RKDF UNIVERSITY RANCHI

SYLLABUS

B.SC. BIOTECHNOLOGY

NEP 2020

From Academic Year 2025 onwards

RKDF UNIVERSITY RANCHI

SEMESTER I

Subject Code	Subject title	Credit
MJ01BIO	**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
MJL01BIO	**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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SEMESTER II

Subject Code	Paper Name	Credit
MJ02BIO	**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. Biotechnology

Subject Code	Paper Name	Credit
MJL02BIO	**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. Biotechnology

Subject Code	Subject title	Credit
MJ03BIO	**Biochemistry & Metabolism**	3

UNIT I: Introduction to Biochemistry

A historical perspective.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT II Lipids:

Structure and functions, classifications,Nomenclature, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol

UNIT III Nucleic Acids:

Nucleic acids: Structure and functions: Physical & chemical p Nucleosides & Nucleotides, purines & pyrimidines, biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z renaturation of DNA

UNITIV Enzymes:

Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilicarchaea and bacteria.Role of: NAD Thiamine pyrophosphate, Pyridoxalphosphate,lipoic and metallic ions, Biotin,Vit B 12.

UNIT V Carbohydrates Metabolism:

Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, TCA, ETC,Glycogenolysis and Oxidative phosphorylation.ß-oxidation of fatty acid

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman andCo.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co.Ltd

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B.Sc. Biotechnology

Subject Code	Paper Name	Credit
MJL03BIO	**Biochemistry& Metabolism-Lab**	1

PRACTICALS:

Good laboratory practice in Biotechnology 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 Inoculums

- 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 buffers.
- Separation of Amino acids by paper chromatography
- Qualitative tests for Carbohydrates, lipids and proteins •
- Study the effect of temperature and organic solvents on semi permeable membrane.
- Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.

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SEMESTER III

Subject Code	Subject title	Credit
MJ04BIO	**Mammalian Physiology**	3

UNIT I:

Digestion and Respiration Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O_2 , CO_2 , Chloride shift, Oxygen dissociation curve.

UNIT II:

Circulation Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT III:

Muscle physiology and osmo regulation Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation

Unit 4.

Nervous and endocrine coordination Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitter Mechanism of action of hormones (insulin and steroids) Description of different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid, adrenal gland.

Reference Books

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. HercourtAsia PTE Ltd. /W.B. SaundersCompany
2. Tortora, G.J. & Grabowski, S, (2006). Principles of anatomy and physiology. XI Editions; John Wiley & sons Inc.

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B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJL04BIO	**Mammalian Physiology -Lab**	1

PRACTICALS:

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

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Subject Code	Subject title	Credit
MJ05BIO	**Plant Physiology**	3

UNIT I:

Plant water relations and micro &macronutrients Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening &closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT II:

Carbon and nitrogen metabolism Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT III:

Growth and development Growth and development: Definitions, phases of growth, growth curve, (auxins, gibberlins, cytokinins, abscisic acid, ethylene)- Physiological role and action. Process and types of seed dormancy. periodism and vernalization

UNIT IV:

Glycolysis, preparatory and pay-off phases, Fermentation. Kreb's cycle, electron transport chain, oxidative phosphorylation, chemiosmotic hypothesis, balance sheet of ATP yield, Respiratory quotient, respiratory inhibitors. Growth and maintenance respiration.

UNIT V:

Enzyme characteristics, classification, specificity of enzymes, Mechanism of action of enzymes, enzyme kinetics, Factors affecting enzyme activity, Enzyme inhibitors.

Reference Books:

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA. 2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
2. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
3. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
4. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/ Cummings Publisher, USA.
5. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4 edition, W.H. Freeman and Company, New York, USA.
6. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co.Ltd.
7. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 edition, Sinauer Associates Inc .MA,USA

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B.Sc. Biotechnology

SEMESTER IV

Subject Code	Subject title	Credit
MJ06BIO	**Industrial Biotechnology**	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. Biotechnology

Subject Code	Subject title	Credit
MJL06BIO	**Industrial Biotechnology-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. Biotechnology

Subject Code	Subject title	Credit
MJ07BIO	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. Biotechnology

Subject Code	Subject title	Credit
MJL07BIO	**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. Biotechnology

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.

