overview, modes of database search, mode of data storage (Flat file format, db-tables), flat file formats of Gene Bank, EMBL, DDBJ, PDB.

UNIT III. Sequence alignment —Concept of local and global sequence alignment, pairwise sequence alignment, scoring an alignment, substitution matrices, multiple sequence alignment.

UNIT IV. Phylogenetic analysis- Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbor joining, Maximum parsimony, Maximum likelihood).

UNIT V. Generation and analysis of high throughput sequence data – Assembly pipeline for clustering of HTGS data, format of ". ace" file, quality assessment of genomic assemblies, international norms for sequence data qua1ity, C1ustering of EST sequences, concept of Unigene. Annotation procedures for high through-put sequence data- Identification of various genomic elements (protein coding genes, repeat elements, strategies for annotation of whole genome, functional annotation of EST c1usters, gene ontology (GO) consortium.

UNIT VI. Structure predictions for nucleic acids and proteins - Approaches for the prediction of RNA secondary and tertiary predictions, energy minimization and base covariance models, Basic approaches for protein structure predictions, comparative modeling, fold recognition/"threading" and ab-ioi/io prediction

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL15MIC	**Bio Informatics** -Lab	1

1. Computer operations-getting acquainted with different parts of Computers. [DOS] and basics of operating a computer.

1. Creating files, folders and directories.
2. Applications of computers in biology using MS-Office.
3. A] MS-Word B] Excel C] Power Point
4. Creating an e-mail account, sending and receiving mails.
5. An introduction to INTERNET, search engines, websites, browsing and Downloading

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

SEMESTER VII

Subject code	Subject title	Credit
MJ16MIC	Molecular Biology & Genomics	3

Group – A

1. **Introduction to Molecular Biology and Genetics.**

Genome organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleo some phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

2. DNA Structure; Replication; Repair &Recombination

StructureofDNA-A-,B-,Z-andtriplexDNA;Measurementofproperties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photo reactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chisequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/ Loxrecombination.

3. Insertion elements & Transposons.

4. Gene, mutation and mutagenesis: UV and chemical mutagens; types of mutation; Ames test for mutagenesis; Methods of genetic analysis, Strain improvement and Mutatorgene.

Group – B

1. Transcription: Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational

modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing.

2. Modifications in RNA: 5- Cap formation, Transcription termination, 3- end processing and polyadenylation, splicing, Editing, Nuclear export of m RNA, m RNA stability.
3. Translation: Prokaryotic and eukaryotic translation, co- and post- translation modifications of proteins.

Group - C

1. Bacterial genetic system: Transformation, Conjugation, Transduction, Bacterial genetics map with reference to E.coli.
2. Biology for Cancer: Oncogenes and tumour suppressor genes; Viral and cellular oncogenes, tumour suppressor genes fromhumans.
3. Antisense and Ribozyme technology: Molecular mechanism of antisense molecules, applications of antisense and ribozyme technologies.
4. Holiday junction, gene targeting gene disruption, Rec A and other recombinases.

Group - D

1. Mapping of Genome: Genetic and physical maps, Physical mapping and map- based cloning, Southern and florescence in situ hybridization (FISH) for genomean alysis micro array analysis.
2. Genome sequencing: Genome sizes, organelle genomics, Genomic libraries YAC, BNC, libraries, Strategies for sequencinggenome.
3. Mendelian Genetics

Essential Readings

1. Garder, Principles of genetics, Wiley Publications, 8thedition

2. Levin, Gene VI to Gene VIII, Oxford Pub.
3. Friefelder, Essentials of Molecular Biology, Panima Pub
4. T. A. Brown ,Genome-2 2ndEdition
5. Old & primrose, Principle of Gene Manipulation, Black well Pub.
6. Weaver Molecular Biology, Mc Graw Hill
7. Brown, Gene Cloning and DNA analysis, Blackwell Pub.
8. Winnacker, From genes to clones ,Panima Pub.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL16MIC	**Molecular Biology & Genomics** -LAB	1