Unit7: 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. Biotechnology

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. Biotechnology

SEMESTER V

Subject Code	Subject title	Credit
MJ09BIO	**Gene based Diagnosis and Therapy**	3

History of human genetics

Autosomal dominant inheritance (HD, MD, CDD etc), Autosomal recessive inheritance (SCA, CF, etc), Sex linked and mitochondrial (DMD, hemophilia, LHON), PKU, Alzheimer, Parkinsonism, Tay-Sachs, Mongolism, Cri-du-chat, Edwards, X and Y chromosomal, Prenatal and Postnatal studies, Chromosome analysis

Genetic mapping

Haplotype, Physical and Cytogenetic mapping, SNP, RFLP, TRE, PCR-OLA, SSCP, RAPD

Gene environment interaction in complex diseases

Genetics of Alzheimer's disease- Causative genes for familial Alzheimer's disease (APP, PSEN1, PSEN2)-Alzheimer's disease susceptibility genes (APOE, BACE1, BACE2, NCSTN, PEN2, SORL1), Environmental factors in Alzheimer's disease pathogenesis, Genetics of Parkinson's disease-Causative genes for familial Parkinson's disease susceptibility genes, Environmental factors in Parkinson's disease pathogenesis, Genetics of Amyotrophic lateral sclerosis-Causative genes for familial Amyotrophic lateral sclerosis-Amyotrophic lateral sclerosis susceptibility genes and Environmental factors Amyotrophic lateral sclerosis pathogenesis, Role of environment on epigenetics of neurodegenerative diseases, Teratology, Molecular genetics of coronary heart disease, Schizophrenia, Diabetes mellitus.

Identifying human disease genes

General gene therapy strategies, Targeted killing of specific cells, Targeted mutation correction, Targeted inhibition of gene expression. Gene replacement therapy by viral vectors: Oncovirus, Lentivirus, Adenovirus, Adeno associated virus, Herpes Simplex virus, Naked DNA or direct injection or particle bombardment-gene gun, Liposome mediated DNA transfer, Receptor mediated endocytosis, Repair of mutations in situ through the cellular DNA repair machinery, Antisense induced exon splicing, In-utero fetal gene therapy

Gene blocking therapies

Gene Knockouts, Gene disruption-p53, prion diseases, immunological, short RNA, Gene therapy for non-inheritable diseases, stem cell therapy, somatic cell gene therapy and germ line gene therapy

Gene therapy: problem, solutions and future prospects

Controversial issues in medical genetics

In vitro fertilization, Prenatal sex determination, Surrogate therapy, Genetic counselling, Germ line gene therapy, ELSI, NBAC, IPR, Patenting, Human transgene

Reference Books:

1. Human Molecular Genetics- Tom Strachan
2. Concepts of Genetics- William s. Klug
3. Emery's Elements of Medical Genetics- Robert F. Mueller & Ian D. Young

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B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJL09BIO	**Gene based Diagnosis and Therapy -Lab**	1

PRACTICALS:

1. Total RNA extraction & quantification.
2. Southern hybridization of the bacterial genome with the non-radioactive probe.
3. DNA fingerprinting using RFLP method
4. Single Nucleotide polymorphism analysis
5. Amplification of human gene with specific primer by PCR technique and analysis by agarose gel electrophoresis.
6. Demonstration of cloning of genomic DNA in standard plasmid vectors & measurement of gene expression using a reporter assay

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B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJ10(BIO)	**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. Biotechnology

Subject Code	Subject title	CREDIT
MJL10BIO	**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. Biotechnology

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.

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

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. Biotechnology

Subject Code	Subject title	Credit
B.Sc. Biotechnology	**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 Biotechnology, 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 Biotechnology, 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. Biotechnology

SEMESTER VI

Subject Code	Subject title	Credit
MJ12BIO	**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. Biotechnology

Subject Code	Subject title	Credit
MJL12BIO	**Immunology- Lab**	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. Biotechnology

Subject Code	Subject title	Credit
MJ13BIO	**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. Biotechnology

Subject Code	Subject title	Credit
MJL13BIO	**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. Biotechnology

Subject Code	Subject Title	Credit
MJ14(BIO)	**Biophysics & Bio techniques**	**3**

1. Bio-techniques Basic Techniques Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

2. Spectroscopy Techniques: UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

3. Chromatography Techniques: TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

4. Electrophoretic techniques: Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

5. Centrifugation: Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge –Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

6. Radioactivity Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radio immunoassay

7. Advanced Techniques: Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

Essential Readings

• Lenhinger. Principles of Biochemistry, Nelson & Cox, 4thEdition.
• Stryer – Biochemistry. W.H. Freeman & Co.
• Plumner. An introduction to practical Biochemistry, 3rd Edition
• J. Jayraman. Lab Manual in Biochemistry.
• Cohn and Stumph. Outline of Biochemistry. Wiley eastern.
• Zube's Biochemistry.4th Edition Macmillan.
• Switzer and Garrity. Experimental Biochemistry WH Freeman. 2nd Edition

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJL14(BIO)	**Biophysics & Bio techniques -Lab**	1

1. Protein Purification Studies of different proteins/enzymes.
2. SDS PAGE and Native Gel

a. CBB – R250 staining technique

b. Silver staining technique

2. Gel Filtration Chromatography
3. Ion Exchange Chromatography: Purification of proteins/enzymes using CM

a. Cellulose / DEAE Cellulose.

b. Induction of Protein synthesis in E. coli cells.

c. Determination of Tm value of nucleic acid

4. Determination of % G + C content
5. The ultraviolet absorption of proteins and amino acids
6. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis- spectrophotometer and validating the Beer- Lambert's law
7. Protein Folding Studies.

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJ15BIO	**Recombinant DNA Technology**	3

UNIT I.

Basics of DNA cloning: Simple cloning and cloning using linkers and adaptors. Cloning vectors — plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

UNIT II.

Methods of DNA and protein analysis: Isolation and purification of DNA. Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes.RFLP analysis. DNA fingerprinting and itsapplication. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins.Western Blottinganalysis.

UNIT III

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR.Designing primers. Long PCR, Inverse PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and Taq Manprobes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms.

UNIT IV

.Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization.

UNIT V.

Genome sequencing: DNA sequencing by Sanger's method — traditional and cycle sequencing. Physical mapping by restriction fragment fingerprinting of BAC clones. Whole genome shotgun sequencing. Clone-by-clone shotgun sequencing of genome — preparation of BAC/YAC library, map construction, random shotgun phase, finishing phase and sequence authentication. Genome annotation at the nucleotide level, protein level and process level. Comparative genome sequencing of micro-organisms to identify and categorize SNPs. Array CGH

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJL15BIO	**Recombinant DNA Technology -Lab**	1

1. Replica of plating techniques
2. Agarose gel electrophoresis and restriction mapping of DNA
3. Demonstration of techniques of PCR
4. Isolation of Genomic DNA from bacterial cell / plantcell
5. Isolation of RNA from Yeastcells
6. Determination of Tm values of DNA

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

SEMESTER VII

Subject code	Subject title	Credit
MJ16BIO	**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. Biotechnology

Subject Code	Subject title	Credit
MJL16(BIO)	**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. Biotechnology

Subject Code	Paper Name	Credit
MJ17BIO	**Biotechnology and Human Welfare**	3

UNIT 1

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation

UNIT II

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock

UNIT III

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV

Forensic science: e.g. solving violent crimes such as murder, rape; solving claims of paternity and theft etc. using various methods of DNA finger printing

UNIT V

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E.coli, human genome project.

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Paper Name	Credit
MJL17BIO	**Biotechnology and Human Welfare -Lab**	1

PRACTICALS:

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolicfermentaion using Baker's yeast
2. Study of a plant part infected with amicrobe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJ18BIO	**Animal Biotechnology**	3

Group - A

1. Structure and organization of animal cell
2. Equipment and materials for animal cell culture technology
3. Primary and established cell line culture
4. Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon dioxide, role of serum and supplements.
5. Serum and protein free defined media and r their application.
6. Biology and characterization of the cultured cell, measuring parameters of growth.
7. Basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.
8. Scaling - up of Animal cell culture.
9. Cell synchronization.

Group - B

1. Cell cloning and micromanipulation.
2. Cell transformation.
3. Application of animal cell culture - special secondary metabolites/products (insulin, Human Growth Hormones, Interferons, t-plasminogen activator, Factor VIII etc.), Hybridoma technology.
4. Stem cell cultures, embryonic stem cells and their applications
5. Cell culture based vaccines
6. Transgenic animal

Essential Readings

• Freshney, Culture of animal Cells, Sixth Edition

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJL18(BIO)	**Animal Biotechnology** -Lab	1

1. Total count of RBC & WBC differential count &Blood grouping
2. Western Blotting
3. Isolation & staining of Mitochondria
4. Blood film preparation and identification of cells.
5. Demonstration of Immunological reaction (WIDAL, VDRL Pregnancy, Hepatitis)

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJ19(BIO)	**Plant Biotechnology**	3

Group A

1. History of plant tissue culture and its present status.
2. Introduction to Cell and tissue culture technique to produce novel plant and hybrids.
3. Tissue culture media (composition and preparation)
4. Phyto hormones a) Chemical nature, biosynthesis, physiological roles and mode of action of Auxins, Gibberellins and Cytokinnins b) Chemical nature and physiological roles of Morphactin, Abscisic acid and Ethylene.