1. Isolation of Genomic DNA from bacterial cell / plant cell
2. Isolation of RNA from Yeast cells
3. Determination of Tm values of DNA
4. Isolation of Temperature sensitive conditional Mutant
5. Isolation of auxo trophic mutant by 5 BrUmutagenesis
6. Bacterial Conjunction
7. Physical mapping with interrupted conjugation techniques (By Problem solving approach)
8. Bacterial Transformation
9. Isolation & Characterization of plasmid DNA
10. Isolation of Lambda phage DNA
11. Quantification of nucleic acid
12. Cloning in Plasmid or Phage vectors
13. Southern Blotting
14. Development of RFLP & RAPD Map
15. Access of population diversity by 16S rRNA sequence.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ17MIC	**Virology**	3

UNIT I. Animal Viruses: Classification, Morphology and Chemistry of Viruses:
Virus evolution and classification, properties of viruses,virus structure. Techniques for visualisation and enumeration of viral particles, measuring biologicalactivity of viruses, characterization of viral products expressed ininfected cells, Diagnostic virology, Physical and chemical manipulation of viruses.

UNIT II. Virus replication Strategies: Principal events involved in replication:
Adsorption, penetration, un coating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection. Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses. Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpes virus, Poliovirus, Influenza virus, VSV, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retro viruses. Sub viral pathogens: HDV, Prions, Viroids.

UNIT III. Pathogenesis of viral infection and control of viral diseases: Stages of infection, Patterns of some viral diseases- epidemiology, transmission, infection, symptoms, risk, transformation and onco genesis, emerging viruses. Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotype and DNA vaccines.

UNIT IV. Plant and microbial viruses: General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis

techniques, their assay and comparison of the sensitivity of assay methods; methods employed in identification of plant viruses and structural and functional genomics.

UNIT V. Symptoms of plant virus diseases, transmission of plant viruses, viral and viroid diseases and their control: General discussion on symptoms caused by viruses and viroids in diseased economically important trees and agricultural crops, and their control including development of virus disease resistant transgenics.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL17MIC	**Virology-Lab**	1

1. Study of typical compound microscope
2. Micrometry measurement of a fungal spore
3. Determination of cell density by counting chamber
4. Isolation of bacteria from soil, air and water
5, Isolation of fungi from soil
6. Contact slide technique
7. Streak and Pour plate techniques
8. Simple staining of a bacterium
9. Negative staining of a bacterium
10. Gram staining — Positive and negative

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ18MIC	**Medical Microbiology**	3

Unit 1: 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

Unit 2: Bacterial diseases

Diseases caused by certain bacterial pathogens *Staphylococcus aureus, Streptococcus pneumoniae, Mycobacterium tuberculosis, Salmonella typhi, Vibrio cholera*

Unit 3: **Viral diseases**

Diseases caused by certain viruses Human Immunodeficiency Virus, Hepatitis Virus, Influenza virus, Herpes virus

Unit 4: **Parasitic diseases**

Diseases caused by protozoa *Giardia* sp., *Plasmodium* sp., *Leshmania* sp., and *Entamoeba* sp.

Unit 5: **Pathogenic fungal disease I**

Dermatophytes- *Trichophyton, Microsporum*
Filamentous fungi causing subcutaneous infection by Mucor, *Rhizopus* and *Aspergillus*

Unit 6: Pathogenic fungal disease II

Systemic mycoses caused by Blastomyces, Histoplasma and Yeast like fungi: *Candida* and *Cryptococci*

Unit 7: **Antibiotics and Chemotherapeutics**

Historical development of chemotherapeutic and antibiotic substances, Major antimicrobial agents, Mode of action of chemotherapeutic and antibiotic substances.

Unit 8: **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

Reference Books:

1. Annadurai, A. A textbook of Immunology and Immuno technology. S. Chand
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 Medica lMicrobiology, Lang

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL18MIC	**Medical Microbiology-Lab**	1

PRACTICALS:

1. Antibiotic sensitivity assay
2. Slide based identification of the diseases caused by *Giardia* sp., *Plasmodium* sp., *Leshmania* sp., and *Entamoeba* sp.
3. Smear preparation and cellular study of skin, mouth

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJ19MIC	**Agriculture Microbiology**	3

Unit 1: 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, (oxidation pond, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

Unit 2: Microbial Bioremediation

Principle and degradation of common pesticides, organic (hydrocarbon, oil spills) and inorganic matter, biosurfactants.