Group – B

1. Initiation and maintenance of callus and suspension culture; singe cellclones.
2. Organogenesis, somatic embryogenesis; transfer and establishment of whole plants insoil.
3. Shoot- tip culture: Rapid clonal propagation and production of virus -freeplants.
4. In vitro pollution, Embryo culture, embryo rescue and syntheticseeds.

Group - C

1. Anther, Pollen and Ovary culture for production of haploid plants and homozygous lines; endospermculture.
2. Protoplast isolation, culture and fusion: selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
3. Nuclear cytology of cultured plant cells and somaclonalvariation.
4. Cryopreservation, slow growth and DNA banking for germplasm conservation.

Group - D

1. Plant transformation technology; basis of tumor formation, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri plasmids as vectors, co-integrative and binary vectors, use of reporter genes, particle bombardment, electroporation, microinjection transformation of monocots.
2. Transgenic plants: insect resistance, virus resistance, resistance to fungal and bacterial diseases, longer shelf life, malesterility.

3. Metabolic engineering and industrial products: Important plant secondary metabolites, control mechanisms and manipulation.
4. Concept of Phyto immunity.

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

Subject Code	Subject title	Credit
MJL19(BIO)	**Plant Biotechnology-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 callus culture
8. Protoplast Isolation &Culture
9. Production of Haploids by anther culture
10. Agro bacterium mediated gene transfer and reporter geneassay
11. In vitro evaluation of Medicinal plants against pathogenic microbes
12. Role of Microorganisms in elevation of heavy metal induced stress in plants

RKDF UNIVERSITY RANCHI

B.Sc. Biotechnology

SEMESTER VIII

Subject Code	Subject title	Credit
MJ20(BIO)	**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. Biotechnology

Subject Code	Subject title	Credit
MJL20BIO	**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

RKDF UNIVERSITY, RANCHI
B.SC. BIOTECHNOLOGY

Subject Code	Subject title	Credit
AMJ01(BIO)	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.

Subject Code	Subject title	Credit
AMJ01L(BIO)	**BIOINFORMATICS AND NANOBIOTECHNOLOGY**-LAB	3

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.

Subject Code	Subject title	Credit
AMJ02(BIO)	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 andrecovery. Fermentative production of glutamic acid Uses, microorganism, inoculums preparation, production medium, fermentation and downstream processing

3. Antibiotics Commercial production of benzyl penicillin, uses, microorganism,inoculums preparation, production medium, fermentation, recovery and semisynthetic 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.

Subject Code	Subject title	Credit
AMJL02(BIO)	MICROBIAL BIOTECHNOLOGY-LAB	3

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.

Subject Code	Subject title	Credit
AMJ03(BIO)	MOLECULAR DIAGNOSTICS	3

UNIT I

Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histo chemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idio types. Antiidio types and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

Reference Books:

1. Bioinstrumentation, Webster
2. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott. Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

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Subject Code	Subject title	Credit
AMJL01(BIO)	**MOLECULAR DIAGNOSTICS -LAB**	1

PRACTICALS:

1. Preparation of solutions for Molecular Biologyexperiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysismethod
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Differential leucocytes count
7. Total leucocytes count
8. Total RBC count
9. Haemagglutination assay
10. Haemagglutination inhibition assay
11. Separation of serum from blood

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 Encyclopaedias, 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.

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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Subject Code	Subject title	Credit
MN0ICHE	**MINOR (CHEMISTRY)**	3

(A)Inorganic Chemistry-I

1. Atomic Structure:

Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, deBroglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

2. Quantum mechanics:

Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations

3. Chemical Bonding and Molecular Structure:

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-pmixing) and heteronuclear diatomic molecules such as CO, NO and NO+ Comparison of VB and MO approaches.