Unit 3 : 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.

Unit 4: Biofertilizer

Definition, Types- Bacterial, Fungal, Phosphate solubilizer, BGA & associative; Mode of application; Advantages and Disadvantages.

Introduction and definition; Types of biopesticides; Integrated pest management (IPM); Mode of action; Factor influencing; Applications, advantages& disadvantages.

Reference Books:

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.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL19MIC	**Agriculture Microbiology-Lab**	1

- Specimen study of plant pathogens. Black rust of wheat, White rust of crucifer, Leaf curl of tomato Downy mildew, Red rot of sugarcane

Study of permanent slide and life materials

- *Cladosporium*
- *Helmithosporium*
- *Mucor*
- *Curvularia*
- *Alternaria*
- *Geotrichurn*
- *Trichoderma*
- *Rhizopus*
- Isolation of Rhizobium sp. from leguminous root nodule.

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

SEMESTER VIII

Subject Code	Subject title	Credit
MJ20MIC	**Techniques in Biology Chemistry, & Quantitative Methods**	3

Biological Chemistry

1. Introduction to measurements: balances and pipetting. Preparation of solutions of given normal it and its standardization.
2. PH meter: buffering capacity of a buffer, Indicators. To determinate the pKa value and hence the dissociation constant of a given acid by using pH meter.
3. Thin layer chromatography: lipids, mixture of dyes.
4. Spectrophotometry: Double beam and recording spectrophotometry
5. ELISA Reader and spectrophotometer: Estimation of protein by Lowry, Biuret and Brad ford methods, Analysis of standard curves, linear regression and assessment of ranges and reliability.
6. SDS-PAGE of proteins.
7. Microscopy: a) Simple, b) compound c) phase contrast microscopes.
8. Chlorophyll estimation

QUANTITATIVEMETHODS

1. Descriptive statistics: systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness (using calculations).
2. Correlations (product moment coefficient, Spearman's rank correlation coefficient) and regression (linear regression, curve fitting).
3. Testing of hypotheses: Tests of significance (mean, standard deviation, correlation coefficient).
4. Chi-squared test for goodness -of- fit, test for independence of attributes using calculators and printed tables and computers.
5. Design of experiments, A NOVA (one- way and two-way).

Reference Books:

1. Griffith, Introduction to genetic analysis, Freeman publication, 8thedition
2. Robert Broker, Genetics, Mc Graw Hill
3. Strick berger, Genetics, Prentice Hall Pub.
4. T. A. Brown, Gene Cloning DNA analysis- Black well Pub.
5. Stephen Hunt, Functional Genomics Oxford, Tokyo

RKDF UNIVERSITY RANCHI

B.Sc. Microbiology

Subject Code	Subject title	Credit
MJL20MIC	**Techniques in Biology Chemistry, & Quantitative Methods-Lab**	1

1. Analysis of oils, iodine numbers, saponification value, acid number
2. Enzyme assay, Enzyme Kinetics, specific activity, Determination of Km & Vmax, Optimum pH, Optimum Temperature of Amylase / Alkaline phosphatase / protease / cellulase
3. Studying comparative effect of Inhibitors on enzyme activity of Amylase/Alkaline phosphatase / protease / cellulose. Alkaline Phosphatase i.e., a) Competitive Inhibition (NaH2PO4,PNP) b) Uncompetitive Inhibition (L – Phenylalanine)
4. Separation of plant pigments by paper chromatography
5. Separation of Amino acids by thin layer chromatography
6. Isolation of chlorophyll and xanthophyll from spinach leaves

1.

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B.Sc. Microbiology

Branch	Subject title	Subject Code
AMJ01MIC	Bioinformatics and nanobiotechnology	3

BIOINFORMATICS

1. Bioinformatics: Introduction – genomics – transcriptome – proteome. Industrial Application of microalgae.
2. Biological databases: Generalized and specialized databases – DNA, protein and carbohydrate databases – nucleic acid sequence databases – premier institutes for databases – nucleic acid codes used in database formats; Collection and down loading of information from databases – literature search.
3. Sequence alignment and its evolutionary basis: Simple alignment and multiple sequence alignment - searching the database for sequence similarity – search programmes with special reference to FASTA, BLAST, CLUSTAL W. Application of bioinformatics in phylogenetic analysis.