(B) Organic Chemistry

1. Fundamentals of Organic Chemistry: Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

2. Stereochemistry: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

3. Aliphatic Hydrocarbons: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

4. Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

5. Alkenes: Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

6. Alkynes: Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions:formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4.

Books Suggested:

1. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.

2. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.

3. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall. 4. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chan

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Subject Code	Subject title	Credit
MNL01(CHE)	**MINOR (CHEMISTRY)-LAB**	1

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO4.
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
4. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.
5. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).
6. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

Books Suggested:

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

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Subject Code	Subject title	Credit
MN03CHE	**CHEMISTRY**	3

(A) Physical Chemistry-I

1. Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

2. Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG_o, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases.

3. Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

(B) Organic Chemistry-I

1. Aromatic hydrocarbons:

benzene

sulphonic acid.

Reactions of benzene: Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation). Side chain oxidation of alkyl benzenes.

2. Alkyl Halides:

Types of Nucleophilic Substitution (S_{N1}, S_{N2} and S_{Ni}) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

3. Aryl Halides

Preparation of chloro, bromo and iodo-benzene: from phenol, Sandmeyer & Gattermann reactions.

Reactions of Chlorobenzene: Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

4. Alcohols:

Preparation: Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation Diols: oxidation of diols. Pinacol-Pinacolone rearrangement.

5. Phenols:

Preparation: Cumene hydroperoxide method, from diazonium salts.

Electrophilic substitution reactions: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction

6. Ethers

Aliphatic and Aromatic Ethers: Cleavage of ethers with HI.

7. Aldehydes and ketones

Aliphatic: Formaldehye, acetaldehyde and acetone Aromatic: benzaldehyde

Preparation: from acid chlorides and from nitriles.

Reactions –With HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction, Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Books Suggested:

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.

2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.

3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.

4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.

5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).

7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).

8. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).

9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).

10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

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Subject Code	Subject title	Credit
MNL03(CHE)	**Chemistry-Lab**	1

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
7. Preparation of buffer solutions: Sodium acetate-acetic acid /Ammonium chloride-ammonium hydroxide.
8. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
9. Determination of melting and boiling points.
10. Synthesis and determination of yield: (a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols

Books Suggested:

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

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Subject Code	Subject title	Credit
MN05BIO	**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.

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.

3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.

4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.

6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

9. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.

10. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.

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Subject Code	Subject title	Credit
MNL05(BIO)	**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. Vive-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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Subject Code	Subject title	Credit
MN07BIO	IPR, Patents and Biotechnological Entrepreneurship, Biosafety	3

Biodiversity

Definition, Historical and geographical causes for diversity; Genetic diversity, Molecular diversity; Species and population biodiversity; Quantifying biodiversity; Maintenance of ecological biodiversity; Biodiversity and centers of origins of plants; Biodiversity hot spots in India; Collection and conservation of biodiversity.

Assessment and documentation of biodiversity

Assessing, analyzing and documenting biodiversity; Morphological and molecular characterization of biodiversity; Vulnerability and extinction of biodiversity; Introduction to biodiversity data base: endangered plants, endemism and Red Data Books; Global biodiversity information system.

IPR, Bioethics and Patents

Intellectual property rights (IPR), sovereignty rights, CBD; Bioethics and patenting; General agreement on trade and tariffs; Indian sui-generis system for plant variety and farmer's rights protection nact.

Biotechnology Entrepreneurship

Introduction and scope in Bio-entrepreneurship, Types of bio-industries, Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in Biotechnology. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India), strategic dimensions of patenting & commercialization strategies; Quality control & transfer of technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliance sand procedures (CDSCO, NBA,GCP, GMP).

Biosafety

Definition, Requirement; Biosafety and biodiversity; Biosafety for human health and environment; Social and ethical issues; Biosafety in relation to transgenic research of applications, regulatory bodies and bio safety guidelines.

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Subject Code	Subject title	Credit
MNL07(BIO)	**IPR,PATENTS AND BIOTECHNOLOGICAL ENTREPRENEURSHIP, BIOSAFETY-LAB**	1

1. Agro bacterium mediated gene transfer and reporter geneassay
2. In vitro evaluation of Medicinal plants against pathogenic microbes
3. Role of Microorganisms in elevation of heavy metal induced stress inplants
4. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
5. Isolation of fungi from soil by warcup's method.
6. Isolation of azotobacter species from soil.
7. Isolation of microorganism from rhizosphere.
8. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression meth