NANO-BIOTECHNOLOGY

1.Introduction of Nanobiotechnology and its applications. Various types of nanomaterial utilized in agriculture.

2.Nanoparticles in agricultural and food diagnostics: Enzyme Biosensors and Diagnostics - DNABased Biosensors and Diagnostics, Radiofrequency Identification.

3.Nanotechnology in food production: Food and new ways of food production -Efficient fractionation of crops, Efficient product structuring -Optimizing Nutritional Values - Applications of Nanotechnology in Foods: Sensing, Engineering Food Ingredients to Improve Bioavailability - Nanocrystalline Food Ingredients – Nano-emulsions – Nano Engineered Protein Fibrils as Ingredient Building Blocks.

4.Nanotechnology in food packaging: Reasons to Package Food Products. Smart nanomaterials for packaging.

Reference Books:

1. Xiong, Essential Bioinformatics. Cambridge University Press.
2. Marketa J Zvelebil, Understanding Bioinformatics. Garland Science.
3. Shui Quing Ye, Bioinformatics: A practical Approach.
4. Anna Tramontano, Introduction to Bioinformatics
5. David W Mount, Bioinformatics. CBS
6. Mani K and Vijayaraj N, Bioinformatics. Kalaikathir Achchagam.
7. Augen Jeff, Bioinformatics in the post genomic era. Addison Wesley.
8. The 2018-2023 World Outlook for Nanobiotechnology Paperback – December 18, 2017, Icon group international.
9. Arunava Goswami and Samrat Roy Choudhury, Nanobiotechnology, Basic and Applied Aspects.
10. Clive Jarvis, Nanobiotechnology: An Introduction.
11. H B Singh, S Mishra, L F Fraceto, R D D Lima; Emerging Trends in Agri-Nanotechnology.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
AMJL01MIC	Bioinformatics and nanobiotechnology-Lab	1

PRACTICALS:

1. Search and Sequence retrieve from GenBank database.
2. Alignment of sequence by using tools: Clustal X, Clustal W, Mega and Bio edit.
3. Phylogenetic tree analysis by using Mega software.
4. Primer designing by using online tools.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
AMJ02MIC	**Microbial Biotechnology**	3

1. Fermentative production of industrial alcohol, uses, raw materials, microorganisms, inoculums preparation, preparation of wort, fermentation and recovery. Fermentative production of beer – Medium components, malt, malt adjuncts, hops, water. Preparation of wort, mashing, wort boiling, microorganism, inoculum preparation, fermentation, cold storage maturation, carbonation, packing and preservation. Principles of wine making – Fruit selection, picking, crushing, sulphite addition, processing, fermentation, aging and bottling.

2. Fermentative production of citric acid, uses, microorganism, inoculum preparation, medium preparation, fermentation, recovery and mechanism of citric acid production. Fermentative production of vitamin B12 – Uses, structure of vit-B12, microorganisms, inoculums preparation, medium preparation, fermentation and recovery. Fermentative production of glutamic acid – Uses, microorganism, inoculum preparation, production medium, fermentation and downstream processing

3. Antibiotics – Commercial production of benzyl penicillin, uses, microorganism, inoculums preparation, production medium, fermentation, recovery and semi synthetic penicillins. Fermentative production of tetracyclines-uses, chlortetracycline, oxy-tetracycline, tetracycline and semisynthetic tetracyclines, structures, microorganisms, inoculum preparation, production medium, fermentation and recovery methods.

4. Production and application of microbial enzymes. – Amylases and proteases, uses, microorganisms, inoculum preparation, production medium, fermentation and recovery, steroid transformations-substrates, typical structures, microorganisms, inoculum preparation,11-hydroxylation, process and recovery. Principles of vaccine

production and types of vaccines, Microbial biopesticides, microbial products from genetically modified organisms eg. insulin. Recent advances and applications in the field.

Reference Books:

1. Microbial Biotechnology: Progress and Trends (2017) 1st ed., Harzevili FD and Chen H, CRC Press; ISBN: 978-1138748699.
2. Microbial Biotechnology (2016) Cooper E, Syrawood Publishing House, ISBN: 978-1682860977.
3. Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases
   and Tools (2015). Nelson, KE Boston, MA, Springer US, ISBN: 978-1-4899-7479-2.
4. Microbial Biotechnology: Principles and Applications. Hackensack, (2013). 2nd ed. Lee, YK, World Scientific. ISBN: 978-981-256-676-8.
5. Comprehensive Biotechnology (2011) 3rd ed., Moo-Young, M, Elsevier, ISBN: 9780444640468.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
AMJL02MIC	**Microbial Biotechnology-Lab**	1

PRACTICALS:

1. Restriction analysis and DNA finger printing methods, RAPD, SSR etc.
2. To study the extraction of RNA from given sample
3. To study introduction to basic linux commands used in omics analyses.
4. To demonstration of NGS pipeline using publically available data for transcriptome analysis.
5. Identification of non-coding RNAs – a demonstration of pipeline.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
AMJ03MIC	**Fermentation and Bioprocess Technology**	3

Unit 1: Concept of Fermentation, Different types of fermentations-Batch, Fed-batch and continuous fermentation, An overview of submerged and solid state fermentations. Factors affecting fermentation; Bioreactor- structure and applications of a laboratory bioreactor; Different types of bioreactors like - Stirred tank reactor, air-lift, packed bed, fluidized and bubble column- their structure and applications; Multiphase bioreactor system.

Unit 2: Sterilization (medium and air)-thermal death kinetics of microorganisms; aeration, agitation and heat transfer in bioprocess. Microbial substrates, Media formulation and optimization; Microbial growth and kinetics. Monitoring of Bioprocesses: On line data analysis for measurement and control of important physicochemical and biochemical parameters, Computer based data acquisition, Techno-economic feasibility of bioprocess.

Unit 3: Isolation and characterization of industrially important Microorganisms; Generation of mutant strains for fermentation. Different approaches for strain improvement for fermentation. Concept of primary and secondary metabolites, Yield coefficient and efficiency. An overview of important products like antibiotic, biofuel, enzymes, An overview of recombinant proteins.

Unit 4: Biological mixture-composition and separation of different components of biological mixture-filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration; Purification of wild and recombinant proteins, Product polishing-drying; crystallization; storage and packaging. Recent advances and applications in the field.

Reference Books:

1. Bioprocess Engineering: Basic Concepts (2017) 3rd ed. Shuler, ML, and Kargi, F. Pearson Prentice Hall, ISBN: 0137062702.
2. Principles of Fermentation Technology (2016) 3rd ed. Stanbury P, Allan Whitaker, Stephen Hall. Imprint (Butterworth-Heinemann), ISBN: 9780080999531.
3. Biochemical Engineering Fundamentals (2013) 5th reprint J. E. Bailey and Ollis, D. F. McGraw Hill Education (India) Pvt Ltd., ISBN: 0070701237.
4. Bioprocess Engineering Principles (2013) 2nd ed. Doran, P.M, Academic Press, ISBN: 978-0-12-220851-5.
5. Bioreactors Analysis and Design (2011) Panda T, Tata McGraw Hill, ISBN: 978-0-07-070424-4.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
AMJL03MIC	**Fermentation and Bioprocess Technology-lab**	1

PRACTICALS:

1. To study the structure and functions of a stirred tank bioreactor.
2. To study the production of metabolites in submerged and solid state fermentations
3. To determine Volumetric Oxygen Transfer Coefficient (kLa) in fermentation system by dynamic method/sulphite method.
4. Comparative studies on the kinetics of free and immobilized enzymes/cells.
5. To study the production of biofuel/enzyme using lignocellulosic biomass.
6. Comparative study of batch, fed-batch and continuous fermentations

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B.Sc. Microbiology

Subject Code	Subject title	Credit
RC01	**RESEARCH METHODOLOGY**	4

1. Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - Understanding the language of Research - Concept, Construct, Definition, Variable. Research Process.

2. Problem Identification & Formulation - Research Question - Investigation Question - Measurement Issues - Hypothesis - Qualities of a good Hypothesis. Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.

3. Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

4. Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.

5. Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurementNominal, Ordinal, Interval, Ratio.

6. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the samplePractical considerations in sampling and sample size.

7. Data Analysis: Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chisquare test including testing hypothesis of association.

8. Interpretation of Data and Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

9. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.

10.**Use of tools I techniques for Research**: methods to search required information effectively, Reference Management Software like Zotero/ Mendeley, Software for paper formatting like LaTeX/ MS Office, Software for detection of Plagiarism

Reference Books :

1. Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th editions.
2. Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology- C. R. Kothari
4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
5. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
6. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

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Subject Code	Subject title	Credit
RC02	**RESEARCH PROPOSAL**	4

Process of writing a research proposal.

That includes the following points:

1. TITLE.
2. INTRODUCTION
3. REVIEW OF LITERATURE (BACKGROUND AND RATIONALE)
4. RESEARCH QUESTION(S) .
5. AIMS & OBJECTIVES
6. RESEARCH METHODOLOGY.
7. PLAN OF WORK
8. REFERENCE/BIBLIOGRAPHY.

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Subject Code	Subject title	Credit
RC03	**Research Report**	4

A research report is a reliable source to recount details about conducted research. It is most often considered to be a true testimony of all the work done to garner specificities of research. Research reports present the results of formal investigations into the properties, behavior, structures, and principles of material and conceptual entities. Almost any physical phenomenon or concept may be investigated in a research framework. The following are some key differences between formal research, and other less structured kinds of inquiry.

1. *Problem definition*: the rigorous reduction of the inquiry to a narrow question with a quantifiable answer. The most significant preliminary phase of research writing is that of effective problem definition. This process is one of identifying an interesting question and narrowing the research inquiry to a manageable size.
2. *Research approach*: the structuring of the research according to a methodology associated with a specialized field of inquiry. Specialized fields have research methodologies that are followed in investigating problems. These range from general methods of interviewing and literature researching to highly specialized procedures for using materials and mechanical devices to establish appropriate conditions for generating data. Adapting a sound research methodology to the investigation of your problem is a major milestone in the conduct of your inquiry.
3. *Research report*: the presentation of the research and its results in a rigorously formatted document that follows a conventional structure. In presenting your research, you pull all its elements together into a focused, coherent document. Research reports contain a standard set of elements that include.

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B.Sc. Microbiology

MINOR (I/ III/ V/ VII)

SEMESTER I

Subject Code	Subject title	Credit
MN01CHE	**Microbiology I**	4

Introductory Microbiology: - History of microbiology; Development of pure culture methods; Enrichment culture methods; Development of microbiology in the twentieth century. Methods of Microbiology: Isolation, pure culture techniques, staining of bacterial cells and its organelles, methods of sterilization-physical and chemical, selection and construction of culture media, enrichment culture technique, assay of amino acids and antibiosis. Microbial evolution, Systematics and Taxonomy: Evolution of earliest life forms, bacterial identification, nomenclature and classification

Microbial Diversity: - Prokaryotic cells**:** structure function: General structure and feature; cell wall of eubacteria, flagella, cell inclusions-endospore and gas vesicles. 2. Prokaryotic diversity: Bacteria; Brief account of all groups of bacteria and cyanobacteria, Rickettsias, Ohlamydias, and mycoplasma. 3. Archae: Archaebacteriaextremophilic microbes - their biotechnological potentials. 4. Viruses: Classification, morphology and composition of virus in general. 5. Bacteriophage: phi X174 cyanophage and retroviruses, viroids and prions.

Microbial growth and Physiology: The definition of the growth, growth curve, measurement of growth and growth yields, synchronous and continuous growth. Culture collection and maintenance of culture. Life style of Prokaryotes, Unicellular Eukaryotes 2. Overview of microbial nutrition: Types and mode of nutrition in bacteria. 3. Metabolic diversity among microorganisms: Photosynthesis in microorganisms, chemolithotrophy, sulphate reduction.

Practicals

1. Good labroratory practice in Microbiology and safety measures. Cleaning and sterilization of glassware and equipment's. Study of aseptic technique- preparation of cotton plug, wrapping of glassware, transfer of media and Inoculum.
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.

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.
4. Staining of bacteria
    a. Simple staining- methylene blue
    b. Gram's staining
    c. Acid fast staining
    d. Ziehl Neelsen staining
    e. Giemsa staining

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B.Sc. Microbiology

SEMESTER III

Subject Code	Subject title	Credit
MN03CHE	**Microbiology II**	3

Environmental Microbiology: -Microorganisms and their habitats Structure and function of ecosystem; Terrestrial environment: soil profile and soil micro flora; Aquatic Environment: micro flora of fresh water and marine habitats; Atmosphere: Aero micro flora and dispersion of microbes; Animal Environment: Microbes in/on human body (micro biomes) & animal (Ruminants) body; Extreme habitats: Extremophiles: Microbes thriving at high & low temperature, pH. High hydrostatic & osmotic pressures, salinity and low nutrient level; Microbial succession in decomposition of plant organic matter.

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: positive-negative interaction; Microbe-Animal interaction: positive-negative interaction.

Systematic Microbiology: Diseases caused by Gram positive cocci-sore throat, pneumonia etc., Diseases caused by Gram negative cocci- meningitis, gonorrhoea etc. Diseases caused by Gram positive bacilli- Tuberculosis, Diptheria, Tetanus, Gas gangrene etc, Diseases caused by Gram negative bacilli of Entrobacteriaceae- Enteric fever, Bacillary dysentery,UTI Diseases caused by Gram negative bacilli- Cholera, plague, Whooping cough, Wound infection, Septicaemia. Sexually transmitted diseases. Disease caused by mycoplasma, Chlamydia, Rickettsia.

Overview of medical Mycology virology: Important fungal diseases- Superficial, Subcutaneous, Systemic and opportunistic Mycosis. Overview of Medical Parasitology, Important Protozoan Diseases-Ascaris,Ankylostomiasis,Falariasis,Taeniasis, Echinococcosis etc. Important Viral DiseasesHerpesvirus,Po1iovirus,Rabies virus,Arboviruses,Hepatitis

Haematology: BasicHaematological Disorders- Classifiacation of Anemia,Iron Deficiency anemia,Mega1ob1asticAnemia, Haemolytic Anemia, Basic Haematological Techniques-Collection of Blood Specimens, Haemolysis of Blood, Separation of Serum and Plasma, Maintenance and Transport of Specimen, Coagulation and Bleeding Disorders in brief.

Practicals

1. Estimation of bacteria, actinomyceles and fungi in soil by dilution — Plating method.
2. Isolation and enumeration of major groups of microorganisms from rhizosphere and non-rhizosphere.
3. Study of root nodules and isolation of Rhizobium from legume root nodules.
4. Isolation of Azospirillum / Azotobacter.
5. Isolation of microorganisms of air by Petri plate exposure method.
6. BacterialConjunction
7. To perform test for antibiotics sensitivity by disc method. To determine the minimum inhibitory concentration of given antibiotics.
8. Preparation of blood smear.
9. To isolate serum from blood plasma.
10. To perform agglutination reaction to identification of blood group.

Reference Books

1. PelczarM.J.Chan, 5th Edition, Microbiology
2. Roger Y.Stanier, 5th Edition General microbiology
3. Powar&DaginawalaVol I &VolII,General Microbiology
4. Prescott L. M. Microbiology, 6th Edition
5. Atlas R.M. Microbiology
6. Jhonson ,Laboratory Experiments in Microbiology,6th Edition, Pearson Education
7. Harold J.Benson, Microbiological applications, 6th Edition
8. Singleton Sainsbury, Dictionary of Microbiology & Molecular Biology, John Wiley
9. R.C. Dubey&Maheshwari,A Textbook of Microbiology,1st Edn,2005.
10. Medical Microbiology, Anantnarayan
11. Nicklin, Instant Notes in Microbiology,2nd Edn

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B.Sc. Microbiology

SEMSESTER V

Subject Code	Subject title	Credit
MN05MIC	**Diversity of Plants, And Environmental Science**	3

DIVERSITY OF PLANTS

Unit 1: Microbes Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Oedogonium, Vaucheria, Ectocarpus, Polysiphonia. Economic importance of algae

Unit 3: Fungi Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi-General characteristics, ecology and significance, life cycle of Penicillium, Puccinia, Ustilago, Alternaria; Symbiotic AssociationsLichens: General account of Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4: Introduction to Archegoniate Identifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5: Bryophytes General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special reference to Sphagnum.

Unit 6: Pteridophytes General characteristics, classification, Early land plants Fossil and Fossilization process (Rhynia). Classification (up to family), morphology, anatomy and reproduction of Lycopodium, Equisetum and Pteris. Heterospory and seed habit, stelar evolution.

Unit 7: Gymnosperms General characteristics, classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. Ecological and economical importance.

ENVIRONMENTAL SCIENCE

Unit 1: Introduction to environmental studies Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

Unit 2: Ecosystems Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: Forest ecosystem Grassland ecosystem Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Natural Resources: Renewable and Non--renewable Resources Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state). Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4: Biodiversity and Conservation Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega--biodiversity nation; Endangered and endemic species of India.Threats to biodiversity: Habitat loss, poaching of wildlife, man--wildlife conflicts, biological invasions; Conservation of biodiversity: In--situ and Ex--situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5: Environmental Pollution Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Pollution case studies.

Unit 6: Environmental Policies & Practices Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International

agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and human wildlife conflicts in India.

Reference Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. 2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
2. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
5. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
6. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
7. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
8. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
9. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MNL05MIC	**Diversity of Plants and Environmental Science-Lab**	1

PRACTICALS:

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle. 2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
2. Gram staining.
3. Morphology and structural details of forms belonging to Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperm prescribed in the syllabus and their temporary/permanent stained microscopic slide preparation and studies.
4. Comments upon the spots
5. Viva-voce
6. Field study report
7. Class records, Herbarium, Charts, Model etc. 9. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, hygrometer, rain gauge and lux meter.

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B.Sc. Microbiology

Subject Code	Subject title	Credit
MN07MIC	**Food Microbiology**	3

Unit 1: Introduction to food & nutrition.

History, Development and Scope of food microbiology; Concept of food and nutrients; Physiochemical properties of food; Importance and types of 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.

Unit 2: Microbial spoilage of various foods

Principal; Spoilage of vegetables, fruits, meats, eggs, milk and butter, bread, canned foods.

Unit 3 : Microbial examination of food

DMC, viable count, examination of faecal Streptococci. Food quality monitoring, Biosensors and Immunoassays.

Unit 4: Food Preservation

Basic Principles, Methods (heating, freezing, dehydration, chemical preservatives, radiation). Modern technologies in food preservation, Packaging material.

Unit 5: Fermented foods:
Fermented dairy products (cheese, butter, yoghurt), Kefir; Other Fermented

foods- Soya sauce, Saurkraut, Dosa, Tempeh; Probiotics: health benefits, types of microorganisms used, probiotic foods available in market.

Unit 6 : 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, pasteurization sterilization and dehydration.

Unit 7 : Food sanitization and control

HACCP, Indices of food sanitary quality and sanitisers; Microbiological quality standard of food

Reference Books:

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

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B.Sc. Microbiology

Branch	Subject title	Subject Code
MNL07MIC	**Food Microbiology-Lab**	1

PRACTICALS:

- **Microbial Ecology:** Food safety depends on understanding what conditions encourage microbial growth and what inhibits it.
- **Pathogens – Gram-negative:** The FDA/USDA are hustling to better understand Shiga-toxin producing E. coli (STEC) and Salmonella.
- **Pathogens – Gram-positive:** *Listeria monocytogenes* has plagued many food manufacturers. We focus on ecology and control.
- **Spoilage:** Yeast and mold are major culprits in food spoilage. Learn how to detect and identify them in food processing facilities.
- **Current Food Safety Issues:** Get the latest on the worst outbreaks to hit the news and consumers' GI tracts.
- **Testing:** A good test done wrong can be more dangerous than no testing at all. Know the uses and abuses of microbial testing.
- **Predictive Models and Quantitative Risk Assessment:** Tools of quantification are continually expanding in power and applicability.

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